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SOME REFLECTIONS ON THE USE OF COMPOSITE INDICATORS FOR MEASURING HEALTH ACHIEVEMENTS AT THE SUBNATIONAL LEVEL: INSIGHTS FROM PORTUGAL

Abstract: The exigency of "leaving no one behind", expressed in the 2030 UN Agenda for Sustainable Development, and the existence in some contexts, such as in Portugal, of new competences for local authorities, call for greater attention to the evaluation of policies and monitoring of results at subnational level. This paper scrutinizes the most critical issues in the construction of composite indicators that are intended to analyze health, as interpreted in the SDGs, at the subnational level. First, the main characteristics of the indicators selected by Statistics Portugal to cover Goal 3 will be analyzed. Then, the paper will examine the priorities to be considered during construction of composite indicators, that take into account the structure of the SDGs. A first element concerns the need to deepen the choice of the indicator set on which the composite indicator will be based. Data limitation and the exclusion of some contextual elements hamper the construction of meaningful composite indicators at the subnational level. It is also critical to examine the possible synergies and trade-offs between the various SDG indicators, which directly or indirectly refer to health, and adequately consider these relationships in the aggregation phase.

Keywords: Health, SDGs, Composite indicator, Subnational level, Portugal.

1. Introduction

There are still significant gaps in the understanding of the determinants of health, but one can largely assume that health is influenced by several factors ([in]direct, [in]tangible, objective or perceived) which occur simultaneously at different levels (micro and macro). Investigating the role of place in health is an important research topic as 'where one lives' impacts not only the physical, mental, and social status of a person but also on the likelihood of being healed. Notwithstanding the positive trends in almost all health-related spheres, at the global level achievements in health are not advancing at the desired speed, or appropriate scale, to address major diseases. Many people still do not have access to essential health services (WHO, 2019). However, the need to encourage new health initiatives is a global priority, as testified by the adoption of the 2030 Agenda for Sustainable Development in September 2015 by the United Nations General Assembly. The 2030 Agenda includes a set of 17 Sustainable Development Goals (SDGs), one of which specifically concerns health – Goal 3 (from now on, SDG 3). According to SDG 3, ensuring healthy lives and promoting well-being for all people during their whole lifetime is essential for sustainable development.

The multiscalar and multidimensional nature of sustainable development requires, on the one hand, the active contribution of all levels of government, including local government, to design and develop policies,

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implement appropriate actions, and involve effective partnering initiatives in order to meet the SDGs; and, on the other hand, the existence of appropriate mechanisms to measure progress in delivering results (Nagy et al., 2018). The SDGs are operationalized through a wide set of indicators, but the individual scrutiny of each single element cannot provide clear policy guidance. This paper aims to contribute to the discussion on the use of composite indicators to monitor accomplishment of the SDGs in the health domain, paying particular attention to their application at the subnational level. Health is a cross-cutting topic that encompasses managerial, organizational, and financial aspects, and is interlaced with environmental policy and the subjective aspects of people's lives. By summarizing in a single numerical value a set of indicators concerning various aspects of health, composite indicators can provide clear evidence of health outcomes and, when applied to the subnational level, push local leaders and other decision makers to be more accountable to their commitments to achieve a higher standard of health and health care in their communities. In this work, we will present a critical examination of data sources and offer insights into the ideal properties of a composite indicator for use in the SDG context. It is beyond the scope of the article to rank the performance of Portuguese subnational units. Similarly to Costanza et al. (2016), we contend that aggregate measurements of progress are needed to guide societal change. However, before moving to the construction of such analytical tools, a careful reflection is necessary of how the concept of health can be operationalized through relevant indicators. The 2030 UN Agenda for Sustainable Development is used as our starting point, more specifically referencing the SDG global indicator framework. In this context, it will also be relevant to reflect on the suitability of the UN indicator set to evaluate local conditions and identify local problems.

Composite indicators are applied to every area of research, but their use at the various subnational levels of analysis are limited and rely extensively on census data (some examples of within-country analyses can be found in the works of: González et al., 2011, 2018; Santana et al., 2015a; Salvati and Carlucci, 2014). Data at the upper levels, especially at the national level, are easier to work with both because of the availability of the data and the reduced presence of outliers and missing data (Zaccomer, 2018). However, data shortage should not prevent research on the evaluation of performance at lower administrative spatial scales. In line with this argument, in this work the choice of the subnational level of analysis is justified by the clear value-added of local indicators in decision-making (Pires, 2017). In addition, despite the political importance attributed to distances within countries (the objective of giving the same opportunities to all is explicitly tackled by SDG 10), very few studies examine the measurement of health-related issues at the subnational level (a notable exception is Suparmi et al., 2018). We will try to provide some insights for this research gap by using indicators selected for Portugal to monitor the SDGs (INE, 2018, 2019) as a statistical information base for our discussion.

