Evaluation of the virulence of SARS-CoV-2 in France, from all-cause mortality 1946-2020

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Evaluation of the virulence of SARS-CoV-2 in France, from all-cause mortality 1946-2020

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Summary

We analyzed historic and recent all-cause mortality data for France, and other jurisdictions for comparison, using model fitting to quantify winter-burden deaths, and deaths from exceptional events. In this way, COVID-19 is put in historic perspective. We prove that the “COVID-peak” feature that is present in the all-cause mortality data of certain mid-latitude Northern hemisphere jurisdictions, including France, cannot be a natural epidemiological event occurring in the absence of a large non-pathogenic perturbation. We are certain that this “COVID-peak” is artificial because it:

i. occurs sharply (one-month width) at an unprecedented location in the seasonal cycle of all-cause mortality (centered at the end of March),

ii. is absent in many jurisdictions (34 of the USA States have no “COVID-peak”), and

iii. varies widely in magnitude from jurisdiction to jurisdiction in which it occurs.

We suggest that:

- the unprecedented strict mass quarantine and isolation of both sick and healthy elderly people, together and separately, killed many of them,
- that this quarantine and isolation is the cause of the “COVID-peak” event that we have quantified,
- and that the medical mechanism is mainly *via* psychological stress and social isolation of individuals with health vulnerabilities.

According to our calculations, this caused some 30.2 K deaths in France in March and April 2020. However, even including the “COVID-peak”, the 2019-2020 winter-burden all-cause mortality is not statistically larger than usual. Therefore SARS-CoV-2 is not an unusually virulent viral respiratory disease pathogen. By analyzing the all-cause mortality data from 1946 to 2020, we also identified a large and steady increase in all-cause mortality that began in approximately 2008, which is too large to be explained by population growth in the relevant age structure, and which may be related to the economic crash of 2008 and its long-term societal consequences.

Résumé en français

Nous avons analysé les données historiques et récentes de mortalité toutes causes confondues pour la France et d'autres juridictions à des fins de comparaison, en lissant une courbe théorique pour quantifier les décès dus à la charge hivernale et les décès dus à des événements exceptionnels. De cette façon, on peut observer le COVID-19 avec une perspective historique. Ainsi, nous prouvons que le « pic COVID » présent dans les données de mortalité toutes causes confondues de certaines juridictions de l'hémisphère Nord à moyenne latitude, y compris la France, ne peut pas être un événement épidémiologique naturel ayant survenu de façon naturelle, en l'absence d'une grande perturbation non pathogène. Nous sommes convaincus que le « pic COVID » est artificiel car :

i. il s’est produit brusquement (largeur d'un mois) à une date sans précédent dans le cycle saisonnier de mortalité toutes causes confondues (milieu du pic à la fin mars),
ii. il est absent dans de nombreuses juridictions (34 des États américains n'ont pas de « pic COVID »), et
iii. l’ampleur de ce pic varie considérablement d’une juridiction à l’autre.

Nous suggérons que :

- la quarantaine de masse et l'isolement strict sans précédent des personnes âgées malades et en bonne santé, ensemble et séparément, a tué beaucoup d'entre eux,

- que cette quarantaine et cet isolement sont la cause de l'événement « pic-COVID » que nous avons quantifié,
- et que le mécanisme médical expliquant ce pic passe principalement par le stress psychologique et l'isolement social des personnes vulnérables au niveau de leur santé.

Selon nos calculs, ces mesures ont provoqué quelques 30,2 K décès en France en mars et avril 2020. Cependant, même en incluant le « pic COVID », la charge hivernale de mortalité toutes causes confondues pour l'hiver 2019-2020 n'est pas statistiquement supérieure aux charges hivernales habituelles, ce qui nous amène à affirmer que le SARS-CoV-2 n'est pas un virus responsable de maladies respiratoires inhabituellement virulent.

