Quantitative data about deaths due to COVID-19 and comparability between countries: An approach through the case of Spain

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ABSTRACT

Mortality statistics tend to be inaccurate because of the imperfections related to individual deaths' recording. Recently, the COVID-19 pandemic has brought controversies regarding the quantification of deaths in many countries. Mainly, controversies were fueled by the sudden change of the criteria being applied, the limited testing and tracing capacities, and the collapse of the healthcare system. This work analyses the case of Spain, which constitutes one of the European countries with the highest number of cases and deaths during the 'first wave', and where these numbers were highly controversial. It provides a discussion about the coherence, traceability, and limitations of quantitative data sources, as a basis to improve the quality of the data and its comparability between different countries and over time. Official data sources and non-official data sources are considered. Finally, suggestions of improvement and research needs are gathered, for the reliability of mortality data as a way to enhance learning and resilience for future crises.

Keywords

COVID-19, mortality data, public health data, crisis analytics, health crisis, open data sources.

INTRODUCTION

The statistics on causes of mortality are not easy to obtain, even in normal times, as shown by the imperfections or omissions that may occur in the recording of data regarding individual deaths. These errors of individual data pose a challenge to obtain aggregated data (Bowker and Star, 2000). In the case of COVID-19, worldwide pandemic first noticed in Wuhan (China), the quantification of deaths is even more difficult than in normal times and for previously known diseases. In this sense, quantitative data about COVID-19 related deaths has been controversial not just in Spain but in other countries (Minder, 2020).

An approach and discussion to such data in the case of Spain may bring useful insights about quantitative data sources available regarding deaths related to COVID-19, their coherence, traceability, and limitations, as a basis for future improvements to the quality of the data, so as to enhance better crisis management and analytics. This is the aim of our paper.

The remaining of this paper is as follows: First, we set up objectives and methodology; secondly, we provide a briefing about the context of Spain regarding this pandemic; thirdly, we provide briefing and discussion to official data sources; fourthly, we provide briefing and discussion about non-official data sources; fifthly, we expose global synthesis and discussions; and finally, we set up our conclusions including suggestions of improvement and further research. Chronologically, this paper is focused on the 'first wave' of the pandemic.

OBJECTIVES AND METHODOLOGY

As objectives of this work in progress we set up:

- Localize all open data sources about numbers of deceased due to COVID-19 pandemics in Spain.
- Discuss the traceability and coherence of these sources, both regarding quantitative data and qualitative methodological information about their data. Traceability is understood as the extent to which the correctness of information is verifiable in the context of a particular activity (Stvilia et al, 2007). Coherence refers to the internal consistency of data (HIQA, 2011).
- Gather insights and suggest improvements and future research about the quality of these data, to enhance better crisis analytics in the present and future pandemics.

We have found the data sources either through Internet search engines, either through searches in digital databases devoted to news in Spain (MyNews) or to international news (Reuters Factiva). Most relevant features and information about sources have been compiled.

We have worked with data of the first wave in Spain, mostly since the beginning of March 2020 to the beginning of June 2020. When judged necessary, criteria of the data sources have been checked through international directives set up by organizations such as the World Health Organization (WHO). We have preferred to work at this point with consolidated data about the 'first wave', rather than more updated data. We think 'first wave' data in Spain are representative enough, as a first approach, about questions regarding these data in developed countries.

SPAIN AND COVID-19 PANDEMICS

Regarding the chronology of data discussed, in Spain the first wave due to COVID-19 occurred mostly since the beginning of March 2020 to the beginning of June 2020 (lockdown in the whole country was adopted on March 14th and gradually removed, since the beginning of May to the end of June). First death attributed to pandemic was confirmed for a person who died on February 13th, and by the end of May the official number provided by the Ministry of Health (*Ministerio de Sanidad*) was 27,127 (on June 1st). Chronologically, Spain was the second European country with a great affectation in the first wave, being Italy the first one. In terms of deaths relatively to the total number of inhabitants, Spain was the second in Europe more affected by this first wave and the fifth worldwide, being Belgium the most affected European country and Peru the most affected worldwide: as of September 16th, death per million was 642 in Spain, 869 in Belgium and 966 in Peru (Statista, 2020).