In line with the reform trend in many European countries, Portugal is in the process of decentralizing health competencies, from central to local administrations (municipal entities). This is regarded as an important means to achieve effective improvements in the efficiency of the health system and to assure equity and quality in access to health care services. More specifically, with decree-law nº 23/2019 the municipalities will have the opportunity to participate in the management and execution of investments for new primary health care units and in the preservation of existing units. Additionally, in collaboration with the National Health Service, local administrations will be responsible for promoting healthier lifestyles and for managing the careers of a specific category of health worker (*assistente operacional*). Therefore, analyzing and monitoring the key dimensions of health performance through an heterogeneous set of indicators at subnational level must be seen as an effective way for local and central governments to promote more and better service provision (both in the definition of the number, type, and location of health care general interest services, and in the assessment of the quality of services provided); and to allocate financial and human resources according to needs and expectations (for example, the distribution of the budget by the central state to municipalities according to needs and health gains). The participation of municipalities in health policies justifies the consolidation of methodological approaches to assess the temporal dynamic and spatial patterns of key health indicators in order to support implementation of local public policies. In other words, it would be limiting to assess the health of the Portuguese population (and

the effectiveness of local policy initiatives) by only referring to the traditional indicator of life expectancy, for example.

The rest of the paper is organized as follows: i) section 2 briefly reviews the 2030 UN Agenda, how its goals and targets are monitored and reviewed, then revises some composite indicators that have been constructed in the SDG and health setting domain; ii) section 3 provides a concise overview of the main aspects of a composite indicator's construction by discussing data availability for SDG 3 in Portugal and the characteristics that it should have to better fit the SDG context; and finally, iii) section 4 discusses the opportunities and limitations of a composite indicator for the SDGs and outlines avenues for further research.

2. Metrics for the SDGs and health

The 2030 Agenda for Sustainable Development, adopted by the General Assembly of the United Nations on September 25, 2015, calls on UN Member States to achieve a better and more sustainable future for all by pursuing a holistic strategy that combines economic development, social inclusion, environmental sustainability, and efficient governance. The 17 Sustainable Development Goals, assumed in the 2030 Agenda, represent a shared and co-responsible global vision of the fundamental components of sustainable development and how they work together in an encompassing framework. The 17 SDGs and their targets (169 in total) substantially outline the pathway that should be taken to promote prosperity, while addressing social needs and committing to the safeguard of the planet. Given these major challenges and their complexity, it is no surprise to find strong interconnections between the various goals, so that one particular achievement may impact positively (in the case of synergies) or negatively (when a trade-off occurs) on other outcomes. Sound metrics and data are critical to transform the SDGs into practical tools for the identification of actions and approaches leading to the achievement of the targets. Accordingly, part of the sustainable development strategy consists of developing a shared statistical information framework to monitor and evaluate progress toward the Agenda's objectives. The Inter-Agency and Expert Advisory Group on SDG Indicators (IAEG-SDGs), created by the UN Statistical Commission gathering different stakeholders and experts representing regional diversity, was tasked with selecting the indicators to monitor the goals and targets to be achieved by 2030. As at July 2019, the official list of indicators consisted of 232 elements (244 considering repetitions). An important statement that should be made is that the overarching principle of the SDGs is that no one should be left behind. Thus, it is not only the global indicator per se that is important, but also its disaggregation by several socio-economic dimensions, such as: income, sex, race, ethnicity, migratory status, disability and geographic location, if relevant. As pointed out by Liverman (2018), major attention should be given to subnational data, as they can help to shed light on within-country performance and inequalities. Despite the importance of local issues (for instance, if residing in contaminated sites leads to an increase in malignant tumors compared to other areas), the use of local data, especially in development, creates many problems as data are often not collected, or are collected but not in a proper way, or are inaccurate (Sultana, 2018).

The current indicator base is undoubtedly fundamental for detailed assessment of specific policy measures, but prevents a straightforward and clear assessment of how a single country is generally performing. The close review of each single indicator allows analysis of trends over time (in Italy, for instance, Bressan et al., 2016). However, indicators within the SDGs are grouped by targets and goals, therefore it is difficult to make a clear statistical evaluation of overall performance, especially when an indicator has moved toward the sustainable development objective and another has moved away. Moreover, an approach based on the analysis of single indicators can lead to overly narrow assessments and a fragmentation of policies, while the analysis of indicators should be integrated to produce a broader evaluation. As highlighted by Rickels et al. (2016), the set of SDG indicators has limitations in providing policy guidance. When considering the overall indicator set as made up of single elements, there is a risk of attributing different and subjective importance to indicators belonging to the same set and not to account for the relationships between indicators. Moreover, there is also the possibility for replacement, deletion,

refinements, adjustments and inclusion of new indicators. Although these decisions are taken collectively and in a transparent way, it implies some assessment of the relative importance of the 'candidate' indicator.

A tool that can contribute to making the complex concise is the composite indicator. It consists of a mathematical combination of a set of indicators that represent the different aspects of a phenomenon to be measured. In the case of the SDGs where a large number of indicators have been adopted, composite indicators can contribute to facilitating the assessment of progress, identification of priorities and weak points in implementation.

Despite the recent adoption of the 2030 UN Agenda, some attempts have already been made to build composite indicators with the intent to provide a straightforward and (possibly) easy-to-interpret score that represents the whole global indicator framework, or single goals.

