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The global fatty liver disease Sustainable Development Goal country score for 195 countries and territories

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Abstract

Background and Aims: Fatty liver disease is highly prevalent, resulting in overarching wellbeing and economic costs. Addressing it requires comprehensive and coordinated multisectoral action. We developed a fatty liver disease Sustainable Development Goal (SDG) country score to provide insights into country-level preparedness to address fatty liver disease through a whole-of-society lens.

Approach and Results: We developed 2 fatty liver disease–SDG score sets. The first included 6 indicators (child wasting, child overweight, noncommunicable disease mortality, a universal health coverage service coverage index, health worker density, and education attainment), covering 195 countries and territories between 1990 and 2017. The second included the aforementioned indicators plus an urban green space indicator, covering

Abbreviations: GBD, Global Burden of Disease; HDI, Human Development Index; NCD, noncommunicable disease; SDG, Sustainable Development Goal; UGS, urban green space; UHC, universal health coverage; UI, uncertainty interval.

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60 countries and territories for which 2017 data were available. To develop the fatty liver disease–SDG score, indicators were categorized as "positive" or "negative" and scaled from 0 to 100. Higher scores indicate better preparedness levels. Fatty liver disease–SDG scores varied between countries and territories (n = 195), from 14.6 (95% uncertainty interval: 8.9 to 19.4) in Niger to 93.5 (91.6 to 95.3) in Japan; 18 countries and territories scored > 85. Regionally, the high-income super-region had the highest score at 88.8 (87.3 to 90.1) in 2017, whereas south Asia had the lowest score at 44.1 (42.4 to 45.8). Between 1990 and 2017, the fatty liver disease–SDG score increased in all super-regions, with the greatest increase in south Asia, but decreased in 8 countries and territories.

Conclusions: The fatty liver disease–SDG score provides a strategic advocacy tool at the national and global levels for the liver health field and noncommunicable disease advocates, highlighting the multisectoral collaborations needed to address fatty liver disease, and noncommunicable diseases overall.

INTRODUCTION

Fatty liver disease refers to a range of conditions in which excess fat builds up in the liver and is largely unknown among the general population,[1] health policy makers, and the global public health community.[2] This potentially serious condition is estimated to affect about one in 3 adults globally[3] and is increasingly problematic in children and adolescents.[4–6] Disease severity is measured through the degree of fibrosis; however, population-based estimates of advanced fibrosis associated with fatty liver disease are limited. Data from Germany have shown it to be around 1%,[7] whereas a Korean study estimated it at 2.6%.[8] A review of studies in patients at risk of clinically significant liver disease in a general population setting found that the prevalence of advanced liver fibrosis ranged between 0.9% and 2.0%, and cirrhosis between 0.1% and 1.7%.[9] Fatty liver disease, and particularly the more aggressive condition NASH, have a substantial impact on individual health,[10] burdening health systems, causing substantial economic encumbrance, and increasing wellbeing costs.[11]

Beyond being a leading cause of cirrhosis[12] and liver cancer,[13,14] fatty liver disease shares a close bidirectional relationship with other highly prevalent noncommunicable diseases (NCDs), most notably cardiovascular disease, type 2 diabetes mellitus, obesity, and nonhepatic cancers.[15–17] In the majority of patients, fatty liver disease emerges in the context of metabolic syndrome.[17] Although fatty liver disease is strongly associated with obesity,[18] it is still prevalent in nonobese individuals, especially those of Asian descent.[19] As a consequence of the lack of overall awareness about the condition, fatty liver disease continues to go largely undiagnosed among the general population,[20] even among some high-risk populations, like people diagnosed with type 2 diabetes mellitus.[21] Furthermore, fatty liver disease is asymptomatic until the occurrence of severe complications, making it difficult to identify the disease[20] and implement treatment and care interventions, such as lifestyle modification.

Much like the other major public health challenges of the 21st century, fatty liver disease requires systems thinking alongside multidisciplinary and multisectoral responses[22] that address the immediate and underlying determinants of the disease. Yet, despite the scale of the challenge posed by fatty liver disease, health system and public health responses have generally been weak and fragmented.[2,23,24] A 2020 study captured data on NAFLD-related policies and guidelines in 102 countries, creating a NAFLD preparedness index that characterized the health system and public health responses in the participating countries. The study found that no country had a written strategy to address the disease and, in most countries, NAFLD was absent within strategies and guidelines for related conditions, including obesity and diabetes.[2] To fill the dearth of strategic guidance, a consortium of 218 experts from 91 countries recently developed NAFLD consensus statements and recommendations to advance public health and policy agendas.[25]

Although health systems sit at the center of efforts to address the burden of fatty liver disease, tackling this public health challenge will require action well

beyond the health sector. To help the public health community and those across other sectors to conceptualize the design of whole-of-society responses to fatty liver disease, we published a NAFLD–Sustainable Development Goal (SDG) framework.[26] The SDGs serve as the mainstay of the 2030 Agenda for Sustainable Development, with clear priorities, from reducing social and economic inequalities to improving nutrition, health, and education, and were adopted by all United Nations member states in 2015. Using the SDGs as a multisectoral framework for action,[27] a multidisciplinary group followed a standard Delphi process to identify the targets and indicators that are most relevant to NAFLD, with the final framework including 7 indicators. The framework is intended as a strategic advocacy tool to build the case for closer collaboration within and between sectors, to address fatty liver disease and other NCDs. Similar work has been undertaken to develop a framework to inform policy approaches on sustainable development and urban health[28] and to highlight the importance of addressing obesity for achieving the SDG agenda.[29]

Here, we present the development of the first fatty liver disease–SDG score, covering 195 countries and territories from 1990 to 2017. The fatty liver disease–SDG score builds on the earlier framework to provide a multisectoral lens through which to view country-level preparedness to address the challenge of fatty liver disease, and to guide future health and development sector collaboration and action on this issue.