There have been public discussions about the official death figures from the very beginning. For instance: in the parliament (*Congreso de los Diputados*) in plenary session on April 9th (Spain, April 9th 2020); the regional Catalan government (*Generalitat de Catalunya*) proposed on April 15th to increase the death count significantly upwards, incorporating more realistic criteria in its opinion, but this has not been incorporated to the official count of the Ministry of Health (López and Ricart, 2020); the Spanish data science company Inverence affirmed since April 13th that the actual deaths in Spain were between 51% and 64% more than those stated in the official count on those dates in the middle of April (Inverence blog, April 13th 2020); the Superior Court of Justice of Castilla La Mancha autonomous region started an investigation about the count of deaths in that region (Sánchez and Sevillano, 2020); the Foundation for Applied Economics Studies (Fedea, 2020) stated that as of April 26th the number of deaths was 46.2% higher than data from the Ministry of Health (Martín-Barroso et al., 2020); etc. These are a few examples of public discussion about these data. The New York Times echoes in April the controversy in Spain, contextualizing it internationally (Minder, 2020) and a Reuters calculation indicates the coronavirus death toll could be as much as 49% above the government's tally (Faus, April 20th 2020). This is not an exclusive issue of Spain: an upward correction was done for the official Chinese figures for fatalities on April 17th (BBC Mundo, 2020); in USA criteria differ from one state to another (Koenig, 2020); and Belgium finds the comparison between countries of the death toll unfair because their counting system is much more comprehensive than others when taking into account not only the hospital cases (Strauss and Rossignol, April 22nd 2020).

According to the current constitution of 1978, the Spanish state has a distribution of power and responsibilities between the national government and the regional governments. This distribution implies that in normal times regional authorities are in charge of the health service and public health issues. In broad terms, in normal times the national government through the Ministry of Health takes care mostly of general regulatory issues all over Spain.

In the rise of the pandemic in Spain, the central government announced the declaration of the State of Alarm (*Estado de Alarma*) (Spain, March 14th 2020). It is a provision provided in the Spanish Constitution, so to empower the central government to deal with some crisis or exceptional issue, such as a great health crisis. This declaration was developed by several legal dispositions, two of them were specifically devoted to regulate the count of death related to COVID-19 (Spain, March 15th 2020; Spain, April 16th 2020), and will be discussed

further on in this paper.

OFFICIAL SOURCES

In the case of Spain (as in most countries), the official data were updated regularly, usually daily, during the first wave, and were regularly accessible on the website of the Ministry of Health on its situation reports page (Ministerio de Sanidad, 2020). These reports included some methodological information and were based on data reported by the regional governments and included cases confirmed with a positive diagnostic test, as well as cases reported before May 11st that required hospitalization or died with a clinical diagnosis of COVID-19. This same data was used as the official reference in the online editions of the newspapers of Spain and other countries, and in international scope websites such as John Hopkins (John Hopkins University, 2020), Statista (Statista, 2020), Datadista (Datadista, 2020), etc.

The data published by the Ministry of Health correspond to the number of deceased people who are known to suffer COVID-19, confirmed by a clinical laboratory test when alive. Based on this idea, the Ministry collected daily the data provided by the autonomous regional authorities (see the Order of April 16th, (Spain, April 16th 2020), which partially corrects the Order of March 15th (Spain, March 15th 2020). The initial criterion of March 15th was more restrictive than that of April 16th. Specifically, from March 15th to April 15th, deaths were counted if a person died in a hospital facility, in addition to having tested positive in a laboratory test when alive. As of April 16th, all deceased persons who had tested positive are considered in the calculation, regardless of where their death occurred (whether in a hospital, in a residence, at their own home, etc.). It is to note that, especially during the first weeks of the pandemic (in broad terms until late April) a significant number of people are reported to have died of COVID-19 outside hospitals. On the other hand, there is no evidence that, when more restrictive criteria set up on March 15th were modified on April 15th, the death account was modified retroactively according to the new criteria. This should have brought a significant sudden increase in the account. In fact, later, on May 24th occurred the opposite: the number of deaths reported by the Ministry of Health decreased to nearly 2,000 without a clear explanation about it (from 28,752 on May 24th to 26,834 on May 25th) (Ministerio de Sanidad, May 24th 2020; Ministerio de Sanidad, May 25th 2020). These mentioned nationwide orders made it mandatory for the regional governments to send their updates daily to the Ministry of Health according to the criteria set up by the national government, who was ultimately responsible for the official national count.

