Received: 22 June 2022 | Revised: 13 September 2022 | Accepted: 29 September 2022

DOI: 10.1002/mpr.1950

ORIGINAL ARTICLE

WILEY

International monitoring of capacity of treatment systems for alcohol and drug use disorders: Methodology of the Service Capacity Index for Substance Use Disorders

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Abstract

Objectives: We aimed to develop a Service Capacity Index for Substance Use Disorders (SCI-SUD) that would reflect the capacity of national health systems to provide treatment for alcohol and drug use disorders, in terms of the proportion of available service elements in a given country from a theoretical maximum.

Methods: Data were collected through the WHO Global Survey on Progress with Sustainable Development Goals (SDG) Health Target 3.5, conducted between December 2019 and July 2020 to produce the SCI-SUD, based on 378 variables overall.

Results: The SCI-SUD was directly derived for 145 countries. We used multiple imputation to produce comparable SCI-SUD estimates for countries that did not submit data (40 countries) or had very high level of missingness (9 countries). The final SCI-SUD demonstrates considerable consistency and internal stability and is

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strongly associated with the macro-level economic, healthcare-related and epidemiologic (such as prevalence rates) variables.

Conclusion: The presented methodology represents a step forward in monitoring the global situation in regard to the development of treatment systems for SU disorders, however, further work is warranted to improve the external validity of the measure (e.g., in-depth data generation in countries) and ensure its feasibility for regular reporting (e.g., reducing the number of variables).

KEYWORDS
global estimates, global monitoring, health systems, service capacity, substance use disorders

1 | INTRODUCTION

Worldwide estimates suggest that, more than 283 million people (5%) aged 15+ years live with alcohol use disorders (AUD) (World Health Organization, 2018), while about 38.6 million individuals are affected with drug use disorders (DUD) (United Nations Office on Drugs and Crime, 2022). The number of annual deaths attributable to alcohol consumption amounts to about 3 million (World Health Organization, 2018), and close to 0.5 million annual deaths are attributable to drug use (World Health Organization, 2021a); many of these deaths are due directly to AUD/DUD (Murray et al., 2020; Rehm et al., 2013). There is a significant overlap between AUD and DUD, with previous studies suggesting that more than 40% of those individuals with current AUD also have lifetime DUD (Castillo-Carniglia et al., 2019).

Prevention and effective management of substance use disorders (SUD) have a significant public health impact on premature mortality and morbidity in populations (United Nations Office on Drugs and Crime & World Health Organization, 2018; World Health Organization & United Nations Office on Drugs and Crime, 2020), but a very low proportion of people who can benefit from treatment have access to it. At best, only one in six people with DUD (United Nations Office on Drugs and Crime, 2018) and a similar proportion of people with alcohol dependence (about 20%) (Carvalho et al., 2019) receive treatment. According to data from the World Mental Health Survey, even fewer people with SUD receive minimally adequate treatment (7.1% of those with past-year SUD: 10.3% in high income, 4.3% in upper-middle income, and 1.0% in low/lower-middle income countries) (Degenhardt et al., 2017). The World Health Organization (WHO) continues to work with partners to advance Universal Health Coverage (UHC) according to its strategic objectives and targets (World Health Organization, 2019b), such as the target that 1 billion more people should benefit from UHC, including people with SUD (World Health Organization, 2019a). Global surveillance of coverage and capacity to provide treatment for people with SUD is essential for monitoring the progress of UHC.

Among the health targets of the United Nations Sustainable Development Goals (SDG) 2030 (United Nations Department of Economic and Social Affairs, 2015), several have direct relevance to the development of treatment systems for AUD and DUD. SDG Health Target 3.5 specifically calls to "strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol". One of two indicators (3.5.1) for measuring progress on SDG Health Target 3.5 attainment is the "coverage of treatment interventions (pharmacological, psychosocial and rehabilitation and aftercare services) for SUD". The WHO, together with the United Nations Office on Drugs and Crime (UNODC) are custodian agencies for the SDG 3.5.1 indicator, and have been working in collaboration to consolidate and implement a methodology for global reporting (United Nations Department of Economic and Social Affairs Statistics Division).

Several approaches have been utilized to assess treatment coverage or its components for mental health conditions, including (1) analysis of data from global population-based (Degenhardt et al., 2017) and health facility surveys (Saxena et al., 2011); (2) analysis of routinely collected medical health records (Li et al., 2007); (3) expert reports and opinions (Lora et al., 2020); (4) utilization of indirect methods (Jones et al., 2016); (5) modelling of data based on a variety of sources or a combination of methods (Jaeschke et al., 2021); and (6) treatment mapping and quantification of treatment system elements, for example, using the WHO Mental Health ATLAS (World Health Organization, 2021b), WHO Assessment Instrument for Mental Health Systems (WHO-AIMS) (World Health Organization, 2005) or Substance Abuse Instrument for the Mapping of Services (WHO-SAIMS) (Babor & Poznyak, 2010) tools. There are substantial limitations for each method and considerable work is still needed to generate valid, reliable, and comparable data allowing reliable and sustainable reporting on the indicator.

The contact coverage of treatment for SUD is supposed to be computed by dividing the number of people receiving treatment services by the total number of people with SUD in need of treatment in the same year, ideally disaggregated for AUD and DUD. With an assumption that all people with SUD require at least some treatment, this computation at the population level requires availability of data on both the prevalence of SUD as well as on service utilization. The disaggregation of contact coverage for AUD and DUD would require separate data for these conditions, that is, data on prevalence and service utilization separately for AUD and DUD.

