



HEALTH SCIENCES

Analysis of the number of deaths in Brazil between 2003 and 2020 and possible inferences about the COVID-19 pandemic and history of other diseases

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Abstract: The historical number of yearly deaths in Brazil has a growing tendency since always. In recent years were observed increases in this number beyond the tendency, probably associated to epidemics. In this work it was implemented an analysis on public data, using the total number of deaths from violence, respiratory diseases, and deaths in hospitals. The historical series of deaths in Brazil from 2003 to 2019 was used to estimate the number of deaths in 2020 by a statistical projection, and this estimate value was compared with the number of deaths recorded as “Deaths with suspicion or confirmation of COVID-19”. It was verified that deaths attributed to COVID-19 far exceed the statistical projections but this result was interpreted together with the numbers of deaths by respiratory diseases. Increasing of deaths between 2019 and 2020 can be partially explained by a lowering in the deaths of violence in 2019. In this paper it was verified that despite de pandemic the difference between number of deaths between 2020 and 2019 remained in the same order of magnitude as the difference in the past, in periods which can be associated to other infectious diseases as H1N1 and dengue, for example.

Key words: COVID-19, Brazil, epidemics, pandemics.

INTRODUCTION

Since the first case of COVID-19, officially reported in December 2019 (Croda & Garcia 2020), in the city of Wuhan, People’s Republic of China, millions of people have been infected worldwide. Most of these have managed to recover, but unfortunately a significant proportion has died. In February 2020 the Brazilian Federal Government declared a national emergency (DOU 2020). The following month, March 2020, the World Health Organization declared the outbreak of a pandemic (GB 2020), which was followed by many efforts of all kinds to prevent its spread and minimize its effects.

The total number of deaths in Brazil was registred in historical series by IBGE (Brazilian Institute of Geography and Statistics) (SIDRA 2019) since the year of 2003 to 2019 (<https://sidra.ibge.gov.br/pesquisa/registro-civil/tabelas/brasil/obitos>) (Table 2684). The data show an increase in the number of deaths that has been observed since the beginning of the historical series, in 2003, except in the year of 2005.

With the data of IBGE it would be possible, at a regular situation (without uncontrolled epidemics, natural catastrophes and wars, for example), estimate the number of deaths in the year of 2020. Unfortunately, as in the whole world, Brazil registered, as of March 2020,

an increasing number of deaths associate to COVID-19 disease.

In this paper we present the estimated number of deaths in 2020 at a regular situation based in IBGE data from 2003 to 2019 and in the Transparency Portal data from 2015 to 2019 to try to evaluate the effect that COVID-19 had on the number of deaths in 2020. In this work we also present the number of deaths attributed to respiratory diseases (non-COVID-19) in the years 2019 and 2020 (<https://transparencia.registrocivil.org.br/especial-covid>), which variation could be assigned to the low COVID-19 testing number and to the method of deaths record.

The number of violence deaths also is presented, from 2003 to 2019. The variation on the numbers from 2017 to 2019 has a strong impact in the jump of total of deaths observed in 2020 (<https://sidra.ibge.gov.br/pesquisa/registro-civil/tabelas/brasil/obitos>).

This study also can be useful in assessing epidemics that have affected Brazil over these years, including COVID-19, because it is clear from the data the existence of strong variations in the numbers of deaths in some periods, which can be assigned to public health emergencies.

Our study was carried out using public data easily accessible to anyone interested and is therefore easy to reproduce. The sources were IBGE (SIDRA 2019) and the Civil Registry Transparency Portal (PORTAL 2021).

The rest of the work is organized as follows: in the MATERIALS AND METHODS section the databases used for its development are described. In the RESULTS section the graphs on total deaths, violent deaths and hospital deaths from 2003 to 2020 are presented. Data on deaths related to other diseases in the years 2019 and 2020 are also presented. In the DISCUSSION section we analyze the graphs presented in the previous section, as well as the correlations

between them, which allow us to arrive at the CONCLUSIONS section where the main findings of our work are summarized.

MATERIALS AND METHODS

The data used for the number of deaths in Brazil (total, violent and in hospitals) were extracted from IBGE, in <https://sidra.ibge.gov.br/pesquisa/registro-civil/tabelas/brasil/obitos> (SIDRA 2019). Data from the Transparency Portal, in <https://transparencia.registrocivil.org.br/registros> (PORTAL 2021) on deaths in Brazil from 2015 to 2020 (the only data available) were also used. Regarding the two databases, it is worth pointing out that in the years included in both databases; the data do not coincide exactly. Data on deaths in Brazil in 2019 and 2020 due to specific diseases were also obtained from the Transparency Portal, in <https://transparencia.registrocivil.org.br/especial-covid>.