The application of these official criteria implies a downward approximation with respect to the real figures. From a qualitative point of view, the press reports on situations of death of people alone in their homes (Bécares and Barrio, 2020) or of the elderly in nursing homes (Sosa Troya, 2020), often without having been subjected to tests and therefore outside of the official list generated with these criteria. Also, the low availability of laboratory tests, and the collapse or near collapse of the health system in many zones during the first weeks of the pandemic contributed to the underestimation.

These data from the Ministry of Health were based on the aggregation of individual data of deaths related with COVID-19. There was another source of official data available, with a different approach based on statistics: it is the Mortality Monitoring System (MoMo) of the National Epidemiology Center and the Carlos III Health Institute (*Sistema de Monitorización de la Mortalidad (MoMo) del Centro Nacional de Epidemiología en Instituto de Salud Carlos III*). Their reports were uploaded and published regularly (MoMo Sistema de Monitorización de la Mortalidad Diaria, 2020) since the beginning of the pandemics in Spain, as well as a dashboard (MoMo Dashboard, 2020). Its methodology is documented on its website (Momo Documentación, 2020).

The idea of this system consists in comparing the statistics of the mortality that is actually occurring in times of a pandemic with the mortality that would have occurred under normal circumstances. Broadly, it is based on the following points:

1. Calculate, based on recent historical data, the expected mortality for a given period.

2. Obtain the total mortality observed, by adding the observed data on deaths at the level of the whole Spain, whatever their cause, collected by civil registries.

3. Then, the difference between observed mortality and expected mortality gives us the excess of deaths attributable to the pandemic.

This method has some limitations, mostly the following: 1) They only collect data of civil registries which are digitized and computerized, which cover the 93% of Spanish population, so not the whole population; 2) They consider a delay of 7 days in notification of death, in practical terms the delay was higher during most of the first wave because of the high workload of funeral services and civil registries; 3) The pandemic and a severe lockdown may have an impact over other causes of mortality different than the pandemic itself (for instance: it may decrease the number of people deceased in working centers or traffic accidents, or it may increase number of deaths due to

other causes, for instance because of people being afraid of going to hospitals or because of hospitals being overwhelmed by the pandemic). Anyway, the methodological explanation offered by MoMo is clear and transparent, and since the beginning of April its primary data can be downloaded, so that one can make their own calculations from them (Momo Datos, 2020). MoMo is part of a European monitoring network, with similar systems in other countries (EURO MOMO, 2020).

The National Statistical Institute (INE) published a preview of data about deaths from January to May classified by cause of death (INE, December 10th 2020). According to these data, there were 45,684 deaths caused by COVID-19 during this period, all of them in March, April and May. It distinguishes between deaths with identified COVID-19 virus (32,652) and deaths with suspected COVID-19 (13,032), that is people with symptoms compatible with the disease. According to the report, these two causes of death related to COVID-19 were added by the WHO to the International Classification of Diseases (ICD-10) in March 2020 (World Health Organization, March 2020). INE bases its methodology for developing statistics of deaths by cause of death on the analysis of the medical death certificates as well as on the application of two international standards, the mentioned ICD and standards adopted by the WHO that determine the different causes of death, comorbidities and how to record them on the International Form of Medical Certificate of Cause of Death (World Health Organization, April 20th 2020). European guidelines, such as the European Center for Disease Prevention and Control (ECDC, 2020), also suggest mortality monitoring should be conducted according to the WHO definition.

