serie ad

WP-AD 2020-02

A synthetic indicator on the impact of COVID-19 on community's health

Carmen Herrero and Antonio Villar

Ivie

Working papers Working papers

ng papers

Los documentos de trabajo del Ivie ofrecen un avance de los resultados de las investigaciones económicas en curso, con objeto de generar un proceso de discusión previo a su remisión a las revistas científicas. Al publicar este documento de trabajo, el Ivie no asume responsabilidad sobre su contenido.

Ivie working papers offer in advance the results of economic research under way in order to encourage a discussion process before sending them to scientific journals for their final publication. Ivie's decision to publish this working paper does not imply any responsibility for its content.

La edición y difusión de los documentos de trabajo del Ivie es una actividad subvencionada por la Generalitat Valenciana, Conselleria de Hacienda y Modelo Económico, en el marco del convenio de colaboración para la promoción y consolidación de las actividades de investigación económica básica y aplicada del Ivie.

The editing and dissemination process of Ivie working papers is funded by the Valencian Regional Government's Ministry for Finance and the Economic Model, through the cooperation agreement signed between both institutions to promote and consolidate the Ivie's basic and applied economic research activities.

La Serie AD es continuadora de la labor iniciada por el Departamento de Fundamentos de Análisis Económico de la Universidad de Alicante en su colección "A DISCUSIÓN" y difunde trabajos de marcado contenido teórico. Esta serie es coordinada por Carmen Herrero.

The AD series, coordinated by Carmen Herrero, is a continuation of the work initiated by the Department of Economic Analysis of the Universidad de Alicante in its collection "A DISCUSIÓN", providing and distributing papers marked by their theoretical content.

Todos los documentos de trabajo están disponibles de forma gratuita en la web del Ivie http://www.ivie.es, así como las instrucciones para los autores que desean publicar en nuestras series.

Working papers can be downloaded free of charge from the Ivie website http://www.ivie.es, as well as the instructions for authors who are interested in publishing in our series.

Versión: abril 2020 / Version: April 2020

Edita / Published by:
Instituto Valenciano de Investigaciones Económicas, S.A.
C/ Guardia Civil, 22 esc. 2 1º - 46020 Valencia (Spain)

DOI: http://dx.medra.org/10.12842/WPAD-2020-02

WP-AD 2020-02

A synthetic indicator on the impact of COVID-19 on community's health *

Carmen Herrero and Antonio Villar**

Abstract

We present in this paper an indicator that approaches the impact of COVID-19 on the community's health, at this early stage of the pandemic. It consists of the product of the *extent* (ratio of those affected over the population) and a measure of *severity* (the intensity of the disease on those affected). We concentrate on the population of those seriously affected by the illness, rather than those infected, given the available data. The severity measure derives from the application of an evaluation protocol that allows comparing population distributions based on the proportions of those affected with different health conditions (the *balanced worth*, developed by Herrero & Villar (2013, 2018)). We illustrate the functioning of this indicator over a case study regarding the situation of the Italian regions on March 9 (the beginning of the confinement) and April 8th, 2020, one month later.

Keywords: Covid-19; community's health; impact; severity; Italian regions.

JEL classification numbers: C18, I11

---

* Thanks are due to Francisco Pérez and Joseph Doyle for helpful comments. Financial support from the Spanish Ministerio de Economia, Industria y Competitividad (projects ECO 2015-65820 and ECO 2015-65820P), and Generalitat Valenciana (PROMETEO 2019/037), are gratefully acknowledged.

** C. Herrero: University of Alicante, FAE and Ivie. A. Villar: Universidad Pablo de Olavide and Ivie.
Correspondence to: Carmen Herrero, email: Carmen.herrero@ua.es

1. Introduction

The speed and spread of transmission of COVID-19 have forced governments all over the world to implement strong defensive measures to control the expansion of the epidemics and avoid the collapse of their health care systems. Assessing the effectiveness of those measures calls for surveillance strategies on its application and continuous monitoring of the disease's evolution. Both aspects depend on the availability of reliable data and adequate evaluation protocols that transform those data into helpful indicators (García-Basteiro et al, 2020).

According to the general recommendations of the World Health Organization (WHO, 2017), there are three variables to consider in a pandemic of this nature: how many people are affected (transmissibility), how severely sick get the infected individuals, and how the pandemic affects the health-care system and society. In a similar vein, the US Department of Health and Human Services has developed the Pandemic Severity Assessment Framework, PSAF (U.S. Department of Health and Human Services, 2017). The PSAF proposes two assessment dimensions, transmissibility, and clinical severity, and distinguishes on how to apply those measurement protocols depending on the stage of the epidemic (Reed et al, 2013). The European Centre for Disease Prevention and Control (ECDC) has recently advised to "monitor the intensity, geographic spread and severity of COVID-19 in the population to estimate the burden of disease, assess the direction of recent time trends, and inform appropriate mitigation measures" (ECDC, 2020). The ECDC recommends countries to comprehensively testing suspected cases and to report the number of confirmed cases, distinguishing between those hospitalized, those in intensive care units (ICU), and those deceased.

There is, therefore, an extensive agreement on the variables that should be considered to track the evolution and the impact of COVID-19. There is also consensus on the way of approaching the evaluation, which can be regarded as a conventional way to assess the global impact of a given phenomenon on a population subgroup: computing both extent (the share of people involved) and severity (how intensely the event affects that population subgroup). Applying this approach to the impact of COVID-

19 on the community's health, though, entails two complex challenges: the availability of data and the construction of adequate indicators.