With the purpose of informing debate and guiding strategic policymaking on the SDGs, in collaboration with the Sustainable Development Solution Network, Bertelsmann Stiftung has published a yearly report describing countries' performance in achieving the 17 SDGs. The aim is to provide a simple analytical tool, the "SDG Index", that can help any country to identify priorities for early action, understand the key implementation challenges, and identify the gaps that must be closed in order to achieve the SDGs by 2030 (for methodological details, refer for example to Sachs et al., 2019). However, as emphasized by the same authors, the existence of significant data gaps poses strong limitations in the scope and coverage of the SDG Index (Schmidt-Traub et al., 2017).

In the wake of this index, and with the aim of monitoring progress across the whole set of goals to make international comparisons, Biggeri et al. (2019) developed the "Integrated Sustainable Development Index". This latter index attempts to address the limits of the SDG Index, which, in their view, fails to consider the heterogeneity of achievements, both within and between goals, and the conceptual problems of the arithmetic and geometric mean. In addition, it is worth recalling the work of Guijarro and Poyatos (2018) who rank the EU-28 countries by using a framework that, similar to the previous index mentioned, considers possible connections between goals.

An interest in the metrics aimed at tracking progress toward the 2030 UN Agenda is evident not only with reference to the SDGs as a whole, as shown above, but also with regard to single domains. Concerning health, the publication that up to now probably presents the most promising tools in helping a country to advance toward the achievement of SDG 3 at the subnational scale is Suparmi et al. (2018). Here, the authors assess public health development and its various dimensions at the national, provincial and district level in Indonesia and then quantify subnational regional inequality. The composite indicator that is discussed in this work, the "Public Health Development Index", was not built purposely to monitor SDG 3. However, the variety of indicators that constitute the Public Health Development Index; the possibility of utilizing it to make further measurements that allow for geographical comparisons; and, as stated by the authors, the culture of competition it creates to improve health development across districts, are undoubtedly worthy of our attention.

Looking to the work that was conducted before the SDGs were present in academic literature, some studies have dealt with the construction of composite indicators in the health domain at the subnational scale of analysis. Among these, it is worth mentioning Prinja et al. (2017), which well illustrates the importance that composite indicators can have for a comprehensive assessment of health system performance, especially in low and medium income countries, such as in their case study, India. In their work, the fact that there is no global consensus of what universal health care is (or its goals) highlights the need to reach an agreement on its definition, so that services to be included in measurement metrics can be clearly identified. With the purpose of studying inequality in China, Fang et al. (2010) constructed an overall index of health status. In their work they recall the importance of measurements: countries in transitions are facing the greatest challenge in offering a fair and equitable health system, so policymakers need to be properly informed before they propose approaches to reduce existing regional gaps.

In the European context, an interesting framework that supports the construction of a population health index was advanced in Portugal (Santana et al., 2015a, 2015b). Despite having the merit of acknowledging the different points of view of key stakeholders and experts taking part in the process, the indicator gives

the possibility of providing a comparison over a span of 10 years, while the ideal would be to conduct analysis on a yearly basis.

3. The measurement of health at the subnational level in Portugal: some insights

3.1. Data selection

So far we have seen that an important component of the sustainable development strategy consists of developing a shared statistical information framework. Moreover, we have highlighted that some attempts have already been made to build composite indicators for the SDGs and the health domain to make the evaluation of performance easier, both in academia and by global institutions. From a methodological perspective, when dealing with composite indicators the first big empirical challenge concerns the definition of the phenomenon to be measured and the selection of a relevant set of indicators. In our case, this issue boils down to the selection of indicators that can be considered as linked to the health domain and that allow coverage, as far as possible, of SDG 3 and related goals. This is a very sensitive step as the inclusion or exclusion of indicators, or the replacement of missing indicators by others, might affect the outcomes attained with the composite indicator and may have impacts in terms of the transparency and soundness of the process.

Leaving the task of examining the current contents of the global indicator framework (UN, 2019) to the reader, here we want to briefly summarize the idea of "health" in SDG 3, before outlining the challenges in the data selection phase. The first consideration is that some of the targets (and consequently indicators) mostly concern the risks and health conditions of populations in the early stages of health transition, where mortality is still very high despite the fact that most of the diseases and conditions leading to death are preventable or treatable; while in developed countries, the most relevant targets are linked to the new epidemiological and environmental context, the aging of the population and lifestyle-related risk factors. The second point is that SDG 3 calls for efforts and investments by the relevant authorities to tackle social and territorial inequalities, and also for the empowerment of citizens toward safeguard of their health and well-being.

Since 2017, Statistics Portugal (INE) has made a data platform available which contains indicators for the country deriving from the overall global indicator framework adopted by the UN to monitor implementation of the UN 2030 Agenda. In 2018, INE also started to publish a yearly publication (INE, 2018, 2019) which presents a description of the performance of the SDG indicators available for Portugal, from 2010 to the last year available. Table 1 below presents the indicators INE selected to cover the various targets and their most relevant characteristics, including: their status, at what geographical level they are available, the last year of available data, and time series' completeness.