However, a number of challenges have been identified in approaching the contact coverage for reporting the SDG 3.5.1 indicator. First, there is a deficit of data suitable for these purposes at the global, regional and national levels. Even when data on a number of service contacts are routinely collected, the availability of and access to these data for research purposes are very limited in the majority of countries. For example, in the WHO Global Health Observatory, Resources for the Prevention and Treatment of Substance Use (SU) Disorders (WHO ATLAS-SU) from 2014, less than 10 out of 162 countries (6%) were able to provide information on the number of treatment episodes and only about 15 out of 162 countries (9%) on the number of in-patient beds for the treatment of SUD (data disaggregation for AUD/DUD is not available). Second, in many countries there is a lack of—or insufficient –capacity to work with existing routinely collected health data for reporting and health system strengthening purposes. Third, nationwide routinely collected health data are unavailable or incomplete in many countries, while the quality of available data is largely unknown due to the lack of data validation exercises. In addition to these issues, there are a number of limitations inherent to health registry studies, such as the lack of confounder information (Thygesen & Ersbøll, 2014). Fourth, in an attempt to compare information across countries/perform cross-country comparisons, one can face problems due to the diversity of health information systems. For example, in some countries service utilization is assessed through the number of cases (treatment episodes), while in other countries through the number of people who get in touch with services in a given year. Fifth, as it was shown in a systematic review of mental health treatment coverage (De Silva et al., 2014), there were no programmes directly evaluating effective treatment coverage (the proportion of those in need who receive health benefits from treatment). In the case of treatment services for people with SUD, one can expect an even worse situation when the ultimate effect of service for people with SUD is poorly measured. In addition, an estimation of the proportion of people with SUD in need of treatment within any particular period of time presents supplementary challenges as well as the overall complexity of defining treatment needs (normative, felt or expressed) (Asadi-Lari et al., 2003). In fact, not all people with normative needs (having a SUD) will look for treatment (felt and expressed needs), and not all who receive care (contact coverage) will benefit from treatment (effective coverage), while some people might have spontaneous remission without formal treatment or receiving support outside of health services (e.g., from mutual support groups). And, finally, one of the key challenges when it comes to SUD is that treatment and care services in many countries are distributed across different sectors (such as medical, social, criminal justice), and governmental and non-governmental structures that complicate further collection, collation and analysis of available information. In some countries, treatment services for AUD and DUD are provided in different facilities and even coordinated by different ministries, therefore, it might be difficult to obtain disaggregated data to measure coverage separately for AUD and DUD, although such information is relevant for various stakeholders and decision makers.

While there is a need to further improve the capacity of global reporting on treatment contact coverage, a parallel activity is needed to understand the capacity of health care systems and the availability of services for people with SUD. This approach is promising because it would create opportunities for targeted activities in countries focussing on elements that are missing or underdeveloped in reporting areas. Over the past several decades, WHO and its partners have been working on a framework for monitoring health systems' performance and to measure health systems' capacity (World Health Organization, 2010a, 2022). The WHO Framework for Monitoring Health Systems (World Health Organization, 2010a) allows the description of health systems in terms of core components or 'building blocks'. This framework helps to disaggregate the complex construct into the defined elements and permits the identification of indicators and measurement strategies for monitoring progress in capacity and performance of health systems in general, but also in particular areas of health systems, such as services for SUD.

Building on previous experience with the WHO-SAIMS (Babor & Poznyak, 2010) and the WHO Global Information System on Resources for the Prevention and Treatment of SUD (WHO ATLAS-SU) (World Health Organization, 2010b), in 2018–2021, the WHO Department of Mental Health and SU developed a methodology for estimating the Service Capacity Index for Substance Use Disorders (SCI-SUD), a metric that is reflective of the national capacity of health systems to provide treatment for AUD and DUD, in terms of the proportions of available service elements in a given country from a theoretical maximum. This paper provides an in-depth description of the index development and initial efforts to establish its validity and robustness. The actual data on SCI-SUD by countries, regions and global estimates will be presented separately in a forthcoming WHO publication.

2 | METHODS

2.1 | Data collection and quality control

The instrument for data collection (WHO Global Survey on Progress with SDG Health Target 3.5) was developed by the WHO Department of Mental Health and SU, Alcohol, Drugs and Addictive Behaviours Unit in consultation with the WHO Technical Advisory Group on Alcohol and Drug Epidemiology based on previous experiences of data collection within WHO ATLAS-SU: Resources for the Prevention and Treatment of SU Disorders in 2010 (World Health Organization, 2010b) and 2014 (World Health Organization). This included an analysis of data collected in previous years (2010 and 2014) to identify and revise questions with low response rates, delete questions not directly related to the treatment of SUD (e.g., questions on primary prevention of SU outside health system), and add new questions important for service provision (e.g., details on access to essential medicines). After piloting the questionnaire between May and June 2019 in three countries, the WHO Global

Survey on Progress with SDG Health Target 3.5 was conducted between December 2019 and July 2020 by the WHO Department of Mental Health and SU in collaboration with WHO Regional and Country Offices. The survey included a section that specifically focused on service coverage and capacity of treatment services to address the needs of populations with SUD. The section on service capacity was structured around the building blocks (domains) of the WHO Framework for Monitoring Health Systems (World Health Organization, 2010a): (1) service delivery; (2) health workforce; (3) health information system; (4) access to medicines; (5) financing; and (6) governance. Each domain included a range of subdomains with specific questions regarding required service elements as presented in Table 1. The development of the data collection tool, and the selection of subdomains and indicators included in each building block were based on expert consultations during the WHO Preparatory Meeting on Monitoring UHC for Alcohol and DUD and a series of meetings of the WHO Technical Advisory Group on Alcohol and Drug Epidemiology.

The survey was completed by WHO focal points in Ministries of Health, nominated by their governments to participate in the survey. The WHO's LimeSurvey platform was used to collect information, with an option to submit a Microsoft Word version, based on individual requests. Respondents were encouraged to contact and consult additional experts from the following areas: (1) persons in charge of or involved in alcohol/drug control in the Ministry of Health, Ministry of Justice or other ministry, or the most senior government official in charge of alcohol control or alcohol-related conditions, or drug demand reduction programmes; (2) the head of a prominent non-governmental organization dedicated to alcohol/drug control; (3) a health professional (e.g., medical doctor, nurse, pharmacist, social worker, psychologist) who specialized in alcohol-related conditions and conditions due to other SU; (4) a faculty member of a public health or other relevant university department; (5) a police or other law enforcement officer; (6) a person at the Ministry of Finance, tax agency or statistical office; (7) a researcher, civil servant, or faculty member with expertise in treatment systems for SUD and treatment/service coverage.

After the data collection, rigorous data quality control was implemented. We inspected all the provided responses and ensured that the rules of the questionnaire were thoroughly followed. Errors, inconsistencies, and ambiguities were identified, and subsequently resolved, either by the analytical team or in consultation with focal

TABLE 1 Structure of the WHO Global survey on progress on SDG Health Target 3.5

Domains	Sub-domains	
Service delivery (114 variables)	Screening and brief interventions	Psychosocial treatment
	Non-structured services	Pharmacological treatment
	Specialized treatment services	Rehabilitation programmes
	5-year progress with the service delivery	
Health workforce (47 variables)	Availability and quantity of specialized human workforce	Maximum level of educational attainment
	Access to continuing professional development	System of ongoing support for health workforce
	5-year progress in the availability and capacity of health workforce	
Health information system (89 variables)	Data on prevalence of SU/SUD	Data on service utilization
	Data on service provision	5-year progress in the development of health information system
Access to medicines (61 variables)	Registered in the country	Provided for free in public health care sector
	Included in national essential list	Included in basic insurance package
	Included into national treatment guidelines	Quantitative data available
	5-year progress in availability of medications	
Financing (14 variables)	Information on governmental expenditures	Information on governmental support
	5-year progress in the level of governmental expenditures for treatment of SUD	
Governance (53 variables)	Having national policy for developing services	Having national guidelines for treatment of SUD
	Having national action plan	Having national system of accreditation of facilities
	Having national legal regulation	Human right protection/monitoring mechanism
	Having proper governance	5-year progress in national policy, plan, treatment standards/guidelines

points in countries. Moreover, we assessed the level of data missingness per country, and, when we deemed it as high, we provided an opportunity to the respective countries to resubmit their surveys. Overall, 154 (79.40%) out of 194 WHO Member States provided a response to the survey.