We know that countries are only computing a small fraction of those infected, depending on detection policies and test availability (e.g. Flaxman, S. et al, 2020). Something similar can be said of the reports on deaths and recovered, as there is evidence that different countries apply different protocols to compute those cases. As a result, we do not have a clear notion of the prevalence of the disease, and it seems more sensible to think of the figures on people diagnosed as corresponding to those affected by the coronavirus with worrisome symptoms. At least for the time being. We shall refer to them as Infected with Worrisome Symptoms (IWS), to underline the lack of reliable information on the prevalence of contagion.

Data availability is a critical problem at this early stage and comparisons may not always be fully informative (Lipsitch, Swerdlow & Finelli, 2020). Despite this, it is still essential to get an idea on how things are evolving (Ribas Freitas, Napimoga & Donalisio, 2020), if only to determine the effectiveness of the solutions that are being implemented, calculating the needs of sanitary supplies, the pressure on the equipment and human resources of the health systems, and predicting the evolution of the disease and the progressive return to normality. Hence the need to tackle the second challenge: to find adequate indicators of the extent and severity of the pandemic.

Regarding the extent, let us point out that focusing on the population of IWS is not necessarily a shortcoming, as this is the population subgroup under the risk of suffering the worst consequences of the virus. Evaluating the severity of the disease among the IWS requires comparing the distributions of the populations with different health conditions. Ideally, we would like to have a numerical indicator that allows for quantitative comparisons so that we can say not only if we are doing better, but also how much better. This involves the design of an evaluation formula that, as a general rule, adopts the structure of a weighted average or a generalized mean of the relative frequencies of health conditions (e.g., hospitalized, in intensive care units, recovered, deceased). That is, we need to assign weights to each of those conditions and decide, for instance, how much we value the death of one person relative to the healing of another. Our conclusions on the severity of the pandemic will depend on those types of judgments, which are extremely difficult to determine for both technical and ethical reasons.

Herrero and Villar (2013, 2018) have developed an evaluation procedure that does not require introducing those judgments, which can help to assess the severity of the impact of COVID-19. Relying on the comparison of the probabilities that members of a community being worse-off than members of some other, we obtain a cardinal measure of the relative severity with which the pandemic affects populations. Note that populations here may refer to the IWS of different countries, regions within a country, demographic groups, or different points in time. We can thus apply this evaluation procedure to estimate the impact on the community's health of COVID-19 in a variety of ways.

2. The proposal

2.1 The index

We propose to measure the impact of COVID-19 by an index made out of two components: extent (share of the population infected with worrisome symptoms) and severity (relative health situation of those in the IWS group). The index consists of the product of extent and severity. That is,

$$I_{Co19} = Extent \times Severity$$

The index provides an intuitive measure of the degree to which each community is affected by the disease, as it describes how many people are severely affected (relative to the whole population) times how severely affected they are. This is a standard measurement rod to estimate the impact of a given phenomenon on a population subgroup; in particular, it is the conventional approach regarding poverty measures (e.g. Chakravarty, 2009, Villar, 2017).

The use of this index, in this context, presents the difficulties mentioned above. On the one hand, the IWS population is not a sufficient indicator of the extent of contagion. On the other hand, measuring severity is a conceptual and practical problem of some import.

2.2 The evaluation protocol for severity

The formal problem consists of comparing a collection of societies, G = {1, 2, …, g}, in terms of the distributions of their populations over an ordered set of health conditions, c = 1, 2, …, C. We describe the health situation of society h by a vector $\boldsymbol{a}(h) = (a_{h1}, a_{h2}, \dots, a_{hC})$, where a_{hc} is the fraction of people in h with health condition c (hence, $a_{hc} \geq 0, \sum_{r=1}^{C} a_{hc} = 1$, for all h).

To assess the relative situation of those societies, we compare the probability of getting worse health conditions for representative members of those societies. Let p_{hk} denote the likelihood that the health condition of a member of society h is worse than that of a member of society k. Assuming that those categories are ordered from worst to best, such a probability can be obtained as follows:

$$p_{hk} = a_{h1}(a_{k2} + \cdots + a_{kC}) + a_{h2}(a_{k3} + \cdots + a_{kC}) + \cdots + a_{h(C-1)}a_{kC}$$

Let $e_{hk} = e_{kh}$ stand for the probability of a tie and define $q_{hk} = p_{hk} + \frac{1}{2}e_{hk}$ (i.e., we split the probability of a tie evenly).

To compare the relative health situation for two societies, h, and k, we apply the following principle: make the evaluations proportional to the probabilities of being worse off. That is if we call w_h, w_k the corresponding evaluations, we let:[9,10]

$$\frac{w_h}{w_k} = \frac{q_{hk}}{q_{kh}}$$

Hence,

$$w_h = \frac{q_{hk}}{q_{kh}} w_k$$

Where the numerator can be interpreted as the relative handicap of h over k, and the denominator the relative advantage.

When there are more than two societies involved, we can extend this notion by taking expectations. That is,

$$w_h = \frac{\sum_{k \neq h} q_{hk} w_k}{\sum_{k \neq h} q_{kh}}$$

With the same meaning as before.