The first point to note is that not all the indicators to monitor the SDGs are available for the country. This might lead to important omissions, e.g. SDG indicators 3.5.1 (coverage of treatment interventions for substance use disorders) and 3.8.1 (average coverage of essential services based on tracer interventions), both related to heath service provision, are missing. There are also some global indicators with which more than one indicator is associated (e.g. SDG indicator 3.8.2 "Proportion of population with large household expenditures on health as a share of total household expenditure or income" is covered by two indicators). Another critical situation is that some indicators do not have an exact match to the SDG indicator (e.g. SDG indicator 3.5.2 "Harmful use of alcohol, defined according to the national context as alcohol per capita consumption [aged 15 years and older] within a calendar year in liters of pure alcohol" is approximated with another indicator in Portugal).

Second, the entire time series is only available for a small subset of indicators. This is clearly a limitation if the goal is to build a composite indicator that aims to monitor progress toward the SDGs over years.

The third point we want to make concerns data coverage. The availability of information at the local level is a problem: the indicators for most targets are only available for the national level or, at best, for

NUTS 2. In its Regional Statistical Yearbooks, INE publishes other data in the health domain, including at the municipal scale, but in most cases these time series only partially cover the SDG indicator (e.g. the variable "mortality rate for malignant neoplasm" is available in Portugal at the municipal level, but this is only one of several aspects covered by 3.4.1). Another point is how to consider the targets and indicators outside SDG 3 that are also related to the concept of health and well-being[1]. This aspect will be explored later as it is both a problem of data selection and of aggregation of indicators.

Table 1. Indicators selected by INE for Portugal to assess SDG 3 and their main characteristics

SDG Indicator	Indicator selected for Portugal (and data source)	Status	Highest geog. level available	Last year available	Time series (2010–2017)
3.1.1	Maternal mortality rate per 100 000 live births (INE)	I	Country	2017	Yes
3.1.2	Proportion of births (live births) attended by skilled health personnel (INE)	I	NUTS 3	2018	Yes
3.2.1	Deaths of children aged 0–4 per 1 000 live births (INE)	I	NUTS 3	2018	Yes
3.2.2	Neonatal mortality rate (INE)	I	NUTS 2	2018	Yes
3.3.1	Incidence rate of notified cases of HIV per 1 000 inhabitants (National Health Institute Dr. Ricardo Jorge)	I	Country	2017	Yes
3.3.2	Incidence rate of notified cases of tuberculosis per 100 000 inhabitants (Health General Directorate)	I	NUTS 2	2017	No (2014 missing)
3.3.3	Incidence rate of notified cases of malaria per 1 000 inhabitants (Health General Directorate)	I	NUTS 2	2017	Yes
3.3.4	Hepatitis B incidence per 100 000 population (Health General Directorate)	I	NUTS 2	2017	No (only 2015–2017)
3.3.5	Number of people requiring interventions against neglected tropical diseases (UN)	I	Country	2015	No (only 2010–2015)
3.4.1	Mortality rate (30 to 70 years) due to diseases of the circulatory system, malignant neoplasms, diabetes mellitus and chronic respiratory diseases per 100 000 inhabitants (INE)	I	Country	2017	Yes
3.4.2	Standardized mortality rate due to intentional self-harm (suicide) per 100 000 inhabitants (INE)	I	NUTS 2	2017	Yes
3.5.2	Proportion of the resident population aged 15 and over who consumed six or more alcoholic drinks on a single occasion in the 12 months prior to the interview (INE, National Health Institute Dr. Ricardo Jorge)	PR	Country	2014	No
3.6.1	Mortality rate due to road accidents per 100 000 inhabitants (INE)	I	NUTS 2	2017	Yes
3.7.1	Proportion of the resident female population aged 15–49 years who used a modern contraceptive method as the main contraception method in the 30 days preceding the interview (INE, National Health Institute Dr. Ricardo Jorge)	I	NUTS 2	2014	No
3.7.2	Adolescent fertility rate (INE)	PR	NUTS 3	2017	Yes

[1] Health is also present in other goals that concern the human dimension, as in SDG 1, Target 1.a (mobilization of resources to implement programmes and policies to end poverty); in SDG 2, Target 2.2 (end all forms of malnutrition); in SDG 4, Target 4.2 (access to quality early childhood development, care and pre-primary education); and in SDG 5, Target 5.6 (access to sexual and reproductive health and reproductive rights). A reference to health also exists in the goals that relate to the economic sphere. To give some examples: SDG 9, Target 9.1 (develop infrastructure to support economic development and human well-being); and SDG 12, Target 12.4 (minimize adverse impacts of wastes on human health and the environment). Last but not least, the entire Goal 11 on cities and human settlements is strongly related to well-being and quality of life. For a broader analysis, see WHO (2019).

