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The Global Fatty Liver Disease-Sustainable Development Goal Country Score for 195 Countries and Territories

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Authors' contributions

JVL conceived the idea for this study and prepared a proposal to IHME with HEM. Data collection was led by HH and MAD.

Providing data or critical feedback on data sources

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All authors had full access to all of the data and reviewed and verified the results, and the first draft of the manuscript was prepared by HEM and JVL. All authors reviewed subsequent drafts, approved the final version, and accept responsibility with regard to submitting the manuscript for publication.

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Keywords

NAFLD; NASH; public health; health index; health policy

Abbreviations

NASH, non-alcoholic steatohepatitis

NCD, non-communicable disease

T2DM, type 2 diabetes mellitus

NAFLD, non-alcoholic fatty liver disease

SDG, Sustainable Development Goal

UHC, universal health coverage

UGS, urban green space score

GBD, Global Burden of Diseases, Risk Factors, and Injuries Study

UI, uncertainty interval

HDI, Human Development Index

Graphic abstract

GA1

Abstract

Background & 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 & Results: We developed two fatty liver disease-SDG score sets. The first included six indicators (child wasting, child overweight, non-communicable disease [NCD] mortality, universal health coverage service coverage index, health worker density, and education attainment), covering 195 countries between 1990-2017. The second included the aforementioned indicators plus an urban green space (UGS) indicator, covering 60 countries for which 2017 data were available. To develop the fatty liver disease-SDG score, indicators were categorised as "positive" or "negative" and scaled from 0–100. Higher scores indicate better preparedness levels. Fatty liver disease-SDG scores varied between countries (n=195), from 14.6 (95% UI 8.9–19.4) in Niger to 93.5 (91.6–95.3) in Japan; 18 countries scored >85. Regionally, the high-income super-region had the highest score at 88.8 (87.3–90.1) in 2017, while south Asia had the lowest score at 44.1 (42.4–45.8). Between 1990-2017, the fatty liver disease-SDG score increased in all super-regions, with the greatest increase in south Asia, but decreased in eight countries.

Conclusions: The fatty liver disease-SDG score provides a strategic advocacy tool at the national and global levels for the liver health field and NCD advocates, highlighting the multi-sectoral collaborations needed to address fatty liver disease, and NCDs 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 three 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 this to be around 1%,[7] while a Korean study estimated this 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, non-alcoholic steatohepatitis (NASH), have a substantial impact on individual health,[10] burdening health systems and 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 non-communicable diseases (NCDs), most notably cardiovascular disease, type 2 diabetes mellitus (T2DM), obesity, and non-hepatic 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 non-obese 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 such as people diagnosed with T2DM.[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 non-alcoholic fatty liver disease (NAFLD)-related policies and guidelines in 102 countries, creating a NAFLD preparedness index which characterised 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]

While health systems sit at the centre 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 conceptualise the design of whole-of-society responses to fatty liver disease, we previously published a Sustainable Development Goal (SDG)-NAFLD 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 most relevant to NAFLD, with the final framework including seven 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 previously 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 from 1990 to 2017. The fatty liver disease-SDG score builds on the earlier framework to providing 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

Fatty liver disease-SDG framework

The fatty liver disease-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 fatty liver disease. Subsequently, a multidisciplinary group of experts (n=15) were invited to select which of the shortlisted targets and indicators to include in the fatty liver disease-SDG framework. Targets and indicators with 75% or greater agreement were included in the final fatty liver disease-SDG framework, with this framework comprising 16 targets and seven indicators (Figure 1). The detailed methodology has been previously published.[26]

Development of the fatty liver disease-SDG score

The indicators included in fatty liver disease-SDG score are shown in Table 1. We developed two sets of fatty liver disease-SDG scores. The first set was developed using six 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 score (UGS) since it was not available for all countries. It covers 195 countries and territories between 1990 and 2017. The second set was constructed using all seven 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 Diseases, Risk Factors, and Injuries Study (GBD).[31-33] Details of the input data and modelling procedures for estimating these indicators have been published previously.[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 (e.g., UHC service coverage index). The "negative" category consisted of indicators where lower estimates were associated with better health outcomes (e.g., child wasting).