The vector or those w_i values is called the *balanced worth* (Herrero & Villar, 2018) and obtains as the dominant eigenvector of a Perron matrix **P** built as follows. The elements in the diagonal are of the form $R_h = (g-1) - \sum_{h \neq k} q_{kh}$; the off-diagonal elements are just the probability values q_{hk}. That is,

$$\mathbf{P} = \begin{pmatrix} R_1 & \dots & q_{1g} \\ \dots & \dots & \dots \\ q_{g1} & \dots & R_g \end{pmatrix}$$

The balanced worth provides a *relative evaluation* of the different societies under consideration. The structure of this matrix ensures that the balanced worth vector $(w_1, \dots, w_g)$ always exists, and it is positive and generically unique, except for the choice of units (it has one degree of freedom).

Remark: There is a friendly and freely accessible algorithm hosted in the Ivie website https://web2011.ivie.es/balanced-worth/balanced-worth-vector.php that performs instantly all calculations required to obtain this vector.

3. A case study: The impact of Covid-19 on the Italian regions

Let us see how this evaluation protocol works in a case study. This section serves the purpose of illustrating the methodological approach we propose rather than to provide an empirical study per se. We consider two different applications. We first compare the situation of the Italian regions on April 8, 2020, which is one month after Italy decreed the confinement. Then we address the change experienced by the regions between March 9th, the day in which the confinement started in Italy, and April 8th.

The data come from the Italian Ministry of Health (Ministero Della Salute). Our target population is made out of the people infected by the virus who have been identified due to the gravity of their symptoms. They include those treated in hospitals, those who have been isolated at home, cured, or have died. We refer to this population as those *infected with worrisome symptoms* (IWS).

3.1 One day in the life of Italy with Covid-19

Table 1 describes the cumulative number of the IWS population on April 8. Individuals in this group may present one of the following five health conditions, ordered from worst to best: deceased, in intensive care units (ICU), hospitalized (non-ICU), isolated at home, and cured.

Table 1: IWS by health state (Italian regions, April 8, 2020)

	Deceased	Intensive care	Hospital	Isolated at home	Cured	Total
Abruzzo	179	62	331	1141	146	1859
Basilicata	14	17	48	205	13	297
Bolzano	183	65	268	948	371	1835
Calabria	60	15	170	570	44	859
Campania	221	97	608	2154	188	3268
Emilia Romagna	2234	361	3769	8980	2890	18234
Friuli V.G.	169	41	162	1212	634	2218
Lazio	244	196	1241	2011	574	4266
Liguria	654	153	1109	1983	1007	4906
Lombardia	9722	1257	11719	15569	15147	53414
Marche	652	133	974	2455	645	4859
Molise	13	4	30	147	32	226
Piemonte	1378	423	3493	7073	1516	13883
Puglia	219	90	639	1509	177	2634
Sardegna	59	31	112	697	76	975
Sicilia	133	65	563	1265	133	2159
Toscana	392	260	1066	4231	430	6379
Trento	255	77	354	1509	407	2602
Umbria	50	41	155	627	416	1289
Valle d'Aosta	102	20	120	466	142	850
Veneto	736	285	1554	8332	1503	12410
Italia	17669	3693	28485	63084	26491	139422

Italian regions exhibit a large variability regarding the extent of the COVID-19, with a coefficient of variation (CV) around 0·8. The highest values are in the Northern regions: Lombardia, Emilia-Romagna, Piemonte, Marche, Liguria, Trento, Bolzano, and Valle d'Aosta. We can decompose the extent figure into two components: the product of the ratio of the IWS over the number of tests performed, and the ratio between the number of tests per 100,000 inhabitants. The first term tells how the IWS relates to the number of tests (a measure of the detection rate). The second term is an index of how intense the search of IWS is between regions.

Table 2: IWS, tests, and population (Italian regions, April 8, 2020)

	IWS/Test	Test per 100,000 inhabs.	IWS per 100,000 inhabs.
Abruzzo	11·73%	1208	142
Basilicata	9·01%	586	53
Bolzano	9·73%	3552	345
Calabria	5·74%	769	44
Campania	11·76%	479	56
Emilia Romagna	23·27%	1757	409
Friuli V.G.	8·94%	2041	183
Lazio	7·74%	937	73
Liguria	28·00%	1130	316
Lombardia	31·88%	1665	531
Marche	27·72%	1149	319
Molise	11·29%	655	74
Piemonte	28·63%	1113	319
Puglia	10·75%	608	65
Sardegna	11·48%	518	59
Sicilia	7·87%	549	43
Toscana	10·46%	1635	171
Trento	19·63%	2450	481
Umbria	9·14%	1599	146
Valle d'Aosta	28·78%	2350	676
Veneto	7·60%	3328	253
Italia	17·27%	1337	231
CV	0·561	0·611	0·793

Data show that the more intense the search, the more cases detected (a coefficient of correlation of 0·624). Despite the variability of the ratio between IWS and the number of tests performed, the extent variable is orthogonal with that measuring the tests per 100.000 inhabitants (a correlation coefficient of 0·1). That is, data suggest that the differential impact of the disease over the regions is for real and not the product of differential search intensities.

Figure 1 shows the proportions of the IWS population into the different health conditions (arranged by increasing order of deceased). The proportions of those deceased and cured present a large variability (with coefficients of variation of 0.4 and 0.57, respectively). For those isolated at home, the variability is relatively low (CV = 0.18), whereas that of those hospitalized or at the ICU is somewhere in between (CV = 0.3 in both cases).