Table 1. Indicators selected by INE for Portugal to assess SDG 3 and their main characteristics (continued)

3.8.2	Proportion of households with expenditure on health greater than 10% of income (INE)	I	NUTS 2	2015	No
	Proportion of households with expenditure on health greater than 25% of income (INE)		NUTS 2	2015	No
3.9.1	Mortality rate attributed to household and ambient air pollution (UN)	I	Country	2016	No
3.9.2	Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene (INE)	I	Country	2017	Yes
3.9.3	Accidental poisoning by drugs, medicaments and biologicals (INE)	PR	Country	2017	Yes
3.a.1	Proportion of the resident population aged 15 and over who smokes (INE)	PR	NUTS 2	2014	No
3.b.1	Vaccination coverage against diphtheria, tetanus and pertussis (3rd dose) in children who completed 1 year old (INE)	I	Country	2017Po	Yes
	Vaccination coverage against measles (2nd dose) in children who completed 6 years old (2010 to 2016 refer to children aged 7 years old) (INE)			2017Po	Yes
	Vaccination coverage against Streptococcus pneumoniae infections by 13-valent serotypes (3 doses) in children who completed 1 year old (INE)			2017	No (only 2016–2017)
	Vaccination coverage against human papillomavirus in children who completed 11 years old (2010 to 2016 refer to children aged 14 years old) (INE)			2017Po	Yes
3.b.2	Total net official development assistance for sector 12182 and series 122 (Camões IP)	I	Country	2017	Yes
3.c.1	Medical doctors per 1 000 inhabitants (INE)	I	Municipality	2017	Yes
	Nurses per 1 000 inhabitants (INE)			2017	Yes
	Pharmacy professionals per 1 000 inhabitants (INE)		NUTS 3	2017	No (2013 missing)
	Dentist medical doctors per 1 000 inhabitants (INE)			2017	Yes

Source: Our elaborations from the INE Publication Table (2019)
Legend: I=Identical, PR=Proxy, Po=Provisional value.

Looking critically at the data set for SDG 3, it is possible to make some comments on the relevance and applicability of the selected indicators for the Portuguese context at the subnational level. Some targets at the national level have been achieved in large part, or totally, such as the neonatal and under-5 mortality targets. The fact of having reached the target at the national level, however, does not mean that the performance of different regions is homogeneous. For example, the Algarve Region and the Lisbon Metropolitan Area stand out for having registered the highest values in 2018, with 5.5 and 4.9 deaths under 5 years per 1 000 live births, respectively (the national value was 4.0). It is important to also consider the applicability of the SDG indicators at the subnational level. For example, possible questions would be, if all indicators are applicable at the lower administrative levels (for SDG indicator 3.c.1, there might be some cross-border effects as the density of health workers within a municipality can have a significant impact on other municipalities' abilities to improve their population's health) or if the evaluation of progress at the subnational level needs to be complemented by other indicators that can capture other relevant characteristics related to SDG 3. In the Portuguese context, for example, population aging calls for more attention on particular aspects related to elderly population health care provision and needs.

When discussing the construction of composite indicators, we should probably consider two main issues. The first is that, once the geographical level at which to carry out the analysis has been selected, the construction needs to account for the fact that there is unevenness in the availability of indicators for

the various targets. The other point is that the introduction of new variables is not without effect in the meaning of the composite indicator and in its results, especially when they are not proxy of the corresponding SDG indicators or are not appropriate to measure a health outcome at that geographical level. For instance, many health services are not provided in each municipality, so those statistical units without these health care resources would be excessively penalized in the construction of the composite indicator when such variables are selected, i.e. the inclusion of a variable such as "bed hospitals" would lead to a massive presence of zero and the consequent need to discard some aggregation methods because the phenomenon to be measured in many records would not exist. The alternative is to use small area statistics and smoothing techniques aiming to find substitutes for missing values or even to correct inaccurate data. Scarcity and quality of data are typical problems when the focus of the spatial analysis is more micro. At regional or municipal level results can be affected by strong instability, or in some cases, in areas where there are no observations, direct estimators cannot even be computed. To overcome some of the problems associated with small area estimations there is a vast literature on methods aiming to correct inaccurate data or to find substitutes for missing values. Such methods consist either of the use of co-variants (vary according to a given fixed effect related to variables which are believed to influence the indication under analysis) or in smoothing procedures based on data for the individual units assumed to have a similar behavior (using any combination of data for areas expected to be equivalent) (Rao and Molina, 2015).

3.2. On the normalization, weighting and aggregation stages

With regard to the procedure for constructing a composite indicator, it must be noted that a commonly assumed sequence of steps is required and several methodological options are available in each step (among the great number of publications on this topic, see Booysen, 2002; Salzman, 2003; Freudenberg, 2003; Nardo et al., 2005; OECD, 2008; Mazziotta and Pareto, 2017; Greco et al., 2019). It is not only data selection, as discussed earlier, that is a source of key criticisms, but also in the following stages. Taking into account the composite indicators reviewed earlier in the paper, here we want to briefly outline some priority questions that should be considered when building a composite indicator to be applied in the SDG framework in the normalization, weighting and aggregation steps. Ideally, the methodological approach should: i) be coherent with the objective of monitoring progress over years; ii) address the nested structure of the SDGs; iii) acknowledge the interlinked nature of the SDGs; and iv) consider that indicators are assigned to targets, which are not always quantified and measurable.