Some regional official entities also published information more disaggregated territorially. Autonomous regions such as Andalusia, Cantabria, Castilla-León, Catalonia, Basque Country or Madrid, have public and daily updated data about the main epidemiological indicators by province or municipality (Cobarsí-Morales, 2020).

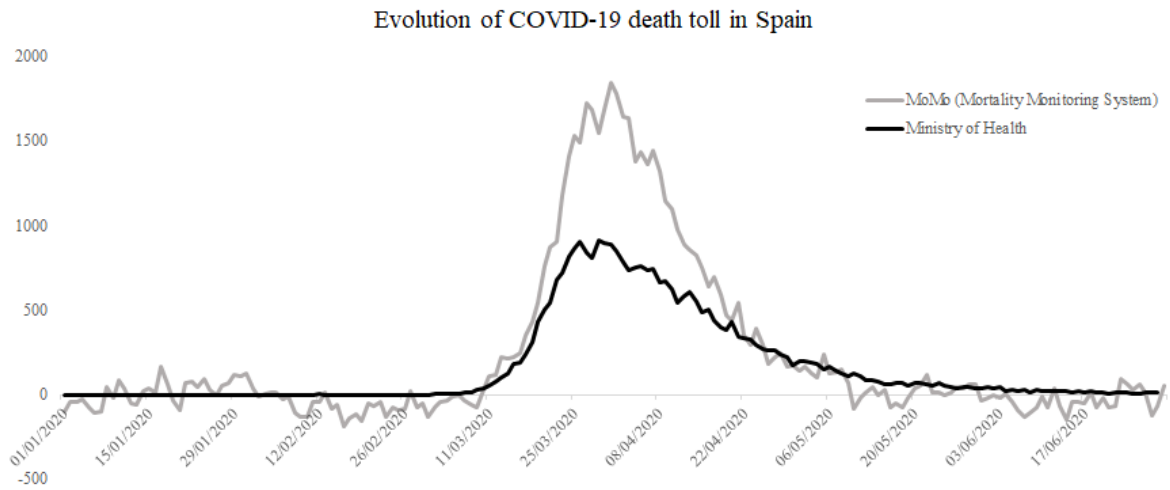

Figure 1. Evolution of death toll in Spain for the 'first wave' of the pandemic with official data sources, Ministry of Health and Mortality Monitoring System

As shown in Figure 1, by the end of the first wave, official sources differ significantly. Indeed, the Ministry of Health reported 27,127 deaths, in contrast with the 44,729 of MoMo. The number provided by INE, 45,684, is closer to that offered by MoMo.

NON-OFFICIAL SOURCES

There are a bunch of non-official estimations, conducted by different organizations in Spain. We explain it in the following in chronological order.

Since the early stage of the pandemic, official numbers by the Ministry of Health were discussed. One of the first journalistic reports to do it was published by ABC Madrid journal on April 9th. They estimated that at that time the real number of deceased was about 10,000 more than the number reported by the Ministry of Health (about 15,000), quoting qualified professional sources involved in the process (Montañés and Miranda, 2020). No explicit calculation or methodology was provided, just informal estimates from insiders.

The first estimates properly said published, alternative to official data, were conducted by the company Inverence, which specializes in data science application to business strategy, with headquarters in Madrid (Inverence, 2020). In broad terms, they acknowledge limitations of data from MoMo covering only 93% of Spanish population, and they also take into account inconsistencies in data regarding some Spanish regions; they use statistical techniques

to correct these limitations and inconsistencies (Inverence blog, April 16th 2020). They began to publish their own estimations in a website created on April 13th and last updated May 20th (Inverence blog, from April 14th to April 20th 2020). Their initial estimation for the end of the first wave was at least 38,700 and at most over 40,000. They published later on their final estimation of death by the end of the first wave on May 17th: near 50,000 deaths (this May 17th date was not far from the end of the first wave, which in broad terms could be considered by the end of May or early June) (Inverence blog, May 17th 2020).