The methodology used in this work was the following: the data presented in the paper were taken from the free access websites of the Brazilian Institute of Geography and Statistics (IBGE), which is a federal public administration entity linked to the Ministry of Economy and is the main Brazilian Institution dedicated to the collection and dissemination of statistical data in the spheres of public federal, state, and municipal authorities. The data on the registration of deaths in registry offices were taken from the free access website of the Civil Registry Transparency Portal, created in 2018 and maintained by ARPEN Brazil, the National Association of Natural Person Registrars (arpenbrasil.org.br/home.php), which registers births, marriages, and deaths since the year 2015. The number of deaths associated with the COVID-19 pandemic and deaths from respiratory diseases were obtained from <https://transparencia.registrocivil.org.br/especial-covid>.

With the numbers of deaths recorded in the IBGE historical series between the years 2004 and 2019, a graph was assembled whose points were adjusted in a linear progression. Extrapolating this straight line, we arrive at an expected value for the year 2020 (there is no consideration of deaths in the pandemic). The data for deaths obtained from the Civil Registry Transparency Portal between the years 2015 and 2020 were also plotted and extrapolated in the same way on the same graph. The value for deaths registered in 2020 at the Transparency Portal (data registered at the registry office) was compared with the extrapolated values (IBGE and Transparency Portal straight lines).

In this work an investigation was also made using the historical series of violent deaths between the years 2003 and 2019, obtained from IBGE (<https://sidra.ibge.gov.br/tabela/2684#resultado>). This data was used in an attempt to verify the impact of violent deaths, especially those occurring in 2019, with the variation of the number of deaths occurring in 2020 in relation to those occurring in 2019.

Hospital deaths data recorded at IBGE between the years 2003 and 2019 (<https://sidra.ibge.gov.br/tabela/2684#resultado>) were also used in this work, plotted on a graph, to observe the possible occurrence of significant increases in deaths between consecutive years, which could be partially associated to past pandemics.

Additionally we analyzed the numbers of deaths from respiratory diseases by comparing 2019 and 2020 data obtained from the Transparency Portal (<https://transparencia.registrocivil.org.br/especial-covid>) in an attempt to relate the variation in the numbers of deaths in respiratory failure (RF), pneumonia (PN) and SARS to the COVID-19 death data in 2020.

For this work, there are not competing interests, was not necessary the patient consent for publication, all data used are available in

open access in Brazilian Institute of Geography and Statistics (IBGE) and Transparency Portal-Civil Registry. Ethical approval is not applicable to the current study because the data are in public domain, available in official sites and because this work does not consider individual identifications.

RESULTS

In Figure 1 we can observe the total number of deaths per year in Brazil from 2003 to 2019 (black circles), obtained from IBGE (SIDRA 2019) and the total number of deaths per year in Brazil from 2015 to 2019 (black triangles), according to data from the Transparency Portal (PORTAL 2021). Figure 1 also represents the point of intersection of the linear adjustment of these two sets of data for 2020. The black square is the total number of deaths for 2020, obtained from the Transparency Portal (PORTAL 2021).

The difference between the two points for 2020 (the intersection point of extrapolations and the data from the Transparency Portal for the year 2020) should be observed, which gives the value of 97,287 deaths. If we compare the actual values of deaths for 2019 and 2020, using the data for 2019 from IBGE and the data for 2020 from the Transparency Portal, the difference is 115,042 deaths. If we use the two values from the Transparency Portal, the difference is 187,023 deaths.

It is important to point out at this point that, given that the number of deaths by COVID-19 officially informed on the Transparency Portal (COVID 2021) until 12/31/2020 was 195,382, the difference between the two values for 2020 (the one extracted from the Transparency Portal (PORTAL 2021) and the one obtained by extrapolating the adjustments for the years 2003-2019 and 2015-2019), should be of this order. However, the extrapolation value