Then, all indicators were scaled from 0–100, 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 two 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 (i.e., physicians, nurses, midwives, and pharmacists). The details of the modified scaling approach for health worker density have been previously published.[34]

The final fatty liver disease-SDG score was calculated in two steps. First, we computed the geometric mean of child wasting and child overweight, two 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 seven 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-SDG 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 previously described NAFLD preparedness index[2] reports a country's preparedness to address NAFLD specifically from a health systems and public health policy perspective. After 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 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 index, 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-SDG scores to the NAFLD preparedness index and the HDI

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. The HDI 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 health service coverage or access to urban green spaces, which are included in the fatty liver disease-SDG score. Two countries/territories (Aruba and Hong Kong) were excluded from this comparison analysis

between fatty liver disease-SDG scores and NAFLD preparedness index, while seven 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 8.92–19.4) in Niger to 93.5 (91.6–95.3) in Japan, with 18 countries scoring >85 on the 0–100 scale (Figure 2A; see Supplementary Table 1 and 2 http://links.lww.com/HEP/F1000 for country scores from 1990 to 2017). The standard deviation of the fatty liver disease-SDG score across all 195 countries in 2017 is 18.58, and the interquartile range is 26.81. The standard deviation and interquartile range of the fatty liver disease-SDG score by GBD super-region can be found in Supplementary Table 3 http://links.lww.com/HEP/F1000.

Regionally, the high-income super-region had the highest score at 88.8 (95% UI 87.3–90.1) in 2017, and south Asia had the lowest score at 44.1 (42.4–45.8). Between 1990 and 2017, the fatty liver disease-SDG score improved in all seven 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 eight countries during the study period, with the largest decrease in Guam (–27.9% [95% UI –32.8 to –20.2]) (Supplementary Table 4 http://links.lww.com/HEP/F1000). On the other hand, the biggest fatty liver disease-SDG score increase (improvement) was observed in Eritrea (1116.1% [531.3–1913.1]), followed by Ethiopia (645.9% [382.6–764.9]) and Laos (628.3% [324.0–1292.3]).

Of the six 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 locations. This was consistent when restricted to the countries with the bottom 20% of the fatty liver disease-SDG scores. The second lowest indicator, however, differed in those two groups. When compared across all 195 locations, 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 where UGS data were available (Figure 2B, Supplementary Table 5 http://links.lww.com/HEP/F1000), the inclusion of the indicators had variable impacts on the fatty liver disease-SDG country scores (Figure 2C). In 21 countries (35%), the inclusion of

UGS improved the score, while in 39 countries (65%), the score worsened with inclusion of this indicator. The average percentage improvement in the score including UGS was 2.62% (95% UI 0.83–3.82), while the average decrease was 9.29% (7.04–11.92) (Figure 2C). Montenegro had the biggest improvement in score with the inclusion of UGS (8.37%), while 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), while 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 NAFLD preparedness index was seen in India, which ranked 88th on the former and first on the latter (Supplementary Table 6 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 (Supplementary Table 7 and 8 http://links.lww.com/HEP/F1000). Although many countries across all seven GBD super-regions had near zero NAFLD preparedness index values, countries with higher NALFD-SDG score were more likely to score higher on the NAFLD preparedness index. A few notable exceptions were found. India and Bulgaria, two countries with sub-optimal fatty liver disease-SDG scores, had one 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 conceptualise and implement the complex responses needed to address today's major health challenges,[22] including the partnerships and collaborations that sit at the centre of systems responses. In this study, we present a novel score for 195 countries and territories (1990 to 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 hepatocellular carcinoma in France, the UK, and the USA. The incidence of NAFLD-related hepatocellular carcinoma 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. While the focus of this study was fatty liver disease, the findings have broader

relevance to NCDs, especially to closely related conditions such as T2DM, cardiovascular disease, and obesity.

We suggest the fatty liver disease-SDG score for three 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. Secondly, 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 national, regional and global liver and other NCD organisations about the types of cross-sectoral actors 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 (e.g., every three to five years), advocates can also use it to scrutinise success and challenges over time, including policy changes. The fatty liver disease-SDG score provides a holistic multisectoral lens through which to view efforts to address fatty liver disease, complementing existing efforts, such as the NAFLD preparedness index, which take a focused look at health systems and public health responses within countries. Furthermore, the data employed 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 of countries. This highlights that advanced economic development is not a guarantee of a higher fatty liver disease-SDG score, emphasising 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%. While we were unable to include UGS data in the score for all countries, 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 utilisation, two points which are not reflected in our score. The use of green space is impacted by socioeconomic and socio-cultural factors,[42,43] and efforts to increase the availability of UGS need to be accompanied by other 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 UGS effects on both physical and mental health.

Whole-of-society and health system responses

We combined the ranking of countries on the fatty liver disease-SDG score with a previously published NAFLD preparedness index.[2] While the fatty liver disease-SDG score provides a multisectoral perspective which 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 address NAFLD. Notably, even those countries that score relatively highly exhibit deficiencies in key domains, suggesting that structural changes are needed to optimise NAFLD management and ensure that effective public health approaches are in place.[42] Further detailed analysis at the regional level of countries 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 decisionmakers 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 for 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-emphasise the longstanding calls for health in all policies' approach.