METHODS

NAFLD Sustainable Development Goal framework

The NAFLD–SDG framework underpinning the fatty liver disease–SDG score was developed through a Delphi process. First, a core team of researchers reviewed the SDG targets and indicators,[30] identifying those directly or indirectly associated with NAFLD. Subsequently, a multidisciplinary group of experts (n = 15) was invited to select which of the shortlisted targets and indicators to include in the NAFLD–SDG framework. Targets and indicators with 75% or greater agreement were included in the final NAFLD–SDG framework, with this framework comprising 16 targets and 7 indicators (Figure 1). The detailed methodology has been published.[26]

Development of the fatty liver disease Sustainable Development Goal score

The indicators included in the fatty liver disease–SDG score are shown in Table 1. We developed 2 sets of fatty liver disease–SDG scores. The first set was developed using 6 indicators [child wasting, child overweight, NCD mortality, a universal health coverage (UHC) service coverage index, health worker density, and education attainment] and excluded the urban green space (UGS) score as it was not available for all countries and territories. It covers 195 countries and territories between 1990 and 2017. The second set was constructed using all 7 indicators and includes only the 60 countries for which the UGS data were available in 2017.

The estimates for child wasting, child overweight, NCD mortality, the UHC service coverage index, health worker density, and education attainment came from the "Global Burden of Disease (GBD), Injuries, and Risk Factors Study."[31–33] Details of the input data and modeling procedures for estimating these indicators have been published.[34] The data for UGS were extracted from a published study conducted by Kwon et al.[35] UGS is a globally comparable metric computed using Sentinel-2 satellite imagery data.[36]

We took an analytical approach similar to the GBD's health-related SDG index to develop the fatty liver disease–SDG score. First, indicators were grouped into either a "positive" or "negative" category. The "positive" category consisted of indicators where higher estimates were associated with better health outcomes (eg, UHC service coverage index). The "negative" category consisted of indicators where lower estimates were associated with better health outcomes (eg, child wasting).

Then, all indicators were scaled from 0 to 100, with 0 denoting the worst observed performance and 100 reflecting the best performance, to make them comparable. To reduce the sensitivity of extreme outliers in a given location-year, we set the lower bound at the 2.5th percentile and the upper bound at the 97.5th percentile of the distribution for a given indicator. For "positive" indicators, any value below the 2.5th percentile was assigned a value of 0 and any value exceeding the 97.5th percentile was assigned a value of 100. The "negative" indicators were scaled and adjusted for outliers similarly but with 0 assigned to any value exceeding the 97.5th percentile and 100 assigned to any value below the 2.5th percentile, over the same study period. A modified scaling approach was applied to 2 indicators: NCD mortality and health worker density. Specifically, NCD mortality was scaled in log-space. Health worker density was scaled to reflect the density of each health worker cadre (ie, physicians, nurses, midwives, and pharmacists). The details of the modified scaling approach for health worker density have been published.[34]

The final fatty liver disease–SDG score was calculated in 2 steps. First, we computed the geometric mean of child wasting and child overweight,