Figure 1: IWS shares by health condition (Italian regions, April 8, 2020)

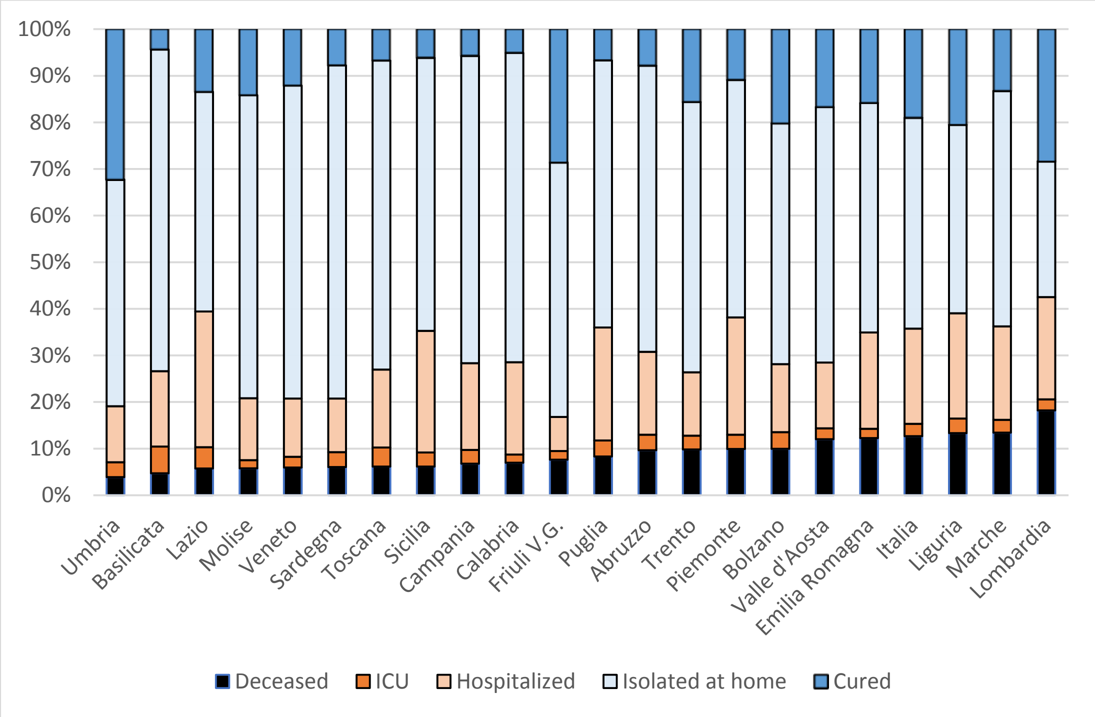


Figure 1 illustrates well the challenge of transforming those data into an indicator of severity and gives a hint on how things can appear depending on the way of attaching values to the health conditions. To obtain the severity measure described in Section 2 (the so-called *balance worth*), we just have to plug the data generating this figure into the web page mentioned in the Remark above. This measure tells us about the relative health situation of the IWS in the Italian regions. To facilitate the comparison, we normalize the values by setting Italy to 100. Table 3 reports the evaluation of the severity of COVID-19. There are two features worth commenting. First, the variability is relatively small, with a coefficient of variation of 0·155. Second, some of the regions with higher severity are in the South, where the extent is much smaller.

The index we propose to measure the impact of COVID-19 over the community's health simply obtained by weighing severity by extent. The resulting data appear in Table 3. The variability of the impact is extremely high, with a coefficient of variation above 0·8. Lombardia and Valle d'Aosta present the highest impact, followed by Trento and Emilia-Romagna. The lowest impact corresponds to Sicilia, Calabria, and Basilicata.

Table 3: Severity and impact of COVID-19 in the Italian regions (April 8, 2020)

	Severity	Impact COVID-19
Abruzzo	106·63	65·43
Basilicata	102·81	23·49
Bolzano	86·45	129·30
Calabria	104·52	19·96
Campania	103·71	25·29
Emilia Romagna	102·60	181·62
Friuli V.G.	63·01	49·79
Lazio	109·86	34·51
Liguria	103·50	141·77
Lombardia	100·56	231·14
Marche	109·68	151·27
Molise	81·33	26·04
Piemonte	114·15	157·49
Puglia	116·20	32·89
Sardegna	89·57	23·06
Sicilia	113·93	21·30
Toscana	100·21	74·20
Trento	89·47	186·26
Umbria	60·64	38·37
Valle d'Aosta	92·08	269·64
Veneto	83·95	91·94
Italy	100	100
CV	0.155	0·805

3.2 Changes after one month of confinement

We discuss now how the data on April 8th are relative to March 9th. Table 4 provides the information on the situation in those two dates, setting Italy to 100 on March 9th, both for severity and impact. There are several features worth commenting.

During this month the impact in Italy multiplied by a factor of 10, whereas in some regions multiplied by more than 40 times: Bolzano (70 times), Trento (60 times), Valle d'Aosta (54 times), Basilicata (49 times), Calabria (47 times), and Sicilia (43 times). All these regions exhibited low impact values on March 9 (especially the last three regions). The regions with a higher impact on March 9 display much smaller factors: Lombardia (6 times), Marche (8 times), Veneto (12 times), Piamonte (17 times), Liguria (18 times). As a consequence, the extreme diversity between the Italian regions we observe regarding impact, as measured by the coefficient of variation (CV), exhibits a strong reduction between March and April. This fact may be regarded as an indication that confinement helps in fighting the disease.