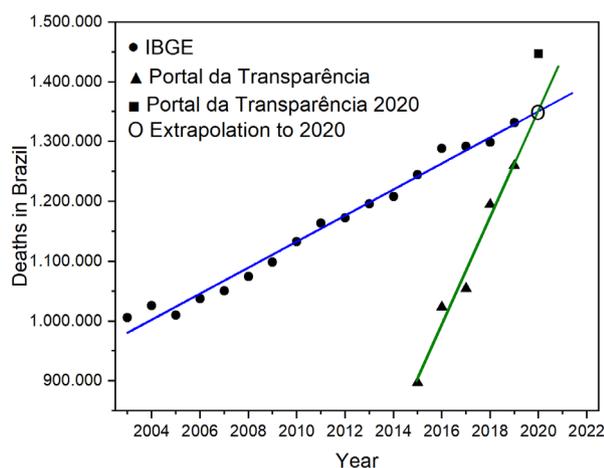


Figure 1. Total number of deaths in Brazil between 2003 and 2019. The black circles correspond to data from IBGE (SIDRA 2019) since the beginning of the series in 2003. The blue line is the linear adjustment and these data. The black triangles represent the data of the Transparency Portal available (PORTAL 2021). The green line is the linear adjustment to this data. The point of intersection between the lines corresponds approximately to the extrapolation of both for the year 2020. The black square is the number of deaths in the Transparency Portal for the year 2020. Note that the two sets of data have years in common, but in which the data do not coincide. The Transparency Portal is a more recent base and we believe that it will gradually be completed, so that in the future the slope will be similar to the slope of the linear adjust from IBGE data. Interestingly, in the graph we observe that as of 2020, without a pandemic, the two series would coincide. It is normal that large databases only guarantee their data after a certain time has elapsed. Clear examples of this are the databases of earthquakes and magnetic storms, among others.

is approximately half (97,287 deaths) of the registered deaths.

It also draws attention, in IBGE data (SIDRA 2019), to the difference between the years 2015 and 2016 (44,298 deaths), as well as the difference between the years 2009 and 2010 (34,326) and between the years 2010 and 2011 (31,039). Another notable difference occurred between the years 2005 and 2006 (27,452). It is important seen that the only decrease in the number of deaths in the historical series was

between two consecutive years, 2004 and 2005 (- 15,839).

Figure 2 shows the number of violent deaths in Brazil between 2003 and 2019. In this graph it is worth noting that between 2009 and 2011 the number remained approximately constant, as well as between 2015 and 2016. Other points that stand out are those between 2017 and 2019 with a systematic drop in the number of violent deaths that led to the lowest number in the historical series in 2019. It is notable the decreasing of the number of deaths by violence in 2019 when comparing with 2017 and 2018. This important decreasing also contributes to the large difference observed in deaths number between the years of 2019 and 2020, as show in Figure 1.

Figure 3 shows the number of deaths in hospitals from 2003 to 2019. Again, the differences between 2009 and 2010, and between 2015 and 2016, are highlighted. A new jump appeared between the years 2005 and 2006. The historical series of numbers of deaths in hospitals shows notable “jumps” in some years. This result points that in non-specific temporal intervals, occur unexpected increasing of the number of deaths by diseases, probably associated to previous epidemics.

Table I shows the data of deaths by the respiratory diseases (respiratory failure (RF), pneumonia (PN) and SARS) in Brazil for years of 2019 and 2020. The total numbers of these diseases are 329008 (2019) and 299298 (2020). The COVID-19 deaths data were compared with respiratory diseases death numbers.

DISCUSSION

The difference between 2019 and 2020, 77,521 deaths is the largest ever observed in the historical series (Figure 1). However, observing Figure 2, we can infer that there are two facts

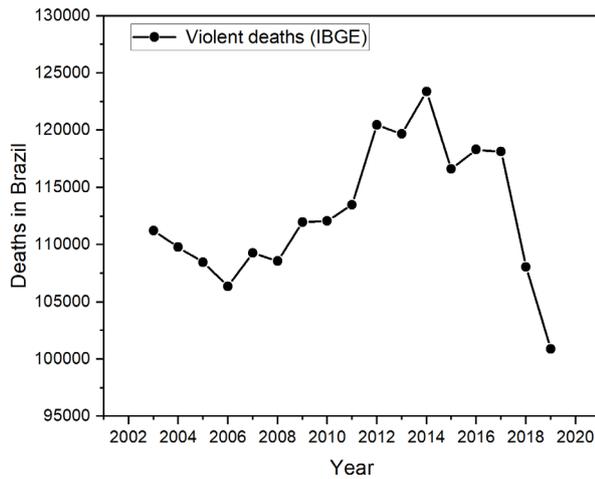


Figure 2. Number of violent deaths in Brazil, between 2003 and 2019. There was a sharp decrease between the years 2017 and 2019, which led to the minimum of the historical series so far.

that must have impacted this difference. The first is the number of violent deaths in 2019 (SIDRA 2019), which is the lowest in the historical series, and which may have led to an increase in the difference in total deaths between the years 2019 and 2020 of the order of 10,000 deaths. The second, which for the time being is partial (ANUÁRIO 2020), is the trend towards an increase in the number of violent deaths during the year 2020.