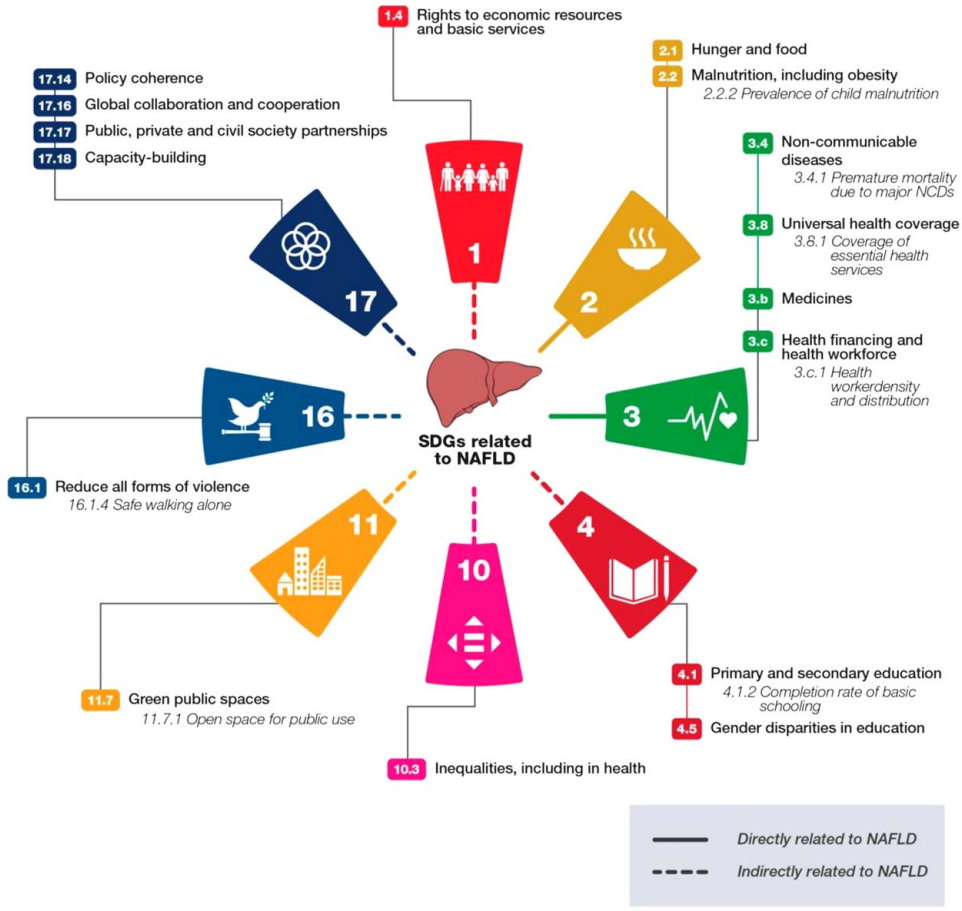

FIGURE 1 NAFLD–SDG framework. The NAFLD–SDG framework shows the SDG targets and indicators that are most relevant to NAFLD. The 8 colored segments indicate the selected targets and the 7 selected indicators are nested within 5 of these targets. Solid lines indicate targets with a direct link to NAFLD and dashed lines show those indirectly related to NAFLD. Abbreviations: NCD, noncommunicable disease; SDG, Sustainable Development Goal.

2 indicators that fall under the same SDG target.[34] Then, we computed the geometric mean of the remaining indicators, including the aggregate child wasting and child overweight score. In both steps, we restricted draws of each indicator score to a minimum value of 1 before computing the geometric mean to mitigate issues with values close to 0. To generate the fatty liver disease–SDG score for the 7 standard GBD super-regions,[37] we aggregated the national-level, unscaled estimates of each indicator for each super-region, using population weights. Then, the national-level 2.5th and 97.5th percentile values for each indicator were applied to scale the indicators for each super-region location, before taking the geometric mean of the indicators, to produce the final fatty liver disease–SDG scores.

Every analytic step was carried out for 1000 draws from the posterior distribution of the previous step, to ensure uncertainty from all inputs, and analyses were propagated through to the final scores. Uncertainty intervals (UIs) were obtained by taking the 2.5th and 97.5th percentiles of the 1000 draw values.

Combining the fatty liver disease Sustainable Development Goal scores with the NAFLD preparedness index

In contrast to our fatty liver disease–SDG score, which aims to measure preparedness to address fatty liver disease from a multisectoral, whole-of-society perspective, the described NAFLD preparedness index[2] reports on country preparedness to address NAFLD specifically from a health system and public health policy perspective. After the development of the fatty liver disease–SDG scores, we combined them with the NAFLD preparedness index for a more comprehensive assessment of countries' fatty liver disease preparedness. Fatty liver disease–SDG scores for 100 countries included in the NAFLD preparedness index were

TABLE 1 List of indicators used to develop the fatty liver disease–SDG score

Indicator	Indicator description	Source	Related SDG indicator	Group category
Child overweight	Prevalence of overweight in children aged 2–4 y (%)	GBD 2017	2.2.2	Negative
Child wasting	Prevalence of wasting in children younger than 5 y (%)	GBD 2017	2.2.2	Negative
NCD mortality	Age-standardized death rate due to cardiovascular disease, cancer, type 2 diabetes, and chronic respiratory disease in populations aged 30–70 y, per 100,000 population	GBD 2017	3.4.1	Negative
UHC service coverage index	Coverage of essential health services, as defined by the UHC service coverage index of 9 tracer interventions and risk-standardized death rates or mortality-to-incidence ratios from 32 causes amenable to personal health care[a]	GBD 2017	3.8.1	Positive
Health worker density	Health worker density per 1000 population, by cadre and summed across cadres[b]	GBD 2017	3.c.1	Positive
Education	Age-standardized level of educational attainment for all ages 15–99	GBD 2020 preliminary analysis	4.1.2	Positive
UGS score	Logarithm of total vegetation index per capita[c]	Kwon et al	11.7.1	Positive

[a]Thirty-two causes amenable to personal health care included tuberculosis, diarrheal diseases, lower respiratory infections, upper respiratory infections, chronic respiratory diseases, diphtheria, whooping cough, tetanus, measles, maternal disorders, neonatal disorders, colon and rectum cancer, nonmelanoma skin cancer, breast cancer, cervical cancer, uterine cancer, testicular cancer, Hodgkin lymphoma, leukemia, rheumatic heart disease, ischemic heart disease, cerebrovascular disease, hypertensive heart disease, peptic ulcer disease, appendicitis, hernia, gallbladder and biliary diseases, epilepsy, diabetes, chronic kidney disease, congenital heart anomalies, and adverse effects of medical treatment.
[b]Cadres included physicians, nurses, midwives, and pharmacists.
[c]Used the normalized difference vegetation index as a basis for the UGS indicator.
Abbreviations: GBD, Global Burden of Disease; NCD, noncommunicable disease; SDG, Sustainable Development Goal; UGS, urban green space; UHC, universal health coverage.

extracted and then ranked. Two countries/territories included in the NAFLD preparedness index (Aruba and Hong Kong) were not included in the fatty liver disease–SDG score and, hence, were excluded. For these 100 countries, we summed the country rankings for the fatty liver disease–SDG score with the rankings of the NAFLD preparedness index.

Comparing the fatty liver disease Sustainable Development Goal scores to the NAFLD preparedness index and the Human Development Index

We separately compared the 2017 estimates of fatty liver disease–SDG scores to the NAFLD preparedness index[2] and the Human Development Index (HDI).[38] The HDI is a composite index of life expectancy, level of education attainment, and gross national income per capita that measures the overall human development of a country. It covers some of the themes also captured in the fatty liver disease–SDG score, namely, education; however, it does not incorporate key issues for fatty liver disease, such as UHC service coverage or access to UGSs, which are included in the fatty liver disease–SDG score. Two countries/territories (Aruba and Hong Kong) were excluded from the comparison analysis between fatty liver disease–SDG scores and the NAFLD preparedness index, whereas 7 countries-/territories (Hong Kong, Liechtenstein, Palau, Saint Kitts and Nevis, San Marino, Eswatini, and Tuvalu) were excluded for the fatty liver disease–SDG score and HDI comparison.