Severity has decreased substantially in most of the regions, with an overall reduction of 33%. This has happened more intensely in those regions with worse indicators so that we observe a sharp decline in its variability, which has dropped by almost one half. This suggests that the health system is responding, and it is doing it more intensely in those regions more in need.

Table 4: Severity and impact in the Italian regions on March 9 and April 8 (Italia = 100 on March 9 for both variables)

	Severity March 9	Severity April 8	Impact March 9	Impact April 8
Abruzzo	138	58	21	541
Basilicata	68	56	4	194
Bolzano	149	51	17	1159
Calabria	97	58	4	168
Campania	74	58	10	215
Emilia-R.	93,5	63,5	191	1709
Friuli V.G.	51	36	26	432
Lazio	116	66	13	315
Liguria	146,5	70,5	68	1468
Lombardia	105,4	73,3	377	2561
Marche	111	69	155	1447
Molise	82	46	25	224
Piemonte	159,6	68,6	84	1439
Puglia	107,4	68	9	293
Sardegna	71	48	5	188
Sicilia	60	64	4	182
Toscana	92,6	55,1	34	620
Trento	69	52,3	28	1655
Umbria	55,3	34,6	12	333
V. d'Aosta	56,2	53,8	44	2395
Veneto	66	47,2	66	786
Italia	100	64,7	100	983
CV	0,347	0,185	1,519	0,853

3. Discussion

Many countries provide daily reports on the effects of COVID-19 regarding the spread of the infection, the numbers of people dead, hospitalized, in intensive care units, and cured. Besides being partial, those data evolve differently both within each population (they increase and decrease and do it at different rates) and between populations (e.g., countries, regions, age groups). These complex dynamics makes it challenging to get an idea of the global impact of COVID-19 on community's health. We have presented a protocol intended to address this evaluation problem. It measures impact as the product of extent and severity, focusing on the population with more severe symptoms.

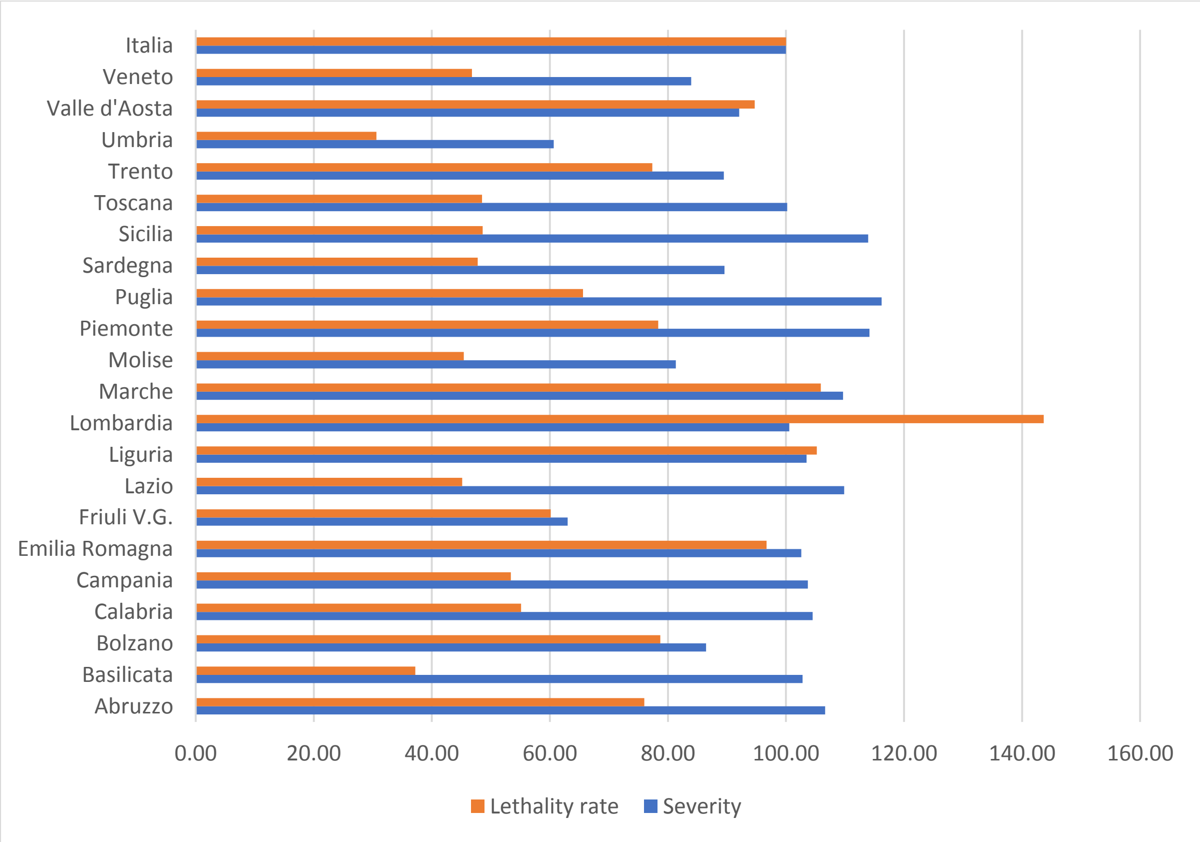
3.1 Severity

Severity obtained by comparing distributions of IWS across different health conditions. The type of comparison proposed here (the balanced worth) permits one to get a cardinal measure without having to attach weights to those health conditions. We depart, therefore, from other approaches based on setting ex-ante scores to those states (e.g., the weights used to ponder different health states in an advanced phase of the epidemics in PSAF) and on the "disability-adjusted life years" metrics used to estimate the "burden of disease." The nature of the available information at this early stage of contagion makes it difficult to apply those evaluation formulae (Reed et al, 2013).