With regard to the first issue (coherence over time), it is recommended that weights should be kept unchanged over time. Data-driven methods such as the Factor Analysis (Hair et al., 2010) or the Benefit of the Doubt Approach (Cherchye et al., 2007) should not be considered. Once the weights are obtained by data, they are not constant over time and for this reason comparison over years is problematic. Weights can be obtained from any participatory process using, for instance, a Multi Criteria Decision Making Analysis (Marsh et al., 2017). However, the ambiguities and inconsistences associated with these kinds of approaches are not easily comprehensible and informative for decision makers or the community as a whole. The level of uncertainty associated with these types of participatory approaches is justified mostly because they are: i) supported by human behaviours; ii) knowledge-dependent; and iii) can result from cognitive biases. Other important motivations are referred to in the literature, see for instance the Theory of Social Choice, more specifically in the Condorcet Paradox and Arrow's Impossibility Theorem, which concern the challenging of aggregating individual decisions (preferences, judgments or votes) satisfying certain hypothesis for what should be considered a good rule (Arrow et al., 2002). Even if the real values of the weights could be accurately defined (meaning that: i) the human and cognitive constraints were neglected; ii) we had coherence of respondents; and iii) financial restrictions of organizing these participatory exercises were ignored), the perceived importance of each sub dimension considered in a specific composite indicator would necessarily be mutable over time. Supported by these arguments, the assumption of equal weights for different indicators is probably the most suitable approach for these

particular cases. It maximizes agreement on whether there is an improvement over time within a population with heterogeneous preferences (Hagerty and Land, 2007), which is a distinctive characteristic when there is a plurality of perspectives on the importance of a specific indicator.

With regard to the second issue (nested structure of the SDGs), it worth recalling that the SDG statistical framework establishes this nested structure, where indicators are assigned to targets and these in turn are the constituents of the goal. Therefore, it is preferable that the composite indicator should also reflect this structure where first, individual indicators are aggregated within each target, then the latter are aggregated into the final composite indicator.

The third issue relates to the fact that the 17 SDGs are interconnected. When considering the overall indicator set, there is the possibility that in focusing on the trend of single indicators we do not account for possible synergies and trade-offs between single elements – a common statistical problem of multicollinearity (Hair et al., 2010). The SDG framework acknowledges that, besides the general availability of health care services and individual characteristics and behaviours, there are environmental, economic and social factors (considered mostly in Goal 11) that affect a population's health and in turn that health is a component of sustainable economic growth (Target 8.8 on working environments). The issue is: i) to investigate these relationships; and ii) in case of the existence of significant relationships, how to account in the composite indicator for the existence of targets which are relevant to monitoring health, but are outside of SDG 3. This issue should probably be addressed with a proper weighting system. As for the relationship between indicators, we can highlight, for instance, that a higher density of human resources (3.c.1) is related to the reduction of maternal mortality (3.1.1); and we can provide a warning about the existence of possible conflicts between targets, for example when analyzing the relationship between economic growth (8.1.1) and the mortality rate attributed to air pollution (3.9.1). If we accept that sustainable development is achieved when all indicators move in the right direction, then there is little room for substitutions among indicators. However, if the idea is that the composite indicator can account for compensability between indicators, then substitution possibilities among indicators measuring similar aspects must be allowed.

Another element that is important to consider is how to address the fact that indicators are assigned to targets, which could have either a quantitative nature or just point to the direction and speed of change. In the normalization procedure we should probably account for this fact. In particular, in the case of indicators without a quantitative target, a transparent and simple approach should be applied.

Finally, there is a difference between agreeing on the methodological choices (sensitivity analysis can dissipate some of the controversy surrounding composite indicators, such as in the choice of equal weights) and constructing an indicator that attracts attention and fosters debate. For this reason, the actual procedure chosen should be consistent above all with the objective of offering an understandable indicator.

4. Conclusion

This paper has advocated the use of composite indicators, as a complement to the analysis of individual indicators, in the health domain. Moreover, it has attempted to highlight the challenges linked to the construction of composite indictors for health achievements at the subnational level, using Portugal as a case study. The choice of the indicators that will make up the composite indicators depends largely on the definition of health that is taken as a reference and the data sources that can be accessed. The 2030 UN Agenda is a reliable background reference to define the current challenges in health. The work conducted by the IAEG-SDGs in the selection of appropriate indicators to monitor goals and targets has led to the creation of a solid statistical information base. Composite indicators, as testified by the increasing number of publications on the SDG context, are important tools to examine performance as they allow each statistical unit to take stock of where it stands in a defined period with regard to fulfilling the SDGs and help to set priorities for action, contribute to the definition of a sustainable development strategy, and offer better guidance to policymaking. In the particular case of Portugal, and in the context of the political and administrative decentralization process (important health competencies are being transferred from the

national to the municipal level – decree-law n° 23/2019), the construction of indicators at local level gains particular importance, both to support the definition of strategic health plans and in monitoring the impact and results of adopted measures. However, a variety of issues are involved in the construction of composite indicators. In this paper, we offer some food for thought concerning the issue of data availability and the priorities that should be considered in the construction of a composite indicator suitable to be applied in the SDG context. There is still much additional work that needs to be elaborated on and further investigations are in any case needed. The objective of the article was not to construct an analytical tool able to motivate and guide local policy makers toward the achievement of SDG 3 at the local level. However, in this work we wanted to draw attention to the technical complexity of measuring SDG performance, by focusing on the indicator set and the methodological options. These issues must not be overlooked (Miola and Schiltz, 2019), as the composite indicator produces a ranking that can have a very strong political impact in the context in which it is applied. In order not to send misleading political messages through composite indicators, it is important to test their robustness. However, a quality assessment of the composite indicator can only be conducted when an empirical application is concretely proposed.