RESULTS

The fatty liver disease–SDG scores for the 195 countries and territories vary substantially, from 14.6 (95% UI: 8.92 to 19.4) in Niger to 93.5 (91.6 to 95.3) in Japan, with 18 countries scoring > 85 on the 0 to100 scale (Figure 2A; Supplemental Table S1 and S2 http://links.lww.com/HEP/F1000 for country and territory scores from 1990 to 2017). The SD of the fatty liver disease–SDG score across all 195 countries and territories in 2017 is 18.58 and the interquartile range is 26.81. The SD and interquartile range of the fatty liver disease–SDG score by GBD super-region can be found in Supplemental Table S3 (http://links.lww.com/HEP/F1000).

Regionally, the high-income super-region had the highest score at 88.8 (95% UI: 87.3 to 90.1) in 2017, and south Asia had the lowest score at 44.1 (42.4 to 45.8). Between 1990 and 2017, the fatty liver disease–SDG score improved in all 7 super-regions, with the percentage increase ranging from 13.3% to 181.2%

(Figure 3). The greatest improvement was in south Asia, despite its poor performance in absolute terms.

Across the 195 countries and territories, the fatty liver disease–SDG score decreased (worsened) in 8 countries and territories during the study period, with the largest decrease in Guam [–27.9% (95% UI: –32.8 to –20.2)] (Supplemental Table S4 http://links.lww.com/HEP/F1000). In contrast, the biggest fatty liver disease–SDG score increase (improvement) was observed in Eritrea [1116.1% (531.3 to 1913.1)], followed by Ethiopia [645.9% (382.6 to 764.9)] and Laos [628.3% (324.0 to 1292.3)].

Of the 6 indicators that were used to develop the fatty liver disease–SDG score, the UHC service coverage index had the lowest average scaled value across all 195 countries and territories. This was consistent when restricted to the countries and territories with the bottom 20% of the fatty liver disease–SDG scores. The second lowest indicator, however, differed in those 2 groups. When compared across all 195 countries and territories, the indicator with the second lowest scaled value was NCD mortality, whereas, when restricted to the bottom 20%, the second lowest was education attainment.

For the 60 countries and territories where UGS data were available (Figure 2B, Supplemental Table S5 http://links.lww.com/HEP/F1000), the inclusion of the indicators had variable impacts on the fatty liver disease–SDG scores (Figure 2C). In 21 countries and territories (35%), the inclusion of UGS data improved the score, whereas in 39 countries and territories (65%), the score worsened with the inclusion of this indicator. The average percentage improvement in the score including UGS data was 2.62% (95% UI: 0.83 to 3.82), whereas the average decrease was 9.29% (7.04 to 11.92) (Figure 2C). Montenegro had the biggest improvement in score with the inclusion of UGS data (8.37%), whereas Bahrain had the largest decrease (51.4%).

Sweden had the highest overall combined rank when comparing the fatty liver disease–SDG score and NAFLD preparedness index (ranked fourth for the fatty liver disease–SDG score and third on the NAFLD preparedness index), whereas Central African Republic had the lowest (ranked 96th for the fatty liver disease–SDG score and joint 71st on the NAFLD preparedness index). Sweden, the UK, Belgium, Germany, and Israel ranked in the top 15 on both indices. The largest difference between the fatty liver disease–SDG score and the NAFLD preparedness index was seen in India, which ranked 88th on the former and first on the latter (Supplemental Table S6 http://links.lww.com/HEP/F1000).

The comparisons of the national fatty liver disease–SDG scores to the NALFD preparedness index and HDI are shown in Figure 4 (Supplemental Tables S7 and S8 http://links.lww.com/HEP/F1000). Although many countries across all 7 GBD super-regions had near zero NAFLD preparedness index values, countries with higher fatty liver disease–SDG scores were more likely to score higher on the NAFLD preparedness index. A few notable exceptions were found. India and Bulgaria, 2 countries with suboptimal fatty liver disease–SDG scores, had some of the highest NAFLD preparedness index values. The correlation was higher, but not 100%, between the fatty liver disease–SDG score and the HDI.

DISCUSSION

There have been increasingly frequent calls to focus on systems thinking and to develop new tools to conceptualize and implement the complex responses needed to address today's major health challenges,[22] including the partnerships and collaborations that sit at the center of systems responses. In this study, we present a score for 195 countries and territories (1990–2017), which uses the SDG framework as a lens through which to assess countries' preparedness to tackle fatty liver disease. The burden of fatty liver disease is high[3] and rapidly increasing,[39] and it is already the fastest growing cause of HCC in France, the UK, and the USA. The incidence of NAFLD-related HCC is projected to increase dramatically by 2030, with increases of 82%, 117%, and 122% from 2016 in China, France, and the USA, respectively.[40] Fatty liver disease is an archetypical public health issue of the 21st century, requiring action across a wide range of sectors and disciplines. Although the focus of this study was fatty liver disease, the findings have broader relevance to NCDs, especially to closely related conditions, such as type 2 diabetes mellitus, cardiovascular disease, and obesity.