From Figure 1 there is a probability that COVID-19 brought a significant increase in the number of deaths, far beyond what would be expected by analyzing the historical series (SIDRA 2019, PORTAL 2021). However, some characteristics that are highlighted in Figure 1 appear in Figure 3 (deaths in hospitals). From the behavior of the differences between the years 2009 and 2010, and between the years 2010 and 2011, it can be inferred that there was some epidemic that affected the health system in Brazil. We risk that it may have been the first appearance of H1N1 (but this should be the object of more detailed studies). Likewise, the difference between the years 2015 and 2016

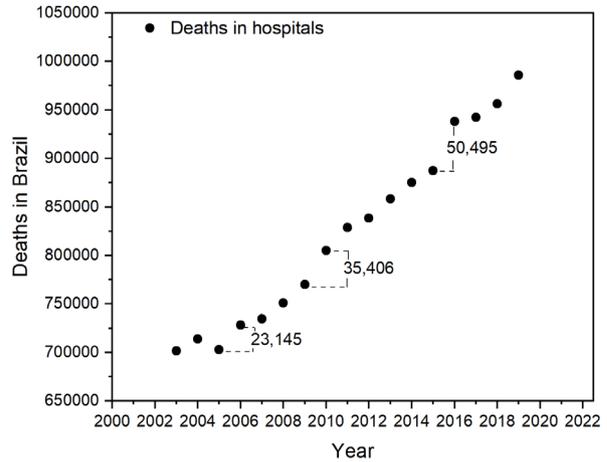


Figure 3. Number of deaths registered in hospitals in Brazil between 2003 and 2019. In this graph, as in Figure 1, the differences between the years 2005 and 2006, 2009 and 2010, and 2015 and 2016 are remarkable.

may be the signature of another epidemic or epidemics that may have affected Brazil in those years, such as chikungunya, zica and dengue (but as in the case of H1N1, this should be the target of more detailed studies). The difference between 2005 and 2006 could perhaps be related to sporadic appearances of swine fever in that period.

From the comparison of the differences between the years 2010 and 2011, 2015 and 2016 and 2019 and 2020, it can be seen that all of them are of the same order of magnitude. Therefore, it is to be expected that there were a number of false positives, as can be observed by the name adopted in the Transparency Portal - Special COVID-19 (COVID 2021) in the Registry Panel of summation: "Deaths with suspicion or confirmation of COVID-19". It is worth mentioning the decrease registered between the years 2019 and 2020 in the number of deaths from other respiratory diseases (not COVID-19). such as pneumonia, which fell by 44 413 deaths (COVID 2021).

However, another plausible hypothesis is that a large part of the deaths that would occur

Table I. Deaths by respiratory diseases for years of 2019 and 2020 in Brazil.

	2019	2020
a) Respiratory failure (RF)	100854	99603
b) Pneumonia (PN)	226652	183037
c) SARS	1502	16658
Total deaths (a+b+c)	329008	299298

naturally over 2020 (or even 2021, 2022 and beyond) due to severe comorbidities have been accelerated by the pandemic. If this hypothesis is correct, a number of deaths will be verified in 2021 and 2022, below what is expected from the extrapolation of historical series from 2003 to 2019, shown in Figure 1. This will obviously occur with the decrease in the number of deaths by COVID-19 by the use of vaccines, treatments and obtaining “herd immunity”. This decrease could be an indication that COVID-19 was controlled although definitely a pandemic is never absolutely over.

Table I shows the data of deaths by respiratory diseases: respiratory failure (RF), pneumonia (PN), and SARS, in Brazil for years of 2019 and 2020 (<https://transparencia.registrocivil.org.br/especial-covid>, accessed in 03/13/2021, Deaths from respiratory diseases. Last Updated 03/13/2021. Painel Registral, Causas respiratórias). The observed decreasing from 2019 (329008) to 2020 (299298) maybe due the register of deaths by non-COVID-19, as RF, PN and SARS, as COVID-19 deaths.