Several of the indicators in this novel fatty liver disease-SDG index, namely, education and availability of 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 where 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 for fatty liver disease, and countries may monitor the disease using different methods. Hence, the full burden and impact of the disease is 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 higher-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.

Further, we recognise that our combination of the fatty liver disease-SDG score with the NAFLD preparedness index uses data from different time points, 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 fatty liver disease-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 included and may thus not be an accurate representation of UGS throughout each country. We also had no information available regarding the quality of UGS scores. For example, there is uncertainty as to whether the UGS practically relates to better walkability and ability to perform outdoor exercise, as green spaces have different factors for usability not captured in a single metric, including safety and environmental health risks.[50,51]

Conclusions

We present a novel fatty liver disease-SDG score for 195 countries and territories over three 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 under-addressed 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 the policy-making processes.

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208. Samsung Advanced Institute for Health Sciences & Technology (SAIHST), 209. High School Economics, 210. IQVIA, 211. Employees' State Insurance Model Hospital, 212. Pharmaceutical Research Associates, 213. Al Farabi Kazakh National University, 214. Pushpagiri Institute of Medical Sciences and Research Centre, 215. University of Milan, 216. Indian Council of Medical Research, 217. University of Medicine and Pharmacy at Ho Chi Minh City, 218. Ajou University, 219. Gachon University, 220. University of Science Malaysia, 221. Ethiopian Public Health Institute, 222. Sihanouk Hospital Center of HOPE, 223. University of Malaya, 224. Peking University People's Hospital, 225. Sun Yat-sen University, 226. Kirk Kerkorian School of Medicine at UNLV, 227. Friedrich Schiller University Jena, 228. University of Sao Paulo, 229. Ministry of Health, 230. BGS Global Institute of Medical Sciences, 231. Gonabad University of Medical Sciences, 232. University of Sydney, 233. University of Concepcion, 234. Medical University of Graz, 235. West Middlesex University Hospital, 236. SevenHills Hospital, 237. National and Kapodistrian University of Athens, 238. Asfendiyarov Kazakh National Medical University, 239. Helsinki University Hospital, 240. University of Duhok, 241. Kyrgyz State Medical Academy, 242. Hamadan University of Medical Sciences, 243. GRID Council, 244. King's College London, 245. Kermanshah University of Medical Sciences, 246. TMSS Medical College, 247. Kurdistan University of Medical Sciences, 248. College of Medicine, University of Sharjah, 249. Mexican Institute of Social Security, 250. Ahmadu Bello University, 251. Guilan University of Medical Sciences, 252. Moscow Institute of Physics and Technology, 253. King Abdulaziz University, 254. University of South Florida, 255. International Islamic University Islamabad, 256. WellStar Atlanta Medical Center, 257. University Hospital of Heraklion, 258. Jundishapur University of Medical Sciences, 259. University of British Columbia, 260. Institute of Medical Sciences, 261. University of Bucharest, 262. Kyung Hee University, 263. Baylor College of Medicine, 264. Salvador Zubiran National Institute of Medical Sciences and Nutrition, 265. Ajman University, 266. Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal, India, 267. Ochsner Medical Center, 268. Yale University, 269. Kalinga Institute of Medical Sciences, 270. Advent Health, 271. Tribhuvan University, 272. State University of New York, 273. University of Bahrain, 274. Diego Portales University, 275. Tairunnessa Memorial Medical College and Hospital, 276. St George's University of London, 277. Jagadguru Sri Shivarathreeswara University, 278. Federal University of Minas Gerais, 279. National Institute of Infectious Diseases, 280. University of Hong Kong, 281. Amirkabir University of Technology, 282. University of Kansas, 283. University of Central Florida, 284. Emory University, 285. PSG Institute of

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Presentation: none.

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Table 1. List of indicators used to develop the fatty liver disease-Sustainable Development Goal (fatty liver disease-SDG) score.