We suggest the fatty liver disease–SDG score for 3 primary uses. Given the lack of awareness about fatty liver disease and the importance of a multisectoral approach in tackling this public health challenge, the score can help to create awareness among key stakeholder groups, within and beyond the health sector. Second, the score can be an advocacy tool for public health professionals, civil society, and patient groups to advocate for greater action across sectors on this neglected public health challenge, at national and global levels. Finally, the score can inform the strategic decision-making within the national, regional, and global liver and other NCD organizations about the types of cross-sectoral actors that they should be engaging and collaborating with. While there is some correlation between the fatty liver disease–SDG score and existing scores, such as the HDI, the new score provides a more granular focus on the key issues impacting fatty liver disease and will support more nuanced discussions at a strategic and policy level. If the score is updated periodically (eg, every

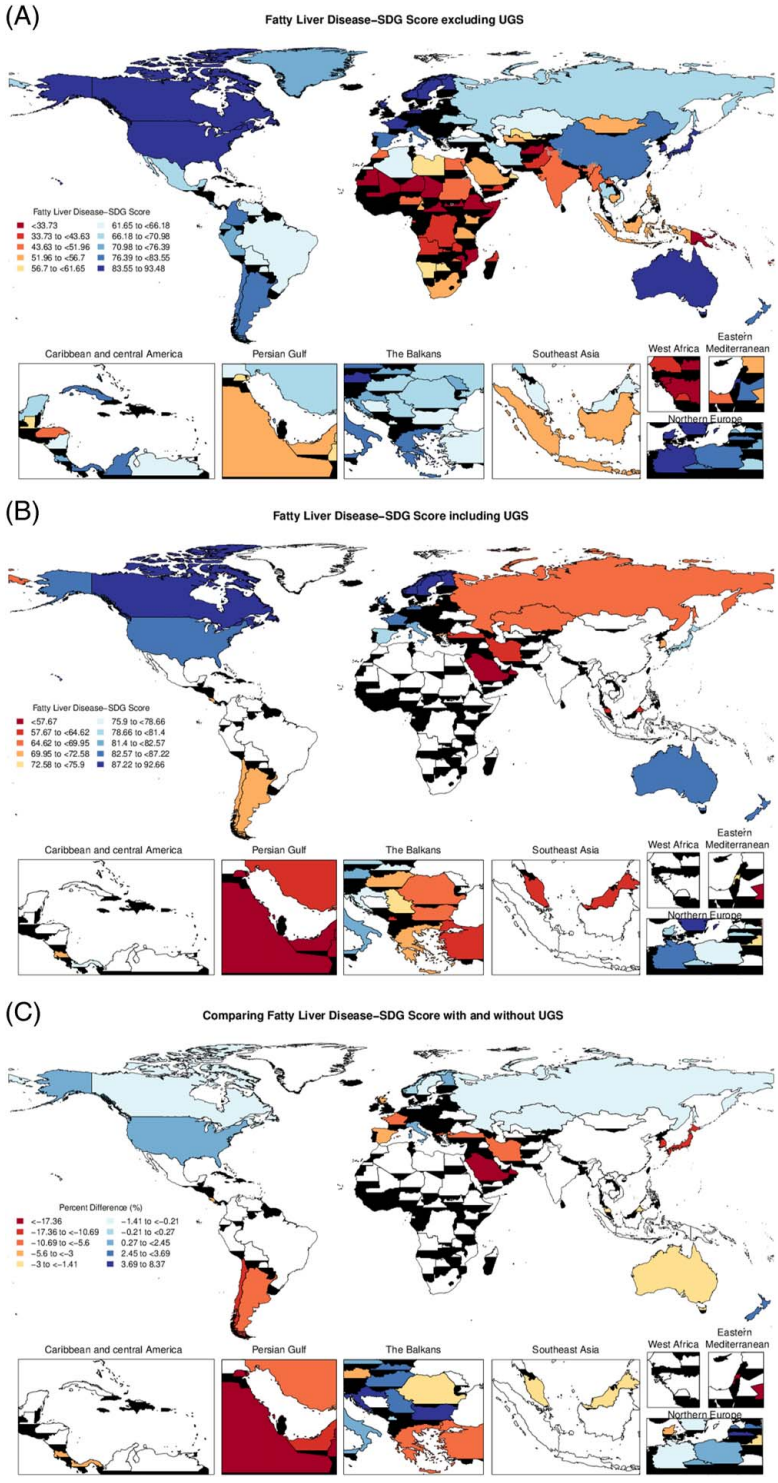

FIGURE 2 Geographical distribution of the fatty liver disease–SDG score, 2017. (A) Fatty liver disease SDG score in 195 countries and territories developed by using 6 indicators (child wasting, child overweight, NCD mortality, a UHC service coverage index, health worker density, and education attainment). (B) Fatty liver disease–SDG score in 60 countries and territories developed by using the 6 aforementioned indicators plus the UGS indicator. Countries and territories with no color indicate that they do not have UGS data. (C) Percentage change (%) of the fatty liver disease–SDG score with and without the UGS indicator in 60 countries that have UGS data. Percent change was calculated by first subtracting the fatty liver disease–SDG score developed without UGS data from the fatty liver disease–SDG score developed with UGS data and then dividing the difference by the fatty liver disease–SDG score without UGS data. Countries and territories with no color indicate that they do not have UGS data. Abbreviations: NCD, noncommunicable disease; SDG, Sustainable Development Goal; UGS, urban green space; UHC, universal health coverage.