2.2 | Direct calculation of SCI-SUD, SCI-AUD and SCI-DUD

We aimed to use all relevant data collected in the WHO Global Survey on Progress with SDG Health Target 3.5 and convert such data to a single value index that would denote the overall capacity of services related to SUD. To achieve this objective, we performed several data transformations. First, we assigned numerical values to originally textual responses. For questions with only two response options, referring to the presence or absence of an element, we applied a binary coding approach, with the value 1 assigned to the presence of the element and the value 0 assigned to its absence. In instances of variables ordered based on the capacity of services, we assumed equidistance between the response options and assigned numerical values to response options accordingly. For example, in the case of questions with 3 response options, the response equal to the lowest service capacity was assigned the value 0, the next one with 1 and the one equal to the largest service capacity with value 2, while in the case of questions with 4 response options, the responses were coded as 0, 0.66, 1.33 and 2. Next, we applied a reverse transformation of continuous variables (e.g., prevalence rates) by binary coding them to reflect the presence or absence of data.

A graphical depiction of the SCI-SUD construction process is provided in Figure 1. For countries that provided an amount of information we deemed as sufficient (i.e., fewer than 90 (approximately 25%) missing values on the 378 key variables), the SCI-SUD was calculated directly. For the direct calculation, the country reported value of a given variable was divided by the theoretical maximum value on that variable, leading to the proportion from maximum for each variable. Then, the proportions from maximum for each of the 378 variables were averaged at the country level. We computed 95% confidence intervals (95% CI) around the mean established via the basic method for constructing bootstrap confidence intervals, using 10,000 replicates. Missing values, when present, were treated as zeros. We opted for this solution since the direction of bias can be a priori established (i.e., potential underestimation of true values). All variables were considered as having the same weight in the computation of the index. The values of the SCI-SUD could then range from 0 to 1 (convertible to percentage points), with higher values indicating higher overall development of services.

To provide complementary indices specifically for AUD and DUD, we followed similar procedure of SCI-SUD construction as outlined above, and calculated the Service Capacity Index for Alcohol Use Disorders (SCI-AUD) and the Service Capacity Index for Drug Use Disorders (SCI-DUD). The SCI-AUD was based on 115 variables, while the SCI-DUD was based on 165 variables. Only countries with less than 25 and 40 missing values (approximately 25%) were included in the calculation of SCI-AUD and SCI-DUD, respectively.

2.3 | Imputation of Service Capacity Index for Substance Use Disorders for countries with missing data

For countries that did not submit any data or had levels of missingness that we deemed as very high, we employed multiple imputation according to the multivariate imputation by chained equations method (van Buuren, 2018) to impute SCI-SUD. We used 30 imputation datasets, roughly corresponding to the percentage of countries for which the SCI-SUD could not be computed directly. We assumed that the data are missing at random (MAR) and used the predictive mean matching method because that can cope well with different data structures and prevents for imputation of unrealistic values (White et al., 2011). We considered a large number of variables to be used in the imputation model to make the MAR assumption more plausible. The final list included 17 variables (Table 2) suggested by experts working in the field, that both showed statistically significant

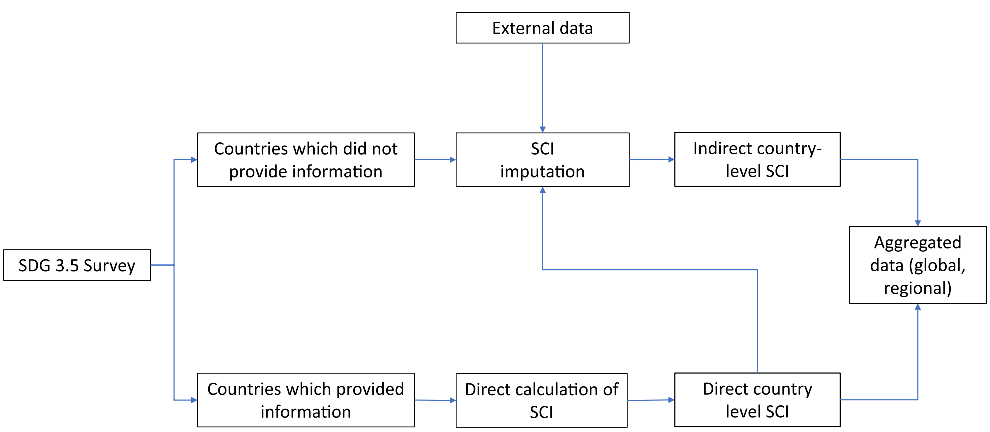

FIGURE 1 Framework of the data analysis

TABLE 2 External variables used for imputation and in regression models

Variable	Source	Latest available year (range)	Number of missing values (%)
Alcohol-attributable fractions, all-cause deaths	WHO Global Information System on Alcohol and Health	2016	11 (5.67)
Alcohol, total per capita (15+) consumption	WHO Global Information System on Alcohol and Health	2019	6 (3.09)
AUD (15+), 12 months prevalence	WHO Global Information System on Alcohol and Health	2016	4 (2.06)
Heavy episodic drinking (HED) (15+) past 30 days, age-standardized	WHO Global Information System on Alcohol and Health	2016	5 (2.58)
Global Domestic Product (GDP) per capita, Purchasing Power Parity (PPP) (in thousands)	The World Bank	2018–2019	12 (6.19)
Poverty headcount ratio at $1.90 a day, PPP	The World Bank	2011	29 (14.95)
Domestic general government health expenditure per capita, PPP (in thousands)	The World Bank	2011–2018	4 (2.06)
Out-of-pocket health expenditure per capita, PPP (in thousands)	The World Bank	2011–2018	4 (2.06)
Life expectancy at birth, years	WHO Global Health Estimates	2019	11 (5.67)
Adult mortality rate	WHO Global Health Observatory	2016	11 (5.67)
Hospital beds (per 1000 people)	The World Bank	1990–2019	3 (1.55)
Physicians (per 1000 people)	The World Bank	2001–2018	3 (1.55)
Prevalence of DUD	The Institute for Health Metrics and Evaluation	2019	0 (0.00)
Death rate related to DUD	The Institute for Health Metrics and Evaluation	2019	0 (0.00)
Global Health Security Index	Global Health Security Index	2019	0 (0.00)
UHC service coverage index	WHO Global Health Observatory	2017	11 (5.67)
Mean year of schooling	United Nations Development Programme, Human Development Data Centre	2019	8 (4.12)