The procedure proposed here to evaluate severity corresponds to a well-known mathematical tool, similar to the one used by Google to order web pages (Brin & Page, 1998) or the principle behind the Eigenfactor (West, Bergstrom & Bergstrom, 2010). The evaluation obtains as the dominant eigenvector of a Perron matrix associated with a Markov chain (e.g. Berman & Plemmons, 1994). Therefore, calculations are conventional, and we know precisely how the evaluation protocol works and what information conveys. With the advantage of providing quantitative estimates.

It is worth mentioning that severity is not a variation of some elementary indicators, such as the lethality rate (i.e., the ratio between deceased and IWS). Figure 2 illustrates this fact by looking at the situation of the Italian regions on April 8, normalizing both the lethality rate and the severity index for Italy to 100.

Figure 2: Lethality rate and Severity in the Italian regions, on March 9 (Italy = 100 for both variables)



3.2 Population subgroups

Our way of comparing distributions implies that the evaluation is relative. That is, we obtain an assessment about how a population fares relative to others. This is important both to understand the meaning of the evaluation and to think of the different questions this protocol permits to address. Besides the types of the evaluation presented here, regarding the comparison of different populations (Italian regions) at a given point in time and different dates, we may consider different types of individuals (depending on age, gender, race, wealth, etc.) or particular population subgroups.[10]

A population subgroup of particular relevance is that corresponding to those who are positive at the reference day, that is, those in the IWS population who are in intensive care units, at hospital or isolated at home. Let us call PAP this population subgroup, as a shorthand for Positive At Present. The impact of Covid-19 over the PAP population is a measure of the effort currently required from the health system, as we discount from the IWS those already cured and those deceased. Severity will measure the intensity of the effort demanded.

Figure 3 describes the shares of the PAP on April 8 in the Italian regions, using the data in Table 1. They show that Lazio, Liguria, Lombardia and Piemonte are the regions with higher shares of people in hospitals (including those in ICU). Those with smaller shares correspond to Friuli V.G., Molise, Sardegna and Veneto.

Figure 3: PAP shares by health condition (Italian regions, April 8, 2020)

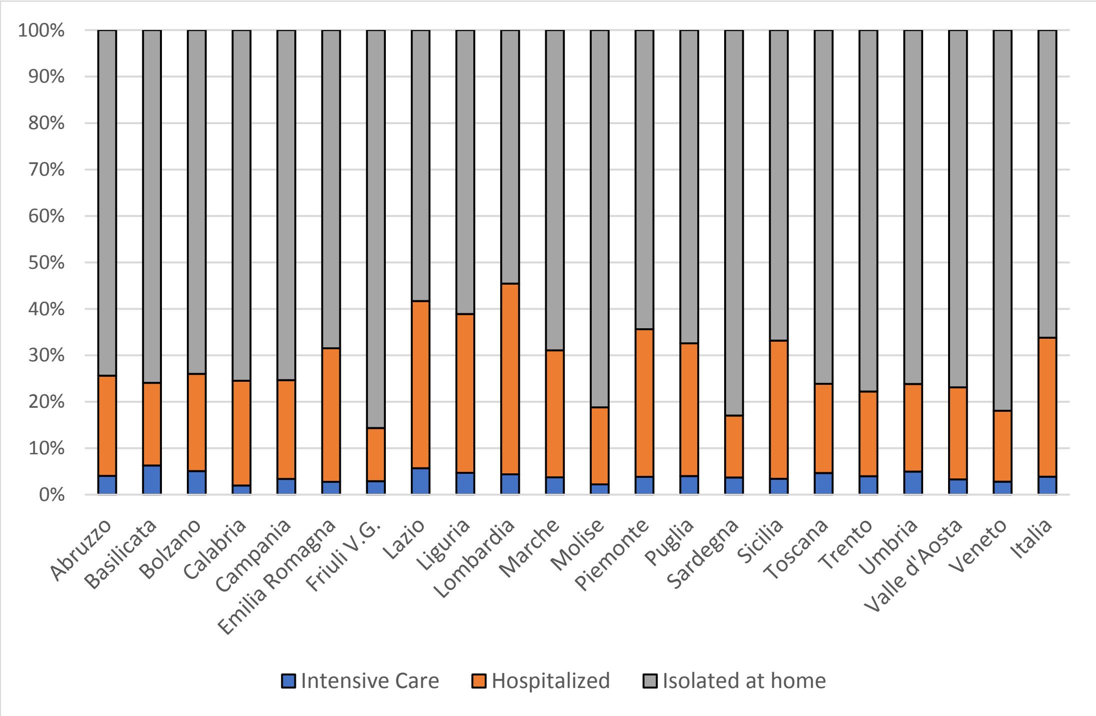


Table 5 provides the evaluation of the Italian regions on April 8, in terms of severity and impact. As it was the case for the IWS population, impact has much larger variability than severity, as measured by the coefficient of variation. Valle d'Aosta, Lombardia, Trento, Emilia-Romagna, Liguria and Bolzano are the regions with a larger impact of Covid-19 on the PAP. Calabria, Campania, Molise and Sicilia are those with smaller impact.