3–5 years), advocates can also use it to scrutinize success and challenges over time, including policy changes. The fatty liver disease–SDG score provides a holistic multisectoral lens, through which to view

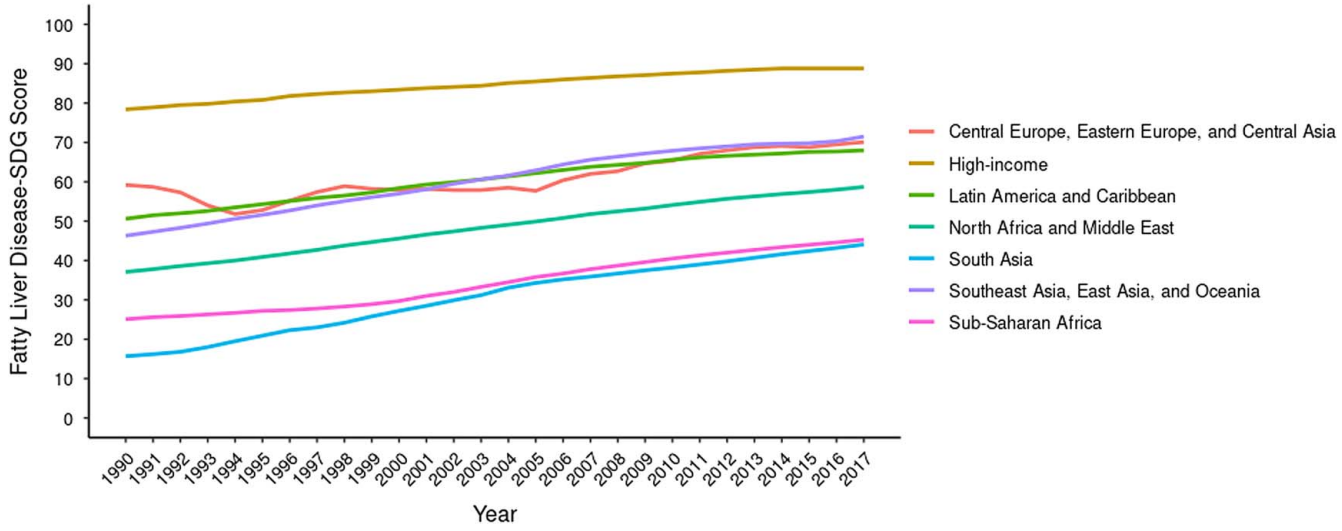

FIGURE 3 Temporal trend of the fatty liver disease–SDG score by GBD super-region, 1990 to 2017. Fatty liver disease–SDG score ranges from 0 to 100. The lines represent the population-weighted average of scores for countries and territories within each super-region. Abbreviations: GBD, Global Burden of Disease; SDG, Sustainable Development Goal.

efforts to address fatty liver disease, complementing existing efforts, such as the NAFLD preparedness index, which takes a focused look at health system and public health responses within countries. Furthermore, the data used to calculate the score are regularly and consistently collected for 195 countries and territories, while the preparedness index had data from only 102 countries.[2]

As expected, high-income countries generally had higher fatty liver disease–SDG scores than low-income and lower middle-income countries. There were some notable exceptions, including Uruguay, Brunei, and Qatar, none of which scored in the top quartile. This highlights that advanced economic development is not a guarantee of a higher fatty liver disease–SDG score, emphasizing the importance of focused policy interventions aimed at addressing the underlying and direct drivers of public health. These may, for example, target inadequate nutrition and sedentary lifestyles at the population level.[41] Although fatty liver disease is a pressing public health problem, no country is yet fully prepared to address it.[25] Geographically, sub-Saharan Africa and south Asia were the GDB super-regions with the lowest scores; however, some countries in these regions performed well overall, such as Cabo Verde and Botswana, which both ranked higher than other more economically advanced countries, highlighting that low- and middle-income countries can take strides in preparing to address conditions such as fatty liver disease.

For the 60 countries where UGS data were available, the inclusion of this indicator had varying impacts on the overall score, improving it in just over one-third of countries and reducing it in the remainder, in the case of Bahrain by over 50%. Although we were unable to include UGS data in the score for all countries and territories, we believe that this indicator captures critical information on the environment in which people live. Importantly, the availability of UGS does not guarantee access and utilization, 2 points that are not reflected in our score. The use of UGS is impacted by socioeconomic and sociocultural factors,[42,43] and efforts to increase its availability need to be accompanied by interventions to increase access and use, such as improved security and lighting. This is especially important among those who can benefit the most from using such space, including people at a higher risk of fatty liver disease and other NCDs, considering that UGS has effects on both physical and mental health.

Whole-of-society and health system responses

We combined the ranking of countries and territories on the fatty liver disease–SDG score with a published NAFLD preparedness index.[2] While the fatty liver disease–SDG score provides a multisectoral perspective that speaks to a country's action on fatty liver disease and NCDs more broadly, the NAFLD preparedness index gives insights into the relevant health system policy, guidelines, and strategies that are in place to address NAFLD. By comparing how well countries performed across both indices, we aimed to provide a holistic view of a country's preparedness to address this public health challenge. Countries that rank highly on both the fatty liver disease–SDG and NAFLD preparedness indices are best prepared to address the challenge of fatty liver disease. The NAFLD preparedness index found substantial variation between countries' readiness to