There is also a study and estimation conducted by researchers of Universidad Politécnica de Madrid (Cascón Porres et al., 2020). Their estimation on April 29th is 42,800 deceased (no more estimations were published). They conducted their own calculation based on official source MoMo, and they did some corrections mostly to address main MoMo's limitations: 1) MoMo gathers its data from civil registries which correspond only to the 93% of Spanish population and 2) MoMo considers a delay of about 7 days between the death and the notification, but based on the study of previous data during the pandemic, these researchers considered the delay between MoMo and real data was larger.

On June 1st, the Spanish Association of Funeral Service Companies and other 5 related organizations published a report (Asociación Española de Profesionales de los Servicios Funerarios, 2020). According to it, the number of deaths until May 25th was 43,985. There is not much methodological explanation in the report; they aggregated the primary data from death certificates, which managed on a daily basis because of their professional duties, and computed not just the main cause of death but other contributor causes, which is aligned with the guidelines of the WHO.

On July 26th, the Spanish journal El País published its own estimation, 48,686 deceased since the beginning of the pandemic to near that date (Romero, 2020). Their approach was mostly based to count all the deceased, true or suspected, according to the data and criteria of regional governments. This is a significantly different approach than the approach of the Ministry of Health, who aggregated the data supplied by regional governments, but with more restrictive criteria in wide terms than the criteria usually held at local level by some regional governments. It brings a significant difference mostly because of the data of 4 regions: Madrid, Catalonia, Castilla-La Mancha and Castilla-León.

On the other hand, the Foundation for Applied Economics Studies (Fedea, 2020) estimated the number of people infected by COVID-19 (Martín-Barroso et al., 2020) from a corrected series of fatalities that integrated data from MoMo and other sources. Then, lethality rates by age obtained in reference epidemiological studies were applied to approximate the infected population. Corrections on the deaths series focused on the following arguments: 1) MoMo defined an excess mortality period (Momo Documentación, 2020) and did not include the first days, between the first death and the beginning of MoMo period, and the last days, those from the end of MoMo period and the official data of daily deaths; 2) It is possible that a percentage of the population that was previously ill, or that fell ill during this period, and who had died from other causes, was infected by COVID-19; 3) Lockdown reduced mobility and attendance at work, so it probably caused a reduction in ordinary mortality due to common causes such as traffic accidents or work-related accidents, as well as Easter holidays travel. This study estimated 40,335 deaths at the end of the first wave, which was considered to end on August 31st 2020.

All in all, we brief as a synthesis in Table 1 the number of deaths according to the mentioned sources (official and non-official):

Table 1. Quantitative estimates by non-official sources of the number of deaths by the end of the 'first wave' with official data sources, Ministry of Health and Mortality Monitoring System.

Institution	Type of source	Number of deaths	Date
Academics from Universidad Politécnica de Madrid	Non-official	42,800	April 29th
Inverence (data science company)	Non-official	49,974	May 17th
Ministry of Health	Official	27,121	May 27th
MoMo (Mortality Monitoring System)	Official	44,419	May 27th
INE (National Statistical Institute)	Official	45,684	May 31st
Association of funeral services companies and 5 other related organizations	Non-official	43,985	June 1st
Journal El País	Non-official	48,686	July 26th
Fedea (Foundation for Applied Economics Studies)	Non-official	40,335	August 31st

According to all sources available, the first wave was mostly finished by the end of May or early June, and the

very end could be by the end of July. Deaths in the period June 1st to July 25th could be between 1,000 and 1,500, a pace significantly slower than in March, April and May.

In this sense, El País does not publish data regarding June 1st, but data published on July 26th suggest that number of deaths at the end of May could be about 47,000, which is not far from Inverence data for May 17th (49,974), and their projection of over 50,000 at the very end of the first wave. We could guess estimations conducted by academics from Universidad Politécnica de Madrid, if they had done some projections, they could bring similar results than those of Inverence and El País. Also, all these counts are not far from the numbers gathered by the Association of Funeral Services Companies and by MoMo, although both of them are lower. In conclusion, the gap between the approaches of these different agents using different methodologies and the official data by the Ministry of Health is great.