correlation (Spearman's correlation coefficient, $p < 0.05$) with the unimputed SCI-SUD and had considerably low levels of missingness (ranging from 0 (0%) to 29 (14.95%)). The only exception from this rule was the inclusion of the variable denoting the alcohol-attributable fractions of all-cause deaths, for which the association was not statistically significant, however, it was deemed as a conceptually crucial variable.

Finally, for those countries not included in the direct SCI-SUD computation, the imputed SCI-SUD values from the 30 imputation datasets were averaged and 95% CI around the mean were established via the basic method for constructing bootstrap confidence intervals, using 10,000 replicates. As the main aim of the present study was to develop the SCI-SUD, we did not construct imputation models for SCI-AUD and SCI-DUD sub-indices.

2.4 | Robustness of the multiple imputation approach

Since no external data were available to evaluate the performance of the imputation procedure, we assessed the concordance between the existing, directly derived SCI-SUD values and the (predicted) values from the imputation model using the leave-one-out cross-validation technique (McDonald et al., 2015). In this technique, the directly derived SCI-SUD value of a single country is temporarily replaced with a missing value, and the remaining data are used to re-estimate it. We performed this procedure separately for each country for which the SCI-SUD was derived directly, and then computed the mean absolute prediction error, indicating how close, on average, were the predicted values from the imputation model to the directly derived SCI-SUD values. Next, we visualized the spread of directly derived and imputed SCI-SUD values across the 30 imputation datasets. Finally, we assessed the consistency of SCI-SUD estimates by computing the average SCI-SUD for all countries with 95% CI across each of the 30 imputation datasets.

2.5 | Associations of directly derived (SCI-SUD, SCI-AUD, SCI-DUD) and imputed SCI-SUD indices with external variables

We fitted a bivariable linear regression model to establish the association between each of the variables related to the epidemiology of SU and SUD as well as macro-level economic and healthcare-related variables (Table 3) and the directly derived SCI-SUD, SCI-AUD and SCI-DUD. Due to left skew, alcohol attributable fractions

TABLE 3 The distribution of directly derived and imputed Service Capacity Indices for Substance Use Disorders (SCI-SUD) across WHO regions

WHO region	Directly derived SCI-SUD *n* countries (%)	Imputed SCI-SUD *n* countries (%)
African Region	29 (61.70)	18 (38.30)
Region of Americas	29 (82.86)	6 (17.14)
Eastern Mediterranean Region	15 (71.43)	6 (28.57)
European Region	48 (90.57)	5 (9.43)
South-East Asia Region	8 (72.73)	3 (27.27)
Western Pacific Region	16 (59.26)	11 (40.74)
TOTAL	145 (74.74)	49 (25.58)

of all-cause deaths and deaths related to DUD, prevalences of AUD and DUD, Gross domestic product (GDP), poverty rate, domestic general government health expenditure, out-of-pocket health expenditure, life expectancy at birth, adult mortality rate, hospitals beds and physicians per 1000 people were log transformed prior to their addition to the models. To facilitate comparisons across the regression models, we performed z-score transformation of the external variables prior to their inclusion into regression models. Complementarily, we fitted a bivariable linear regression model on each of the 30 imputation datasets to establish the association between the external variables and the imputed SCI-SUD. We used Rubin's rules to pool together the results from these regression models (Rubin, 1987). All results are expressed as unstandardized beta coefficients (B) with 95% CI. Associations with $p < 0.05$ were considered as statistically significant.

3 | RESULTS

Overall, 154 countries responded to the survey with different numbers of people involved in completing the questionnaire across countries in addition to the main focal point: at least 5 experts in 44 countries, 4 experts in 12 countries, 3 experts in 28 countries, 2 experts in 22 countries, 1 expert in 16 countries, and no additional experts indicated in 44 countries. Data for direct SCI-SUD computation were available for 145 countries, while other countries and territories either did not submit data (40 countries) or had very high levels of missingness (9 countries). In the countries included for direct SCI-SUD computation, around 95% had missing values on 30 or less of the 378 variables: 84 (57.93%) had zero missing values, while 35 (24.14%), 15 (10.34%) and 11 (7.59%) had 1–10, 11–20 and more than 20 missing values, respectively. The proportion of countries for which the SCI-SUD was directly derived ranged from 61.70% for countries in Africa to 90.57% for European countries (Table 3). The SCI-AUD was calculated based on 115 variables for 141 countries (13 countries were excluded for having missing information on 25 or more variables). The SCI-DUD was based on 165 variables and calculated for 145 countries (9 countries were excluded for having missing information on 40 or more variables).

The distribution of directly derived SCI-SUD values followed approximately a normal distribution, with values ranging from 0.01 to 0.80 (Figure 2). The distribution of SCI-SUD values within a broad range suggests that the index is capable of differentiating the countries from each other in terms of their service capacity.

The detailed bivariate associations between the imputed SCI-SUD as well as unimputed SCI-SUD, SCI-AUD, SCI-DUD and variables related to the epidemiology of SU and SUD as well as macro-level economic and healthcare-related variables, are provided in Table 4. With regards to variables related to the epidemiology of SU/SUD, countries with higher total alcohol consumption (6.04; 3.34–8.75), prevalences of AUD (2.96; 0.14–5.78) and heavy episodic drinking (4.66; 1.88–7.44), higher prevalences of DUD (6.59; 3.84–9.34) and death rates related to DUD (8.00; 5.33–10.68) had higher values on the imputed SCI-SUD, indicating a greater overall development of services for people with SUD. When considering macro-level economic variables, countries with higher GDP per capita (8.56; 5.94–11.17), out-of-pocket health expenditures per capita (7.62; 4.83–10.42), Global Health Security Index (10.51; 8.01–13.02), and higher mean years of schooling (8.94; 6.35–11.53) demonstrated higher values on the imputed SCI-SUD, while, on the other hand, countries with a larger proportion of their population in poverty had lower values in the imputed SCI-SUD (−8.53; −11.40 to −5.67), translating to lesser development of services for people with SUD. Then, for healthcare-related variables, countries with higher general government health expenditures per capita (8.88; 6.30–11.46), life expectancies (9.78; 7.18–12.38), higher number of hospital beds (7.19; 4.48–9.90) and physicians (8.78; 6.23–11.33), UHC service coverage index (9.65; 6.95–12.35) were associated with higher values of the imputed SCI-SUD, while countries with higher adult mortality displayed lower SCI-SUD values (−9.48; −12.02 to −6.94). While the largely overlapping CI between the variables warrants a cautious interpretation, the strongest associations were between the SCI-SUD and the Global Health Security Index (10.51; 8.01–13.02), life expectancies (9.78; 7.18–12.38), and the UHC service coverage index (9.65; 6.95–12.35).