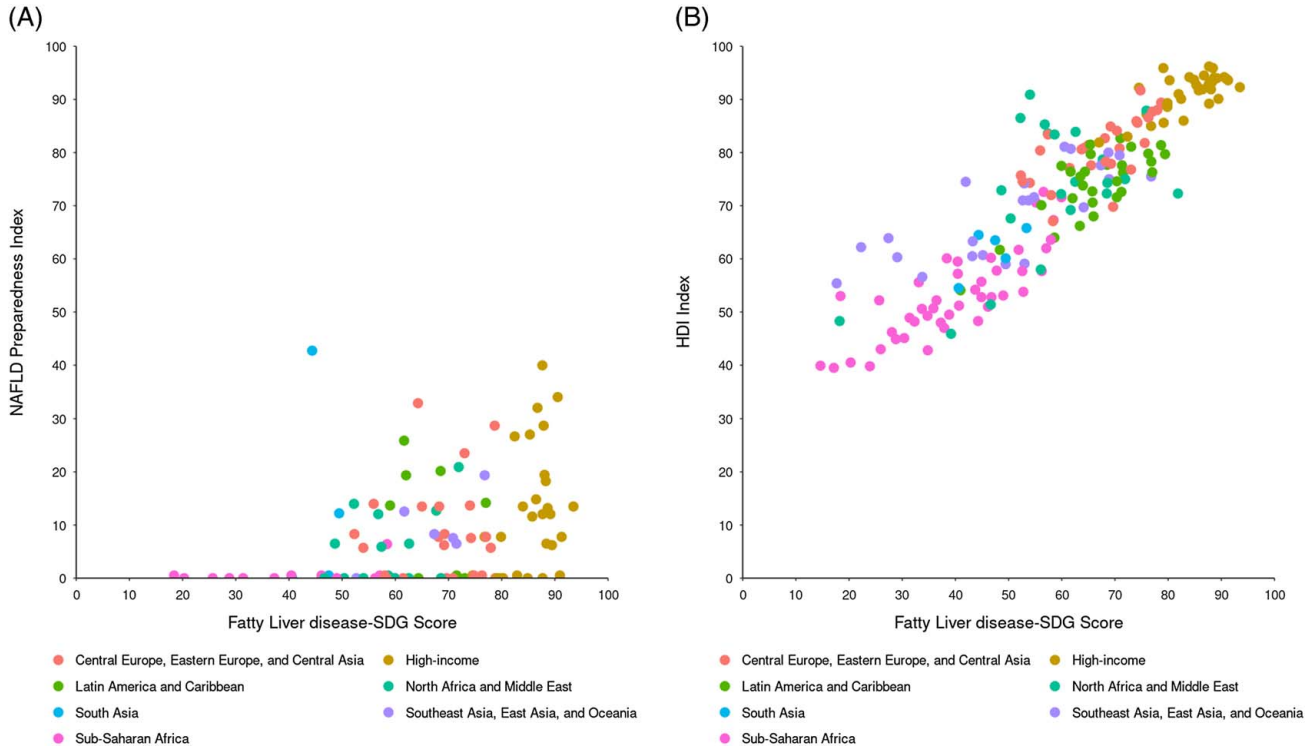

FIGURE 4 Comparisons of the fatty liver disease–SDG score to the (A) NAFLD preparedness index and (B) HDI by GBD super-region. The fatty liver disease–SDG score, NAFLD preparedness index, and HDI range from 0 to 100. The dots represent the population-weighted average of scores for countries and territories within each super-region. Abbreviations: GBD, Global Burden of Disease; HDI, Human Development Index; SDG, Sustainable Development Goal.

address NAFLD. Notably, even those countries that score relatively highly exhibit deficiencies in key domains, suggesting that structural changes are needed to optimize NAFLD management and ensure that effective public health approaches are in place.[42] Further detailed analysis at the regional level of countries and territories ranking highly on both indices could provide useful case studies to understand the policy measures that have been implemented and how these could be implemented in other national or subnational contexts.

Informing national responses to fatty liver disease

While national development priorities vary, fatty liver disease and NCDs—more broadly—are important considerations for decision-makers in all countries. For example, in low-income and lower middle–income countries, where public health issues have traditionally focused on communicable diseases, NCDs are becoming a major cause of morbidity and mortality,[44,45] with important implications for individual health, health systems, and economic development.[46,47]

Fatty liver disease, to date, is not addressed in global health policy or technical guidance. Improving public health is a central pillar of the SDG agenda[48] and should be a primary goal in all countries as a means of driving economic and social progress. While health system preparedness, underpinned by achieving UHC and health equity, is crucial, the underlying causes of fatty liver disease and other highly prevalent diseases cannot be addressed in the health sector alone. Our findings re-emphasize the longstanding calls for health in all policies' approaches.

Several indicators in this fatty liver disease–SDG score, namely, education attainment and UGS, fall beyond the direct scope of the public health community, pointing to the need to engage across various sectors, and for the public health community to support and champion the work of other sectors. Successful multisectoral action requires strong governance mechanisms that enable different stakeholders to collaborate around shared goals. Such governance structures are frequently missing or insufficient, especially in low- and middle-income countries, where institutions are commonly weak and fragmentation is common.[49] More detailed analysis is still needed to understand how multisectoral action can best work in practice.

Limitations

This study has several limitations. There is variation in the clinical definition of fatty liver disease and countries

may monitor the disease using different methods. Hence, the full burden and impact of the disease are unknown, precluding the potential to externally validate the fatty liver disease–SDG score using the estimated disease burden of fatty liver disease and NASH in each country. While such a validation would theoretically show if high-scoring countries have a lower disease burden and vice versa, interpretation of such an analysis is challenging, in part because primary data on fatty liver disease prevalence are scant and heterogeneous. Changes in fatty liver disease epidemiology occur slowly over time; in theory, the fatty liver disease–SDG scores for 1990, 2000, and 2010 will provide useful insights into the disease burden today, yet the myriad of confounding factors and data quality over this time makes such comparisons fraught.

Furthermore, we recognize that our combination of the fatty liver disease–SDG score with the NAFLD preparedness index uses data from different timepoints, with the former using data from 2017—the latest available data—and the latter from 2020. However, we suggest that it is unlikely that the fatty liver disease–SDG score will have changed substantially between these timepoints and find value in the aggregate score.