At 2019 the number of deaths by respiratory diseases was 329009 while at 2020 the number was 299298. The difference between the respiratory diseases (RF+PN+SARS), in Brazil for years of 2019 (329008) and 2020 (299298) was 29710. Deaths assigned to COVID-19 at 12/31/2020 were 195.382 (<https://transparencia.registrocivil.org.br/especial-covid>). Could be the COVID-19

deaths actually lower than 195 382? For example, the 29710 deaths could be by respiratory diseases and the COVID-19 deaths would be 165 672? That is, how many deaths in which the patient was a tested carrier of one of the co-morbidities RF, PN, SARS and also of COVID-19 were declared as COVID-19, and how many deaths with suspected (untested) COVID-19 but occurring due to RF, PN or SARS morbidities were declared as COVID-19 due to similarity of symptoms? This doubt implies an ignorance of the actual numbers of deaths and about the impact of COVID-19 on the death rates of the country. So, it remains unknown the actual mortality of the COVID-19, as well as the death rates of other respiratory diseases. On the other hand, the number of false-negatives in COVID-19 detection is 20% (Li et al. 2020), while the false positives were refereed in up to 5% of the tests (Healy et al. 2021). The number of false positives and false negatives results are attributed to contamination of reagents and fails in manipulation of biological materials (Huggett et al. 2020).

It is known that the acute respiratory failure (ARF) and sepsis are the main causes of death in COVID-19 patients (Wang et al. 2021). Therefore, it is not surprising that deaths from respiratory syndromes in patients with coronavirus are attributed to COVID-19. At the same time, the Brazilian sanitary authorities determinate that all suspected deaths are attributed, in the deaths certificates, to the COVID-19 (transparencia.

registrocivil.org.br/especial-covid). From these two facts it is possible to ask how many of these 29710 deaths which were not assigned to respiratory diseases could be, truly, respiratory diseases.

Could be the deaths by COVID-19 overestimated in Brazil? This question maybe can be answer with a massive testing in the suspected patients, to confirm the actual dimension of pandemic and, also, necropsies to confirm the *causa mortis*. The known of the real dimension of the pandemic and of the deaths associated to COVID-19 in a country as Brazil, with a lot social and economic troubles, is important to avoid that economic resources will be directed to an only diseases to the detriment of others diseases as important as COVID-19.

The declaration of COVID-19 as a pandemic brought widespread concern that must have contributed to the increase in the number of deaths by 2020 compared to 2019. One example is the increase in SARS deaths of 15044 (COVID 2021).

One can mention the abandonment by patients of treatment for pre-existing diseases, suicides and domestic violence, among others. The initial extreme concern must have been caused by the rapid spread of the disease in populations especially vulnerable to it (elderly population in European countries), even in places of high human development. It draws attention to the relatively low morbidity that the virus has caused in populations of places theoretically less prepared to face this type of disorder (Africa). But it is also worth mentioning that the African population is, in general and due to low life expectancy, young. Brazil is not at either extreme.

CONCLUSIONS

The number of deaths in Brazil in 2020, expected by extrapolation of the historical series 2003-2019 (IBGE) and 2015-2019 (Portal da Transparência), has increased sharply since the appearance of COVID-19. The total number of deaths, although representing an immeasurable human loss, remained in the same order of magnitude as the number of deaths due, possibly, to other infectious diseases in previous periods. The difference between the total number of deaths in the years 2019 and 2020 may also be associated with an increase in the number of violent deaths in 2020 and with a decreasing of this kind of deaths in 2019. That is, as the number of violent deaths in 2019 has decreased substantially when compared to the numbers in 2018 and 2017, it causes a “jump” in the total number of deaths comparing the years 2018 and 2019 with 2020. On the other hand, the number of deaths reported on the Transparency Portal as “Deaths with suspicion or confirmation of COVID-19” far exceeds the statistical projections presented in this work, specifically, the difference between the extrapolation of the historical series of the IBGE and the Portal until 2019, and the data of the Transparency Portal for 2020, as well as seem to be related to the variation in the number of deaths due to other respiratory diseases. It would be very interesting to do similar studies for others countries and eventually to the whole world, to know the actual impact of the COVID-19 worldwide. A major limitation of this study is that there is no confirmation of the actual deaths from COVID-19, since on the death certificate the mention of coronavirus is enough for the death to be registered as COVID-19. On the other hand, this research points to the possibility that COVID is actually less deadly than is believed today. Knowing the actual mortality or even an indication of a lower mortality of the disease

would prevent resources from being spent in the future on COVID-19 that would cause neglect of other diseases (epidemic or pandemic) equally deadly and serious.

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L.P. Sosman and A.R.R. Papa: Both conceived the work and the analysis; collected the data; contributed data and analysis tools; performed the analysis and wrote the paper.