The direction as well as the magnitude of the associations between the imputed SCI-SUD and external variables was largely

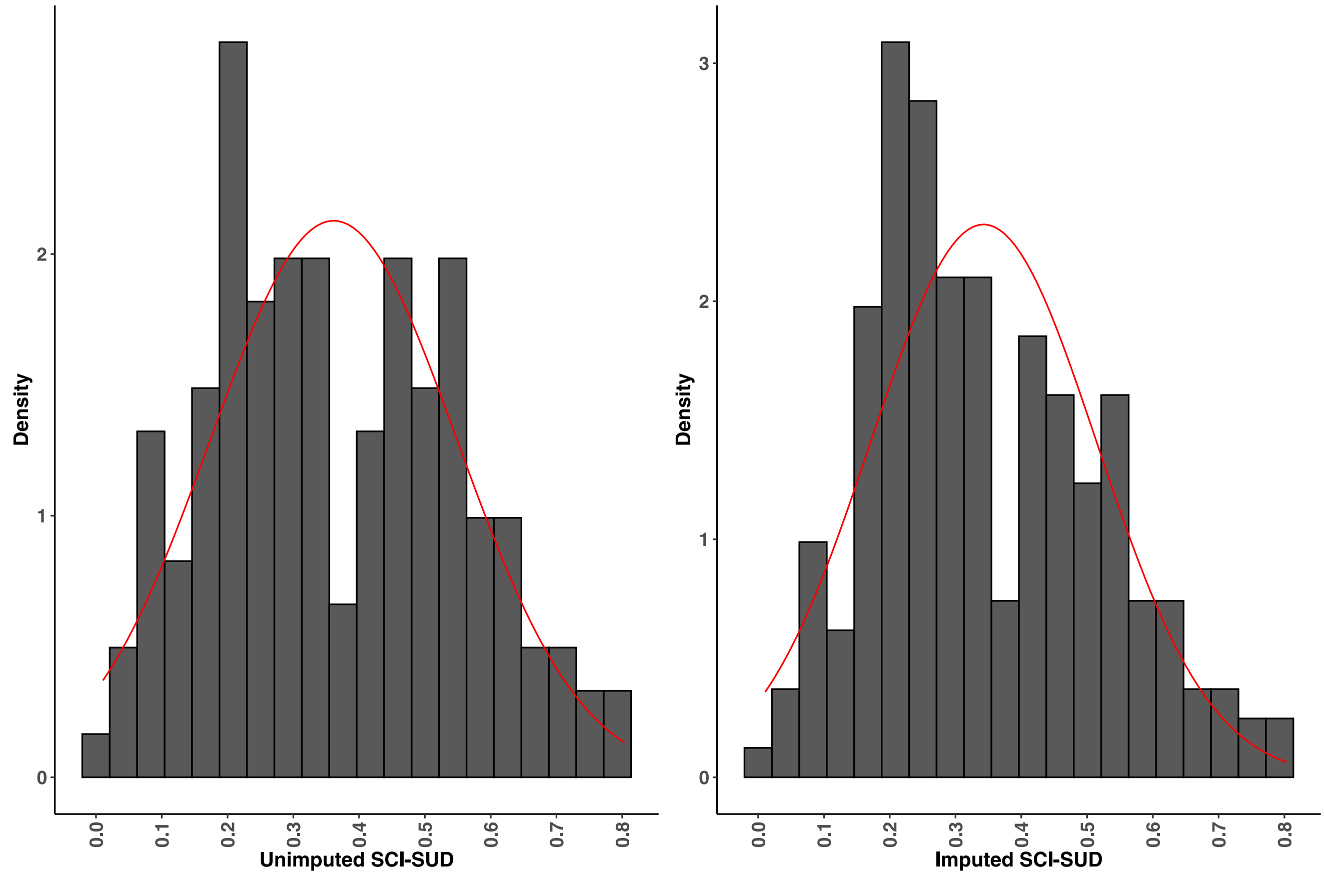

FIGURE 2 Histogram of unimputed and imputed Service Capacity Index for Substance Use Disorders (SCI-SUD) with superimposed normal curve

consistent with the associations between the directly derived SCI-SUD and these variables.

Both unimputed specific indices (SCI-AUD and SCI-DUD) were associated with all external macro-level economic and healthcare-related variables. For variables related to the epidemiology of SU and SUD, there were notable differences between the indices and their associations with these variables. While SCI-AUD was associated with the prevalence of AUD (4.19; 0.64–7.75) and with the alcohol-attributable fractions of all-cause deaths (4.47; 0.79–8.14), for SCI-DUD these associations were statistically insignificant (2.77; −0.66–6.20 and 3.11; −0.48–6.69). Then, while cautious interpretation is required because of largely overlapping CI, the magnitude of associations between SCI-DUD and drug related variables tended to be larger than between SCI-AUD and these variables, whereas SCI-AUD tended to display stronger associations with alcohol-related variables than did SCI-DUD. The only exception was the association of SCI-AUD and prevalence of DUD, which tended to be stronger than the association between SCI-DUD and this variable (8.07; 4.79–11.35 vs. 7.50; 4.34–10.66).

The evaluation of the robustness of the SCI-SUD multiple imputation procedure using the leave-one-out cross-validation showed that the mean absolute prediction error for SCI-SUD was 0.133 (95% CI = 0.117; 0.148), meaning that, on average, the predicted values were higher or lower than the observed values by 13.3%. The overall distribution of SCI-SUD values after the imputation largely resembled those derived directly from data reported by the countries. We did not detect any substantial clustering of values around the mean, or around the tails of the distribution (Figure 2) that would suggest that the procedure systematically under-estimates, over-estimates or estimates values around the mean. Similarly, the distribution of imputed SCI-SUD values seems to resemble the distribution of directly derived SCI-SUD values (Figure 3). As indicated by the small differences between the average SCI-SUD values for all countries across the 30 imputation datasets, the imputation procedure seems to produce highly consistent SCI-SUD estimates (Figure 4).