GLOBAL SYNTHESIS AND DISCUSSION

Statistics of health crises are key to monitor their evolution, make predictions, assess the effects of the strategies already applied, and help to plan new ones. These statistics have to be relevant, timely, reliable, and designed and implemented by independent, transparent, mature, and strong statistics institutes. Their methodology has to be solid, based on international standards to ensure comparability between territories and periods of time, and publicly available, so anyone interested may get all the information.

In this work we have introduced different sources of quantitative estimates of the number of deaths: 3 official and 5 non-official. Regarding the official sources, the Ministry of Health published data regularly but followed some criteria that clearly underestimate the real number of deaths by COVID-19 and modified the methodology without updating the previous estimates accordingly. The second official source, MoMo, presented a clear and transparent methodology (including limitations), which allows the comparison of different European countries. The third official source, INE, presented also a solid methodology following international standards but reported its estimates months later. It is important to note that these big differences regarding quantitative estimates and methodologies applied from these official sources add complexity to the understanding of the crisis and its management, likely causing confusion among citizens.

Aiming to correct the estimates of the official sources, several non-official ones reported their own estimates. In table 2 we compare the main aspects of their methodologies. All of them presented estimates higher than those of the Ministry of Health. However, many of them do not publish a comprehensive methodology and/or do not provide timely and regularly updated estimates. An important fact is the alignment with the WHO guidelines in terms of counting both confirmed and suspected cases. Only one of the official sources, the National Statistical Institute (INE), is compliance with these guidelines. The Ministry of Health, as the main official source, was not counting neither deaths with symptoms compatible with the disease (Pérez, June 10th 2020) nor the cases of COVID-19 confirmed after death (Méndez and Coll, June 16th 2020). Some non-official sources tried to correct this mismatch by computing not just the main cause of death but other contributor causes.

Table 2. Comparison of the methodologies of official and non-officials data sources.

Institution	Data source	Criteria	Periodicity	Weaknesses	Strengths
Ministry of Health	Regional governments.	Cases confirmed by a clinical laboratory test when alive.	Daily data and post.	1) Deaths without previous tests are not counted. 2) Before April 15th, only deaths in hospitals were counted. 3) Methodology was modified without updating data retrospectively.	Unique and mandatory criteria for regional governments.
MoMo	Expected mortality from recent historical data and observed mortality from civil registries (for any cause).	The excess of deaths attributable to the pandemic is estimated as the difference between observed mortality and expected	Daily data and regularly post.	1) Only digitized civil registries data (93% of population). 2) A delay of 7 days in notification of death is considered, but it was higher during most of the first wave. 3) Pandemic and lockdown may have an impact over other causes of	1) Clear and transparent methodology. 2) Data can be downloaded. 3) Similar systems in other countries (EURO MOMO, 2020).

		mortality.		mortality.	
INE	Medical death certificates.	It distinguishes between deaths with identified and suspected COVID-19 virus.	Aggregated data and specific publication.	1) Time series not published. 2) It does not publish current data but from a past period.	1) People with symptoms compatible with the disease are counted. 2) Aligned with the WHO guidelines.
Inverence	MoMo data.	Statistical techniques to correct MoMo limitations and inconsistencies.	Daily data and specific publication.	No details about their methodology.	Improve MoMo data.
Universidad Politécnica de Madrid	MoMo data.	Corrections to MoMo limitations.	Daily data and specific publication.	Poor details about their methodology.	Improve MoMo data.
Funeral services companies	Aggregated data from death certificates.	Computed not just the main cause of death but other contributor causes.	Aggregated data and specific publication.	Poor details about their methodology.	Aligned with the WHO guidelines.
Journal El País	Regional governments.	Counting all the deceased, true or suspected, according to regional governments data and criteria.	Aggregated data and specific publication.	Heterogeneous criteria for regional governments.	1) Aligned with the WHO guidelines. 2) People with symptoms compatible with the disease are counted.
Fedea	MoMo data and other sources.	Corrections to MoMo limitations based on lethality rates by age obtained in reference epidemiological studies.	Daily data and specific publication.	Data is not regularly updated.	1) Some details about their methodology. 2) Improve MoMo data.