Table 5: Severity and impact of COVID-19 in the population of positive on April 8, 2020. Italian regions

	Severity	Impact
Abruzzo	85,48	63,34
Basilicata	84,04	25,54
Bolzano	86,61	132,35
Calabria	82,68	20,31
Campania	83,59	26,10
Emilia Romagna	95,08	177,11
Friuli V.G.	68,17	50,30
Lazio	117,88	43,81
Liguria	110,99	147,17
Lombardia	126,10	226,70
Marche	94,83	140,32
Molise	74,07	27,80
Piemonte	103,66	165,68
Puglia	97,77	34,41
Sardegna	72,18	23,43
Sicilia	98,59	23,65
Toscana	82,92	78,28
Trento	79,99	181,72
Umbria	82,99	49,07
Valle d'Aosta	81,06	247,69
Veneto	73,31	96,30
Italia	100	100
CV	0.166	0.759

It is also interesting to observe how severity has changed along this month by comparting our two reference dates and anchoring the evaluation by setting Italy to 100 on March 9. There are two remarkable features that those data reveal. First, the sharp decline of the severity values in all regions, to almost one half of the initial value for the whole country. Second, the even sharper reduction of the variability between regions (60% reduction in the coefficient of variation). That suggests, once more, that the health system is reacting in a balanced way and absorbing the shock according to need.

Table 6: Severity in the PAP population on March 9 and April 8, 2020. Italian regions

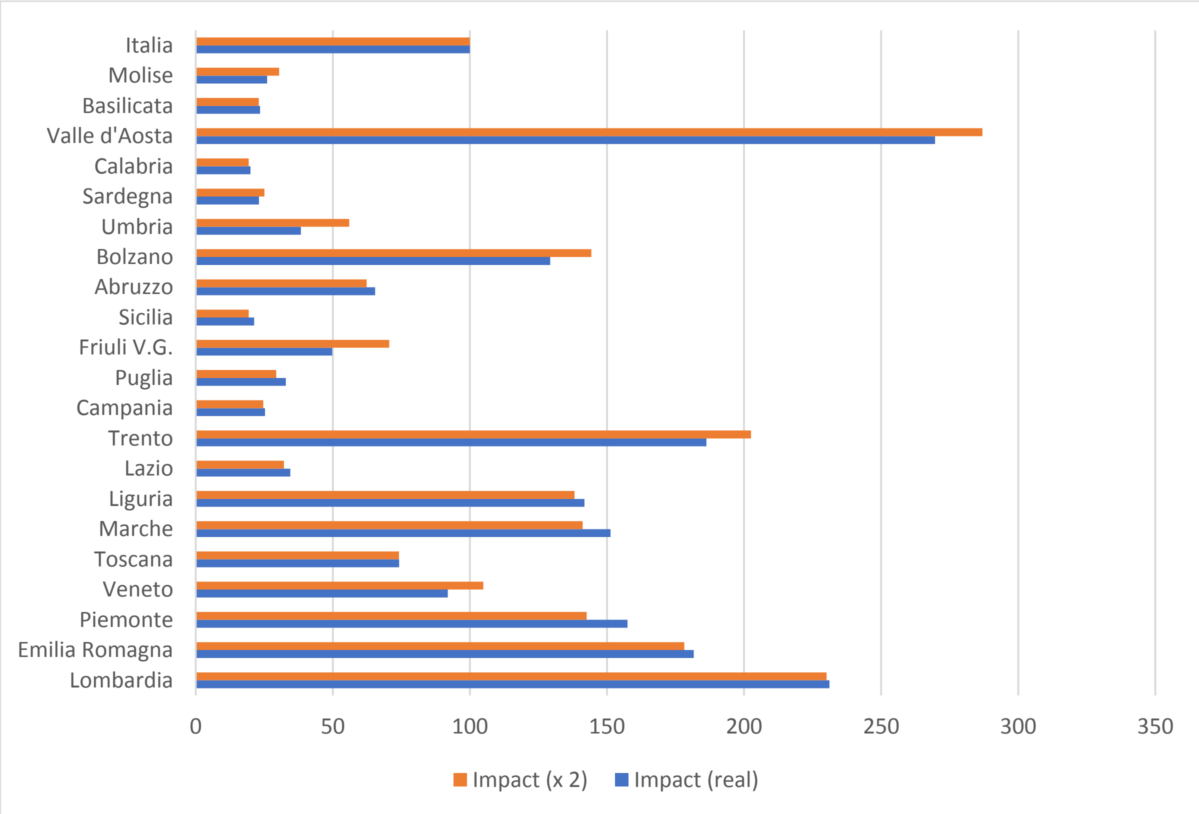
	Mar-09	Apr-08
Abruzzo	140,42	44,47
Basilicata	57,26	37,70
Bolzano	159,81	44,09
Calabria	159,81	41,85
Campania	63,72	62,64
Emilia Romagna	77,63	49,55
Friuli V.G.	39,38	43,29
Lazio	107,48	58,68
Liguria	154,91	41,37
Lombardia	121,58	66,71
Marche	96,05	43,15
Molise	69,76	43,25
Piemonte	155,17	37,37
Puglia	90,56	34,45
Sardegna	59,73	36,88
Sicilia	53,39	51,30
Toscana	82,85	49,61
Trento	56,53	51,62
Umbria	42,08	45,30
Valle d'Aosta	43,56	42,51
Veneto	54,77	54,49
Italia	100	52,50
CV	0,462	0,178