Overall, the proposed SCI-SUD and procedures for its estimation demonstrate considerable consistency and internal stability as well as a strong association with key variables related to the epidemiology of SU/SUD and key macro-level economic and healthcare-related variables.

4 | DISCUSSION

The presented methodology for data collection (WHO Global Survey on Progress with SDG Health Target 3.5) and analysis (producing comparable SCI-SUD estimates for all countries) offers a new

TABLE 4 Bivariate associations of imputed Service Capacity Index for Substance Use Disorders (SCI-SUD) and directly derived SCI-SUD, Service Capacity Index for Alcohol Use Disorders (SCI-AUD), Service Capacity Index for Drug Use Disorders (SCI-DUD) with external variables

	Unimputed SCI-SUD		Imputed SCI-SUD		Unimputed SCI-AUD		Unimputed SCI-DUD	
Variable	B (95% CI)	p-value	B (95% CI)	p-value	B (95% CI)	p-value	B (95% CI)	p-value
Alcohol-attributable fractions, all-cause deaths	3.49 (0.21; 6.77)	0.04	3.22 (0.38; 6.06)	0.03	4.47 (0.79; 8.14)	0.02	3.11 (−0.48; 6.69)	0.09
Alcohol, total per capita (15+) consumption	6.03 (3.08; 8.98)	<0.001	6.04 (3.34; 8.75)	<0.001	7.54 (4.26; 10.82)	<0.001	6.43 (3.27; 9.60)	<0.001
AUD (15+), 12 months prevalence	3.16 (0.01; 6.32)	0.05	2.96 (0.14; 5.78)	0.04	4.19 (0.64; 7.75)	0.02	2.77 (−0.66; 6.20)	0.11
Heavy episodic drinking (HED) (15+) past 30 days, age-standardized	5.64 (2.56; 8.71)	<0.001	4.66 (1.88; 7.44)	<0.001	6.73 (3.29; 10.17)	<0.001	6.30 (2.99; 9.60)	<0.001
GDP per capita, Purchasing power parity (PPP) (in thousands)	8.85 (6.02; 11.69)	<0.001	8.56 (5.94; 11.17)	<0.001	10.59 (7.48; 13.70)	<0.001	9.54 (6.46; 12.62)	<0.001
Poverty headcount ratio at $1.90 a day, PPP	−10.72 (−13.49; −7.94)	<0.001	−8.53 (−11.40; −5.67)	<0.001	−11.63 (−14.79; −8.48)	<0.001	−11.17 (−14.24; −8.10)	<0.001
Domestic general government health expenditure per capita, PPP (in thousands)	9.21 (6.49; 11.93)	<0.001	8.88 (6.30; 11.46)	<0.001	11.25 (8.29; 14.22)	<0.001	9.80 (6.85; 12.75)	<0.001
Out-of-pocket health expenditure per capita, PPP (in thousands)	8.28 (5.20; 11.36)	<0.001	7.62 (4.83; 10.42)	<0.001	9.61 (6.16; 13.05)	<0.001	9.07 (5.75; 12.40)	<0.001
Life expectancy at birth, years	10.18 (7.47; 12.90)	<0.001	9.78 (7.18; 12.38)	<0.001	11.62 (8.61; 14.62)	<0.001	11.05 (8.11; 13.99)	<0.001
Adult mortality rate	−9.49 (−12.12; −6.86)	<0.001	−9.48 (−12.02; −6.94)	<0.001	−10.94 (−13.87; −8.01)	<0.001	−10.47 (−13.31; −7.64)	<0.001
Hospital beds (per 1000 people)	8.10 (5.35; 10.86)	<0.001	7.19 (4.48; 9.90)	<0.001	10.20 (7.19; 13.20)	<0.001	8.04 (4.98; 11.10)	<0.001
Physicians (per 1000 people)	9.08 (6.29; 11.86)	<0.001	8.78 (6.23; 11.33)	<0.001	11.31 (8.20; 14.42)	<0.001	9.37 (6.33; 12.42)	<0.001
Prevalence of DUD	7.25 (4.35; 10.16)	<0.001	6.59 (3.84; 9.34)	<0.001	8.07 (4.79; 11.35)	<0.001	7.50 (4.34; 10.66)	<0.001
Death rate related to DUD	8.81 (6.10; 11.53)	<0.001	8.00 (5.33; 10.68)	<0.001	9.35 (6.28; 12.41)	<0.001	9.98 (7.10; 12.87)	<0.001
Global Health Security Index	11.40 (8.80; 14.01)	<0.001	10.51 (8.01; 13.02)	<0.001	12.17 (9.21; 15.14)	<0.001	12.80 (10.03; 15.56)	<0.001
UHC service coverage index	10.30 (7.61; 13.00)	<0.001	9.65 (6.95; 12.35)	<0.001	12.35 (9.39; 15.30)	<0.001	10.82 (7.87; 13.76)	<0.001
Mean year of schooling	9.56 (6.83; 12.29)	<0.001	8.94 (6.35; 11.53)	<0.001	10.89 (7.84; 13.93)	<0.001	10.14 (7.18; 13.11)	<0.001

Note: The indices were converted to percentage points. Due to left skew, alcohol attributable fractions of all-cause deaths and deaths related to DUD, prevalences of AUD and DUD, GDP, poverty rate, domestic general government health expenditure, out-of-pocket health expenditure, life expectancy at birth, adult mortality rate, hospitals beds and physicians per 1000 people were log transformed prior to their addition to the models. All external variables were z-score transformed prior to their inclusion into regression models. The results are expressed as unstandardized beta coefficients with 95% confidence intervals.