During the first weeks of the pandemic, the WHO encouraged countries to accompany social distancing measures with enough diagnostic tests (Corbella, March 14th 2020). At first, Spain was unable to perform the proper amount of tests. Availability, variety and criteria for performing the tests, as well as the number of locations where it was possible to perform them, improved over time, although it was not enough in most Spanish regions (Sevillano, April 19th 2020). Despite the variety of tests available in Spain, the Ministry of Health only counts deaths confirmed with PCR (*polymerase chain reaction*) (Cano, April 28th 2020) for being the most reliable. It means that a large number of deaths with virus unconfirmed, due to lack of tests or system saturation, or confirmed with another type of test are not included.

Differences between the number of deaths from official sources and the estimate for excess deaths also occurs in other countries. In Table 3 we show the number of deaths and excess deaths for some of the most affected European countries in the first wave of the COVID-19 pandemic, data per 100,000 citizens, and a calculation of the percentage that represents the difference between deaths (as reported by ministries of Health) and excess deaths (as reported by statistical monitorization systems).

Table 3. European countries ordered by death toll for the first wave of the pandemic.

Country	Deaths per 100,000	Excess deaths per 100,000	% Difference	Time frame
Belgium	83	79	-4.8	Mar 2nd - May 31st
United Kingdom	78	96	23.1	Feb 29th - Jun 5th
Spain	63	95	50.8	Mar 4th - Jun 2nd

Italy	50	87	58.2	Mar 4th - Jun 2nd
France	45	42	-6.7	Mar 4th - Jun 2nd

Data source: Tozer and González (2020)

Thus, this analysis demonstrates the need to strengthen official statistics institutes that collaborate with other institutes and international organizations from all over the world. Statistics are key to understand and combat pandemics, but they need to be of high quality. Otherwise, they may lead to wrong conclusions and inefficient or even counterproductive policies.

CONCLUSION

Spain has been one of European countries most affected by the COVID-19 pandemic during the first wave. There have been controversies regarding the quantification of deaths in many countries. In this paper we analyze the criteria of both official and non-official data sources and the estimates for the case of Spain. The official data sources considered are the Ministry of Health, the Mortality Monitoring System (Momo) of the National Epidemiology Center and the Carlos III Health Institute and the Instituto Nacional de Estadística (INE). Regarding non-official data sources, we compile the following ones: Academics from Universidad Politécnica de Madrid, Inverence (data science company), Association of funeral services companies and 5 other related organizations, Fedea and journal El País. While there are significant differences among the estimates of all these sources (their criteria and their methodological traceability have been presented and discussed in the previous sections), the lowest estimate corresponds to the Ministry of Health and the difference with respect to the mean is huge, mostly because of the fact of taking into account (or not) comorbidities and suspected cases.

Several lines of research stem from this work. For instance, it would be interesting to expand this work by comparing mortality statistics (their methodologies, criteria, and results) among different countries. A deeper discussion regarding the causes and the consequences of the different criteria applied is required, as well as an analysis of the most common criteria. Indeed, all the countries need reliable data sources that may provide statistics of high quality, complete, and timely published and updated to enable politicians, scientists, companies, citizens and the whole society to understand the magnitude of the pandemics, their evolution, and the effects of the different strategies applied. In this sense, WHO criteria and its application in different countries should be reconsidered for future pandemics, in order to have better data for future health crises management and analytics. In this sense, we think a significant practical development could be the boosting of the systems devoted to monitoring excess of death (MoMo type) with three major improvements: 1) assuring unified criteria between countries, 2) providing more territorial granularity, and 3) providing real time data. In order to achieve 2) and 3), the experience reported from Italy by Buonnano and Puca (2021) seems promising.

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