One SDG indicator (16.1.4: proportion of population that feel safe walking alone around the area they live after dark) was included in the NAFLD–SDG framework;[26] however, data for this indicator were unavailable to include in the fatty liver disease–SDG score.[30] We note that the metric for UGS was developed using data from only 90 cities within the 60 countries and territories included and may, thus, not be an accurate representation of UGS throughout each country and territory. We also had no information available regarding the quality of UGS scores. For example, there is uncertainty as to whether UGS practically relates to better walkability and ability to perform outdoor exercise, as UGS has different factors for usability not captured in a single metric, including safety and environmental health risks.[50,51]

We present a fatty liver disease–SDG score for 195 countries and territories over 3 decades, with the aim of supporting efforts to address the public health challenge of fatty liver disease through a whole-of-society approach. Fatty liver disease remains a high-prevalence, largely unknown, and underaddressed disease, yet one that will have an increasing impact on health, health systems, and economies in the years ahead. The fatty liver disease–SDG score can help support efforts to raise awareness about fatty liver disease and ultimately assist all levels of policy-making processes to address it.

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Jeffrey V. Lazarus: conceived the idea for this study and prepared a proposal to IHME with Henry E. Mark. They also prepared the first draft of the manuscript. Hannah Han and M. Ashworth Dirac: led the data collection. Manik Aggarwal, Ali Ahmadi, Fares Alahdab, Motasem Alkhayyat, Sami Almustanyir, Hubert Amu, Tahira Ashraf, Bantalem Tilaye Tilaye Atinafu, Sara Bagherieh, Mainak Bardhan, Diana Fernanda Bejarano Ramirez, Ajay Nagesh Bhat, Vijay Kumar Chattu, Daniela Contreras, Sandra Cortés, Omar B Da'ar, Bardia Danaei, Rupak Desai, M Ashworth Dirac, Haneil Larson Dsouza, Temitope Cyrus Ekundayo, Iman El Sayed, Noha Mousaad Elemam, Sayeh Ezzikouri, Amr Farwati, Farshad Farzadfar, Ginenus Fekadu, Tushar Garg, Mahaveer Golechha, Pouya Goleij, Vivek Kumar Gupta, Adel Hajj Ali, Saeed S Hamid, Harapan Harapan, Simon I Hay, Reza Homayounfar, Salman Hussain, Segun Emmanuel Ibitoye, Nahlah Elkudssiah Ismail, Linda Merin J, Shubha Jayaram, Bijay Mukesh Jeswani, Jost B Jonas, Abel Joseph, Charity Ehimwenma Joshua, Jacek Jerzy Jozwiak, Vidya Kadashetti, Tesfaye K Kanko, Rami S Kantar, Nitin Kapoor, Moien AB Khan, Sang-woong Lee, Yeong Yeh Lee, Lee-Ling Lim, Stephen S Lim, Stefan Lorkowski, Erkin M Mirrakhimov, Awoke Misganaw, Ali H Mokdad, Jibran Sualeh Muhammad, Efrén Murillo-Zamora, Christopher J L Murray, Sreenivas Narasimha Swamy, Zuhair S Natto, Robina Khan Niazi, Bogdan Oancea, In-Hwan Oh, Jagadish Rao Padubidri, Seoyeon Park, Harsh K Patel, Venkata Suresh Patthipati, Simone Perna, Vivek Podder, Sina Rashedi, Jefferson Antonio Buendia Rodriguez, Leonardo Roever, Umar Saeed, Abdallah M Samy, Danish Iltaf Satti, Allen Seylani, Pritik A Shah, Ali Shamekh, Parnian Shobeiri, Jasvinder A Singh, Anna Aleksandrovna Skryabina, Ker-Kan Tan, Nikhil Kenny Thomas, Tommi Juhani Vasankari, Song Wang, Suowen Xu, Chuanhua Yu, and Zhi-Jiang Zhang: provided data or critical feedback on data sources. Ali Ahmadi, Hubert Amu, Akshaya Srikanth Bhagavathula, Daniela Contreras, M Ashworth Dirac, Adel Hajj Ali, Simon I Hay, Bijay Mukesh Jeswani, Sang-woong Lee, Ali H Mokdad, Christopher J L Murray, Seoyeon Park, Umar Saeed, Abdallah M Samy, and Theo Vos: developed methods or computational machinery. Amir-ali Aali, Mohsen Abbasi-Kangevari, Eman Abu-Gharbieh, Manik Aggarwal, Bright Opoku Ahinkorah, Ali Ahmadi, Fares Alahdab, Sami Almustanyir, Hubert Amu, Amir Anoushiravani, Sina Azadnajafabad, Sara Bagherieh, Mainak Bardhan, Diana Fernanda Bejarano Ramirez, Akshaya Srikanth Bhagavathula, Ajay Nagesh Bhat, Mariah Malak Bilalaga, Antonio Biondi, Saeid Bitaraf, Srinivasa Rao Bolla, Daniela Calina, Vijay Kumar Chattu, Sandra Cortés, Omar B Da'ar, Bardia Danaei, Rupak Desai, M Ashworth Dirac, Deepa Dongarwar, Haneil Larson Dsouza, Iman El Sayed, Noha Mousaad Elemam, Mohamed A Elmonem, Aisha Elsharkawy, Sayeh Ezzikouri, Amr Farwati, Florian Fischer, Tushar Garg, Elena S George, Seyyed-Hadi Ghamari, Mohammad Ghasemi Nour, Vivek Kumar

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