3.3 What next?

There is a strong suspicion that the number of people infected is much larger than that presently reported. This fact opens the question of how the evaluation will change when enhancing the tests and taking infected people as the target population. There are two consequences of so doing. First, the extent of the epidemics will increase significantly. Second, measuring severity will require introducing another health condition, that corresponding to infected people with light or no symptoms. Figure 4 illustrates the change that will experience the impact on the relative situation of the

Italian regions when we duplicate the number of infected people while keeping the absolute numbers of the IWS subgroup. The variability of the impact slightly reduces as severity becomes more homogeneous due to the effect of the new health condition.

Figure 4: Impact of COVID-19 when we incorporate in each region twice as many infected while keeping the IWS figures



The critical question, though, is whether it is convenient to change the focus from the IWS population to the whole population of infected. This seems unclear to us and will have to be decided when the detection pattern changes. Note that extensive testing will induce the extent to grow and severity over time to decline. In the first case, because the figure in the numerator will increase notably, in the second case because of the presence of a better health state gathering a population subgroup much larger than the IWS. Yet the effect of severity between societies at a given point in time is unclear as this type of evaluation is relative so that it will depend on the speed of the relative changes.

References

Berman, A. & Plemmons, R.J. (1994), **Nonnegative matrices in the mathematical sciences.** Society for Industrial and Applied Mathematics.

Brin, S. & Page L. (1998). The anatomy of a large-scale hypertextual web search engine. **Computer Networks and ISDN systems**, **30**: 107—117

Chakravarty, S.R. (2009), **Inequality, Polarization, and Poverty**, Springer, New York.

European Centre for Disease Prevention and Control (2020), Strategies for the surveillance of COVID-19. Stockholm: ECDC; 2020. https://www.ecdc.europa.eu/sites/default/files/documents/COVID-19-surveillance-strategy-9-Apr-2020.pdf

Flaxman, S. et al. (2020), Estimating the number of infections and the impact of non-pharmaceutical interventions on COVID-19 in 11 European countries, **Imperial College COVID-19 Response Team**, March 30, 2020.

García-Basteiro, A.L. et al. (2020), Monitoring the COVID-19 epidemic in the context of widespread local transmission, **Lancet Respir Med**, published on-line, April 2, 2020, https://doi.org/10.1016/ S2213-2600(20)30162-4.

Herrero, C. & Villar, A. (2013), On the Comparison of Group Performance with Categorical Data. **PLoS ONE**, **8** (12): e84784.

Herrero, C. & Villar, A. (2028), The Balanced Worth: A procedure to evaluate performance in terms of ordered attributes, **Social Indicators Research**, **140**: 1279—1300.

Lipsitch, M., Swerdlow, D. & Finelli, L. (2020), Defining the Epidemiology of COVID-19 — Studies Needed, **New England Journal of Medicine**, **382**: 1194—1196, DOI: 10.1056/NEJMp2002125.

Ministero della Salute (Italia), Nuovo Coronavirus, http://www.salute.gov.it/nuovocoronavirus

Reed, C. et al. (2013), Novel framework for assessing the epidemiologic effect of influenza epidemics and pandemics, **Emerg Infect Dis**, **19**: 85–91.

Ribas Freitas, A.R., Napimoga, M. & Donalisio, M.R. (2020), Assessing the severity of COVID-19, Opinion Article, **Epidemiol. Serv. Saúde**, **29** (2) https://doi.org/10.5123/S1679-49742020000200008.

U.S. Department of Health and Human Services. Office of the Assistant Secretary for Preparedness H. Pandemic influenza plan - update IV (December 2017). Washington, D.C.: U.S. Department of Health and Human Services; 2017. Available from: https://www.cdc.gov/flu/pandemic-resources/pdf/pan-flu-report-2017v2.pdf

Villar, A. (2017), **Lectures on Inequality, Poverty and Welfare**, New York, Springer-Verlag.

West, J.D., Bergstrom, T.C. & Bergstrom, C.T. (2010), The Eigenfactor™ Metrics: A network approach to assessing scholarly journals, **College and Research Libraries**, **71**: 236–244.

World Health Organization (2017), Pandemic Influenza Severity Assessment (PISA): A WHO guide to assess the severity of influenza epidemics and pandemics. Geneva: WHO; 2017. https://apps.who.int/iris/bitstream/handle/10665/259392/WHO-WHE-IHM-GIP-2017.2-eng.pdf;jsessionid=614D77C9474EFF4ECBE33EE0886261D8?sequence=1

serie ad

Ivie

Guardia Civil, 22 - Esc. 2, 1º
46020 Valencia - Spain
Phone: +34 963 190 050
Fax: +34 963 190 055

Website: www.ivie.es
E-mail: publicaciones@ivie.es