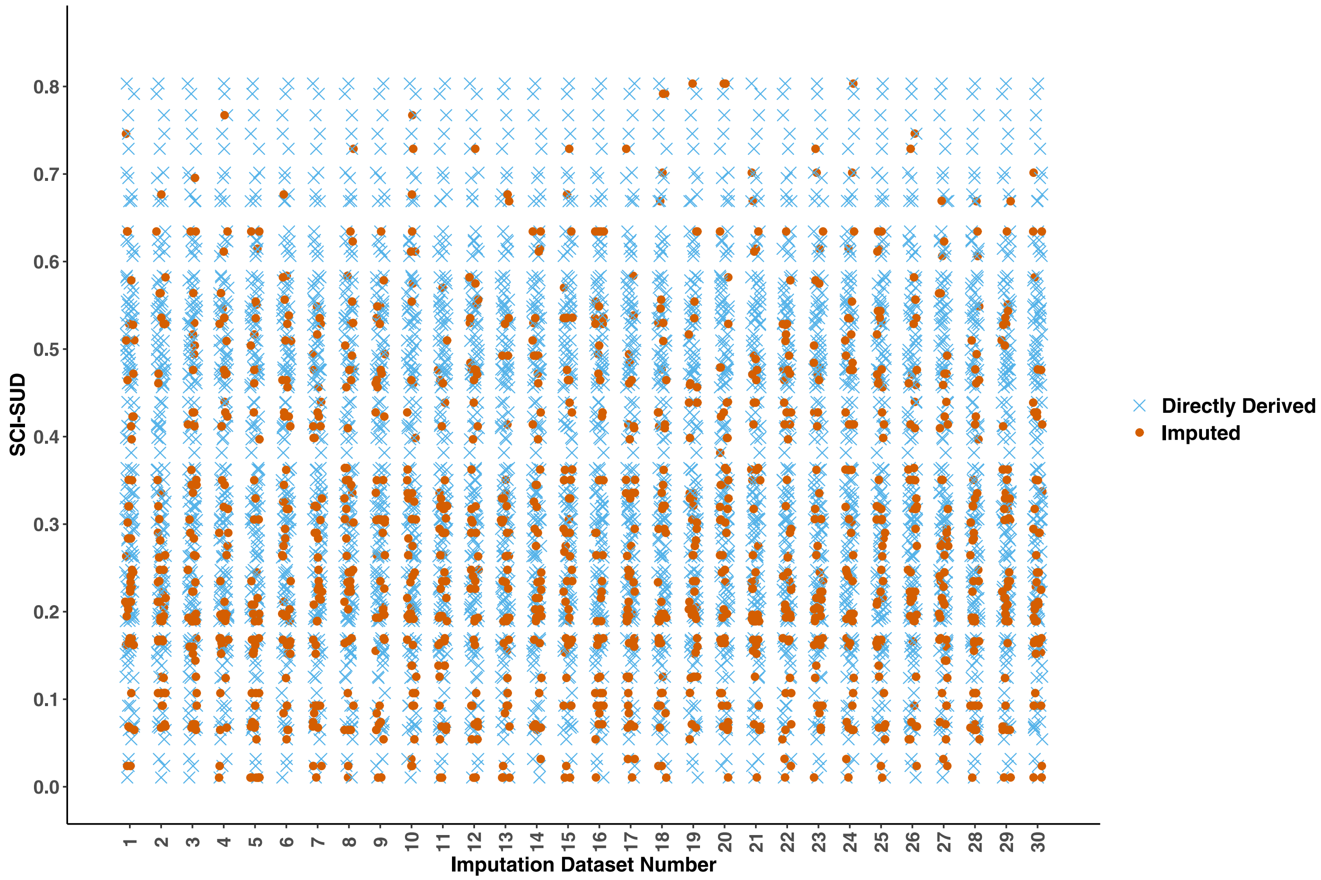

FIGURE 3 Distribution of directly derived and imputed Service Capacity Index for Substance Use Disorders (SCI-SUD) values across the imputation datasets

approach to monitoring the capacity of treatment systems for AUD and DUD, representing how well health systems are prepared to deliver services to people with these conditions. It demonstrates the feasibility of producing meaningful indices appropriate for continuing reporting that is (1) based upon national data; (2) feasible for monitoring at global; regional and national levels; (3) produces data which are comparable across countries; and (4) can inform local actions for service strengthening.

The presented method has several advantages and represents a significant step forward in understanding and regularly monitoring the global situation in regard to the development of treatment systems for SUD. For the first time, a method allowing estimation of service capacity for all countries and territories was presented. Based on the data collected, it is possible to produce indices reflecting the overall capacity of services to provide treatment for people with SUD, but also specifically for AUD and DUD, which importantly reflects differences across countries in treatment provision for these conditions. All three directly derived indices (SCI-SUD, SCI-AUD, SCI-DUD) and imputed SCI-SUD are strongly associated with macro-level economic and healthcare-related variables and variables related to the basic epidemiology of SU and SUD. The strong association with external variables indicates good construct validity of the measure. As one would expect, countries with a higher GDP, security, longer mean education, and less poverty demonstrated higher SCI-SUD. Similarly, the indices are associated with variables related to population health and healthcare, with countries having higher health expenditure, longer life expectancy, lower mortality, higher numbers of hospital beds and physicians displaying higher SCI-SUD. Importantly, the index is strongly associated with the UHC service coverage index (Lozano et al., 2020) which is an indication of a good convergent validity since both try to measure development of health services, just for different conditions. In addition, the indices seem to be specific, with SCI-AUD tending to display stronger associations with variables related to the epidemiology of AUD than does SCI-DUD, and vice versa. Then, by covering a wide range of values, there is an indication that the SCI-SUD might be well-suited to differentiate the countries in terms of service capacity.

Several limitations of the adapted approach require attention. First, from a conceptual point of view, since treatment of SUD is often distributed across different sectors, using the WHO Framework for Monitoring Health Systems might result in missing information from social care, criminal justice systems and others. Next, for the SCI-SUD values derived directly from country-level data, there might be issues with the quality of reported data, both because of human error and the imperfection of health information systems and imprecision of population-level statistics. The extent of these is,