Indicator	Indicator description	Source	Related SDG indicator	Group category
Child overweight	Prevalence of overweight in children aged 2–4 years (%)	GBD 2017	2.2.2	Negative
Child wasting	Prevalence of wasting in children younger than 5 years (%)	GBD 2017	2.2.2	Negative
NCD mortality	Age-standardised death rate due to cardiovascular disease, cancer, type 2 diabetes, and chronic respiratory disease in populations aged 30–70 years, 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 nine tracer interventions and risk-standardised 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-standardised level of educational attainment for all ages 15–99	GBD 2020 preliminary analysis	4.1.2	Positive
Urban green space score	Logarithm of total vegetation index per capita[c]	Kwon et al.	11.7.1	Positive

[a]32 causes amenable to personal health care included tuberculosis, diarrhoeal diseases, lower respiratory infections, upper respiratory infections, chronic respiratory diseases, diphtheria, whooping cough, tetanus, measles, maternal disorders, neonatal disorders, colon and rectum cancer, non-melanoma skin cancer, breast cancer, cervical cancer, uterine cancer, testicular

cancer, Hodgkin lymphoma, leukaemia, rheumatic heart disease, ischaemic 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 and midwives, and pharmacists.

[c]Used the normalised difference vegetation index as a basis for the urban green space indicator.

Global Burden of Disease (GBD); non-communicable disease (NCD); universal health coverage (UHC).

Figure 1. Fatty liver disease-Sustainable Development Goal (fatty liver disease-SDG) framework. The fatty
liver disease-SDG framework shows the SDG targets and indicators that are most relevant to fatty liver
disease. The eight coloured segments indicate the selected targets and the seven selected indicators are
nested within five of these targets. Solid lines indicate targets with a direct link to fatty liver disease and
dashed lines show those indirectly related to fatty liver disease.
NAFLD, non-alcoholic fatty liver disease; NCD, non-communicable disease.

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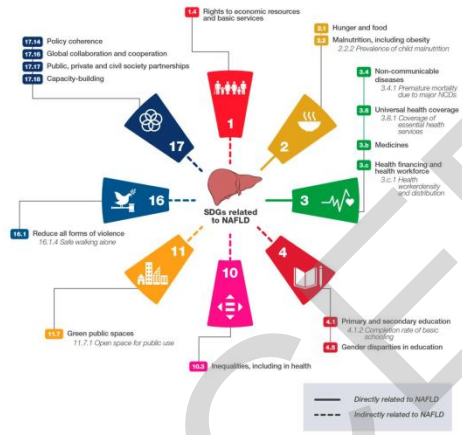

Figure 2. Geographical distribution of the fatty liver disease-Sustainable Development Goal (fatty liver
disease-SDG) score, 2017.
A) Fatty liver disease-SDG score in 195 countries and territories developed by using six indicators (child
wasting, child overweight, non-communicable disease mortality, a universal health coverage service
coverage index, health worker density, and education attainment). B) Fatty liver disease-SDG score in 60
countries and territories developed by using the six aforementioned indicators plus the indicator urban green
space (UGS). Countries with no colour indicate that they do not have UGS data. C) Percentage change (%)
of the fatty liver disease-SDG score with or 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
from the fatty liver disease-SDG score developed with UGS, and then dividing the difference by the fatty
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NAFLD, non-alcoholic fatty liver disease.

A)

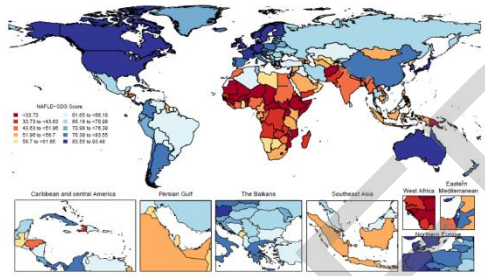

Figure 3. Temporal trend of the fatty liver disease-Sustainable Development Goal (fatty liver disease-SDG)
score by Global Burden of Disease super-region, 1990-2017.
Fatty liver disease-SDG score ranges from 0 to 100. The lines represent the population-weighted average of
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Figure 3. Temporal trend of the fatty liver disease-Sustainable Development Goal (fatty liver disease-SDG) score by Global Burden of Disease super-region, 1990-2017.

Fatty liver disease-SDG score ranges from 0 to 100. The lines represent the population-weighted average of scores for countries within each super-region.

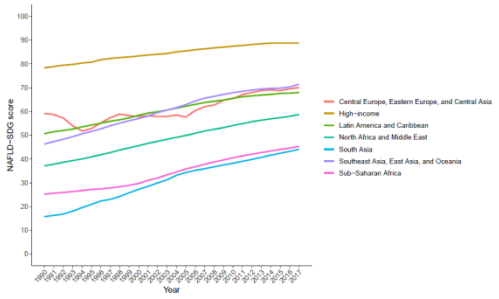

Figure 4. Comparisons of the fatty liver disease-Sustainable Development Goal (fatty liver disease-SDG)
score to the A) Non-alcoholic fatty liver disease (NAFLD) preparedness score and B) Human Development
Index (HDI) by Global Burden of Disease super-region.
The fatty liver disease-SDG score, NAFLD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