Sound metrics are critical to build the evidence base for action. Sustainable Development Goals and targets are operationalized through a wide set of indicators, but the scrutiny of each individual indicator trend cannot provide clear policy guidance. With this paper we wanted to highlight the importance of the metrics on the 2030 Agenda for Sustainable Development. The limited availability of disaggregated data hampers effective monitoring of performance at subnational level and the existence of relationships among indicators, between and among goals, call for greater prudence in the weighting and aggregation step. In our view, future research should prioritize: i) the execution of comparative studies to examine how the selection of variables to be included in the health domain changes from country to country according to their relevance; and ii), the assessment of how the lack of statistically adequate data (i.e. collected and processed in a statistically reliable way) can be compensated with other data (e.g. real-time, big data), which can better capture the phenomenon under analysis. Other possible research questions in the geographic domain could be to examine the conceptual framework behind the global indicator framework (Hák, 2016) and analyze the consensus that led to the identification of the indicator set (Nightingale, 2018). It is to be hoped that taking this work as a premise, major attention will be given to the SDGs at the subnational level of analysis and to the tools that can adequately assess it.

References

ARROW K.J., SEN A.K., SUZUMURA K. (2002), *Handbook of Social Choice and Welfare Vol.1,* Elsevier Science B.V., Amsterdam.

BIGGERI M., CLARK D.A., FERRANNINI A., MAURO V. (2019), Tracking the SDGs in an "integrated" manner: A proposal for a new index to capture synergies and trade-offs between and within goals, *World Development*, 122, 628-647.

BOOYSEN F. (2002), An overview and evaluation of composite indices of development, *Social Indicators Research*, 59, 115-151.

BRESSAN G., RICCARDINI F., VAZQUEZ PIZZI D. (2016), Una prima lettura per l'Italia degli indicatori per gli obiettivi di sviluppo sostenibile, in RICCARDINI F., S*viluppo e benessere sostenibili. Una lettura per l'Italia*, UniversItalia, Roma, 225-313.

CHERCHYE L., MOESEN W., ROGGE, N., VAN PUYENBROECK (2007), An introduction to "benefit of the doubt" composite indicators, *Social Indicator Research*, 82(1), 111-145.

COSTANZA R, DALY, L., FIORAMONTI L., GIOVANNINI, E., KUBISZEWSKI I., MORTENSEN L.F., PICKETT K.E., RAGNARSDOTTIR K.V., DE VOGLI R. WILKINSON R. (2016), Modelling and measuring sustainable wellbeing in connection with the US Sustainable Development Goals, *Ecological Economics*, 130, 350-355.