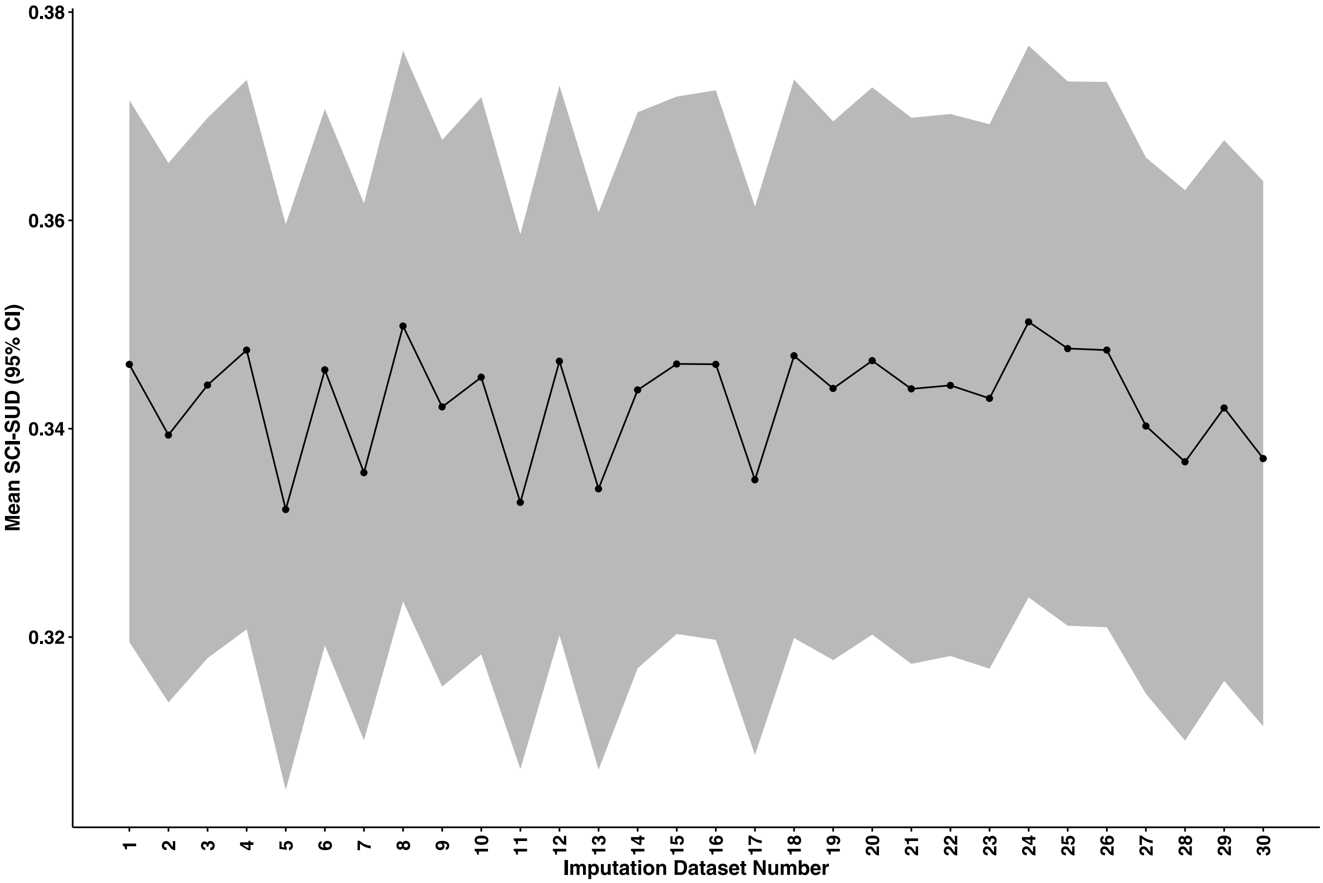

FIGURE 4 Consistency of Service Capacity Index for Substance Use Disorders (SCI-SUD) estimates across the imputation datasets

however, difficult to evaluate because of the absence of alternative data sources and validation studies. Complementarily, given its design, we cannot rule out the possibility that the SCI-SUD captures not only the overall development of services related to SUD but also the quality of data reporting systems in a given country. Moreover, some countries included in the direct SCI-SUD computation had a small proportion of missing values on key variables. By treating these as zeroes, this step might have introduced an underestimation of the true SCI-SUD for the affected countries. Next, for the imputed SCI-SUD, the approach relied on the use of external data sources, which, in most cases, are not direct estimates themselves, thus potentially introducing a non-trivial level of artificiality to the estimates. Moreover, even after multiple rounds of consultations with domain experts, we cannot rule out that some variables that might be crucial for the imputation of SCI-SUD were not identified. Also, while for the majority of countries the last available data on variables used for imputation were close to the time of the realization of the WHO Global Survey on Progress with SDG Health Target 3.5, there were instances when the data were considerably older, which could have led to the introduction of imprecision in the SCI-SUD estimation. Next, while the leave-one-out cross-validation technique showcased acceptable concordance between predicted and observed SCI-SUD values, good predictions are not necessarily indicative of good imputation models. In the absence of gold standard metrics, we were not able to examine the performance of our index against external data. Given this, the external validity of the SCI-SUD remains largely unknown. Ideally, this would require additional activities that would allow more detailed collection of information on health system indicators in selected countries: a future direction for strengthening the indicator. Further, the index consists of a substantial number of variables, making its applicability for routine collection potentially difficult for a non-negligible proportion of countries. Thus, additional efforts are warranted to reduce the number of collected variables while retaining the key properties of the index.

The SCI-SUD might be helpful in understanding service capacity, but additional work is needed to assess if the SCI-SUD is suitable as a proxy measure for assessment of treatment contact or effective coverage and prediction of overall service impact. The feasibility of routine data collection for SCI-SUD also requires further investigation.

ACKNOWLEDGEMENTS

We would like to express our gratitude to the experts involved in consultations on the development of the methodology: Ms Chloé Carpentier, Ms Angela Me, Mr Kamran Niaz (UNODC, Vienna, Austria), Prof. Colin Drummond (Institute of Psychiatry, Psychology and Neuroscience, King's College London, London, UK), Dr Gerhard Gmel (Addiction Info Switzerland, Lausanne, Switzerland), Prof. Ludwig Kraus (IFT Institut für Therapieforschung, München, Germany), Dr Jacek Moskaliewicz (Institute of Psychiatry and Neurology, Warsaw, Poland), Dr Alessandro Pirona (European Monitoring Centre for Drugs and Drug Addiction, Lisbon, Portugal), Dr Brian Rush (Health Systems and Health Equity Research group, Social and Epidemiological Research Department, Centre for Addiction and Mental Health, Toronto, Canada), Dr Maristela Goldnadel Monteiro (PAHO), Prof. Shekar Saxena (Harvard T. H. Chan School of Public Health, Boston, USA), Dr Hamad Al-Ghaferi (National Rehabilitation Centre, Abu Dhabi, United Arab Emirates).

CONFLICT OF INTEREST

The authors alone are responsible for the views expressed in this article and they do not necessarily represent the views, decisions or policies of the institutions with which they are affiliated. The authors declare there are no conflicts of interest.

DATA AVAILABILITY STATEMENT

Upon following publication of WHO Report, data will be openly available to anyone interested in the WHO Global Health Observatory. The analytical code used for thea index computation can be shared by corresponding author upon request.

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How to cite this article: Krupchanka, D., Formanek, T., Shield, K., Rehm, J., Heymans, M. W., Fleischmann, A., Degenhardt, L., Gawad, T., & Poznyak, V. (2022). International monitoring of capacity of treatment systems for alcohol and drug use disorders: Methodology of the Service Capacity Index for Substance Use Disorders. *International Journal of Methods in Psychiatric Research*, e1950. https://doi.org/10.1002/mpr.1950