FANG P., DONG S., XIAO J., LIU C., FENG X., WANG Y. (2010), Regional inequalities in health and its determinants: evidence from China, *Health Policy*, 94, 14-25.
FREUDENBERG, M. (2003), Composite indicators of country performance. A critical assessment, *OECD Science, Technology and Industry Working Papers*, OECD Publishing, Paris.
GONZÁLEZ E., CÁRCABA A., VENTURA J. (2011), The importance of the geographic level of analysis in the assessment of the quality of life: the case of Spain, *Social Indicator Research*, 102, 209-228.
GONZÁLEZ E., CÁRCABA A., VENTURA J. (2018), Weight constrained DEA measurement of the quality of life in Spanish Municipalities in 2011, *Social Indicator Research*, 136, 1157-1182.
GRECO S., ISHIZAKA A., TASIOU M., TORRISI G. (2019), On the methodological framework of composite indices: a review of the issues of weighting, aggregation, and robustness, S*ocial Indicator Research*, 141, 61-94.
GUIJARRO F., POYATOS J.A. (2018), Designing a sustainable development goal index through a goal programming model: the case of EU-28 countries, *Sustainability*, 10, 3167.
HAGERTY M.R., LAND K.C. (2007), Constructing summary Indices of Quality of Life. A model for the effect of heterogeneous importance weights, *Sociological Methods & Research*, 35(4), 4455-4496.
HAIR JR J.F, BLACK W.C., BABIN B.J., ANDERSON R.E. (2010), *Multivariate Data Analysis* (7th Edition), Pearson Prentice Hall, Upper Saddle River.
HÁK T., JANOUŠKOVÁ S., MOLDAN B. (2016), Sustainable Development Goals: a need for relevant indicators, *Ecological Indicators*, 60, 565-573.
INE (2018), Objetivos de Desenvolvimento Sustentável - Indicadores para Portugal. Agenda 2030, Instituto Nacional de Estatística, I.P., Lisbon.
INE (2019), Objetivos de Desenvolvimento Sustentável - Indicadores para Portugal. Agenda 2030, Instituto Nacional de Estatística, I.P., Lisbon.
LIVERMAN D.M. (2018), Geographic perspectives on development goals: constructive engagements and critical perspectives on the MDGs and the SDGs, *Dialogues in Human Geography*, 8(2), 168-185.
MARSH, K., GOETGHEBEUR, M., THOKALA, P., BALTUSSEN, R. (2017), *Multi-Criteria decision analysis to support healthcare decisions,* Springer International Publishing AG, Cham.
MAZZIOTTA M, PARETO A. (2017), Synthesis of indicators: the composite indicators approach, in MAGGINO F. (ed.), *Complexity in society: from indicators construction to their synthesis*, Springer, Cham, 159-191.
MIOLA A., SCHILTZ F. (2019), Measuring Sustainable Development Goals performance: how to monitor policy action in the 2030 Agenda implementation? *Ecological Economics*, 164, 106373.
NAGY J.A., BENEDEK J., IVAN K. (2018), Measuring Sustainable Development Goals at a local level: a case of a Metropolitan Area in Romania, *Sustainability*, 10, 3962.
NARDO, M., SAISANA, M., SALTELLI, A., TARANTOLA, S., HOFFMAN, A., GIOVANNINI, E. (2005), Handbook on constructing composite indicators, OECD Publishing, Paris.
NIGHTINGALE A.J. (2018), Geography's contribution to the Sustainable Development Goals: ambivalence and performance, *Dialogues in Human Geography*, 8(2), 196-200.
OECD (2008), *Handbook on constructing composite indicators. Methodology and user guide*. OECD Publications, Paris.
PIRES, S. (2017), Indicadores locais de desenvolvimento sustentável: Tão importantes quanto negligenciados, in PIRES S., ARAGÃO A., FIDÉLIS T., MENDES I. (eds.), *Indicadores de Desenvolvimento Sustentável: Instrumentos estratégicos e inovadores para municípios sustentáveis - O caso de Estarreja*, Instituto Jurídico da Faculdade de Direito da Universidade de Coimbra; Universidade de Aveiro, OHMI Estarreja, 49–85.
PORTUGUESE PRESIDENCY OF THE COUNCIL OF MINISTERS (2019), *Decreto-Lei nº 23/2019*, Diário da República n.º 21/2019, Série I de 2019-01-30, 753-769.
PRINJA S., GUPTA R., BAHUGUNA P., SHARMA A., AGGARWAL A.K., PHOGAT A., KUMAR R. (2017), A composite indicator to measure health care coverage in India: way forward for post-2015 health system performance monitoring framework, *Health Policy and Planning*, 32, 43-56.

RAO J.N.K, MOLINA I. (2015), *Small Area Estimation* (2nd Edition), John Wiley & Sons, Inc., Hoboken, New Jersey.
RICKELS W., DOVERN J., HOFFMANN J., QUAAS M.F., SCHMIDT J.O., VISBECK M. (2016), Indicators for monitoring Sustainable Development Goals: an application to oceanic development in the European Union, *Earth's Future*, 4, 252-267.
SACHS J., SCHMIDT-TRAUB G., KROLL C., LAFORTUNE G., FULLER G. (2019): *Sustainable Development Report 2019*, Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN), New York.
SALVATI L., CARLUCCI M. (2014), A composite index of sustainable development at the local scale: Italy as a case study, *Ecological Indicators*, 43, 162-171.
SALZMAN, J. (2003), *Methodological choices encountered in the construction of composite indices of economic and social well-being*, Technical Report, Center for the Study of Living Standards, Ottawa.
SANTANA P., FREITAS Â., ALMENDRA R. (2015a), Ìndice da Saúde da População nos últimos 20 anos, in SANTANA P. *A Geografia da Saúde da População. Evolução nos últimos 20 anos em Portugal Continental*, CEGOT, Universidade de Coimbra, 80-106.
SANTANA P., FREITAS Â., COSTA C., VAZ A. (2015b), Evaluating Population Health: The Selection of Main Dimensions and Indicators Through a Participatory Approach, *European Journal of Geography*, 6(1), 51-63.
SCHMIDT-TRAUB G., KROLL C., TEKSOZ K., DURAND-DELACRE D., SACHS J.D. (2017), National baselines for the Sustainable Development Goals assessed in the SDG Index and Dashboards, *Nature Geoscience*, 10(8), 547-555.
SULTANA F. (2018), An(Other) geographical critique of development and SDGs, *Dialogues in Human Geography*, 8(2), 186-190.
SUPARMI, KUSUMAWARDANI N., NAMBIAR D., TRIHONO, HOSSEINPOOR A.R. (2018), Subnational regional inequality in the public health development index in Indonesia, *Global Health Action*, 11:sup1, 41-53.
UN (2019), Global indicator framework adopted by the General Assembly (A/RES/71/313) including annual refinements contained in E/CN.3/2018/2 (Annex II) and E/CN.3/2019/2 (Annex II), available at https://unstats.un.org/sdgs/indicators/indicators-list/ (last accessed: 13/07/2019).
WHO (2019), *World health statistics 2019: monitoring health for the SDGs, sustainable development goals*. World Health Organization, Geneva.
ZACCOMER G.P. (2018), *L'analisi territoriale socio-economica in ambito paesaggistico: Gli indicatori compositi per la zonizzazione territoriale del Friuli Venezia Giulia*, Forum, Udine.

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