En analysant les données de mortalité toutes causes confondues de 1946 à 2020, nous avons également identifié une augmentation importante et régulière de la mortalité toutes causes confondues qui a commencé vers 2008, trop importante pour être expliquée par la croissance de la population étant donné la pyramide des âges, mais qui pourrait être liée à la crise économique de 2008 et à ses conséquences sociétales sur le long terme.

1. Introduction

France is said to be one of the five European countries most impacted by COVID-19, with Belgium, UK, Italy and Spain.

France has applied broad response measures since the pandemic was declared by the WHO on 11 March 2020, including national lockdown and systematic quarantine of sick and healthy individuals together in care homes and facilities for elderly persons.

The question arises: Is there bias-free hard evidence that the extraordinary measures were and are warranted? After all, if the pathogen is as contagious and virulent as believed, then, irrespective of the array of efforts to mitigate spread of the epidemic, it should be evident by now that the decisions to impose the measures were warranted.

Alternatively, if there is little evidence of an abnormal increase in mortality, then either SARS-CoV-2 is not as dangerous as imagined, or the array of *ad hoc* mitigation measures has been effective and should be considered proven.

2. Data and methods

2.1. Data selection

Cause-of-death assignation and COVID-19 mass “testing” are both susceptible to bias (Cummins, 2020). All-cause mortality is not. Therefore, we use the extensive database of all-cause mortality by month for metropolitan France 1946-2020, and other data (see section 2.2), to cast recent deaths in their historical context. Here, “metropolitan France” means continental France and Corsica (i.e. European France).

2.2. Data retrieval

Table 1 describes the data retrieved and which source it has been collected from.

Data type	Country	Period	Time base	Source
Population	Metropolitan France	1946-2020	Year	Insee (2020c)
All-cause mortality	France	1982-2019	Year	Insee (2020a)
All-cause mortality	Metropolitan France	1946-2020	Month	Insee (2020d)
All-cause mortality	France	1994-2020	Month	Insee (2020e)
All-cause mortality	France	1 March to 20 July for 2018, 2019 and 2020	Day	Insee (2020b)
All-cause mortality	Metropolitan France	1968-2018	Day	Insee (2019)
All-cause mortality	Canada	2014-2020	Week	StatCan (2020)
All-cause mortality	USA	2013-2020	Week	CDC (2020)

Table 1. Data retrieved. Metropolitan France means continental France and Corsica. France means metropolitan France and overseas France.

2.3. Epidemiological data analysis

We chose not to analyse the data by the common method of using a sinusoidal signal intended to separate viral respiratory disease deaths from other seasonally varying deaths. We believe the latter method, although widely applied, is problematic for the following main reasons:

- The assumed underlying sinusoidal component does not reliably separate deaths assigned as being primarily caused by the viral respiratory disease of interest and the deaths assigned as being primarily due to other seasonally varying (non-viral) causes.
- The sinusoidal model does not correctly fit the non-viral seasonal component of all-cause deaths, since it has systematic residuals in those segments assumed to be unaffected by the viral pathogen.
- There is no biological or medical reason that any seasonal component will have a simple sinusoidal functional form, and many reasons that it would not.

Instead, we analyse the all-cause mortality by month data using a sum of one to three Voigt lines for each peak or feature that rises above the assumed-linear summer baseline for the fitting region. In practice, we select a fitting region over which the summer baseline delimited by the bottoms of the summer troughs is approximately a straight line with a given slope, and use the Voigt lines to fit the peaks that rise above this summer baseline for the fitting region. In this way, the total area of all the Voigt lines in a given winter peak, for example, is the winter-burden mortality for the given winter.

Figure 1 shows that whereas the winter-peak values vary somewhat erratically from year to year, the summer-trough bottoms delineate linear trends with time (the “summer baselines”), in distinct time periods. We delineated the data into five regions as:

2005-2020:	linear with positive slope	"region-I"
1994-2005:	linear with near-zero slope	"region-II"
1968-1994:	linear with near-zero slope	"region-III"
1958-1968:	linear with positive slope	"region-IV"
1946-1958:	linear with near-zero slope	"region-V"

Here, regions II and III both have essentially the same linear summer baselines (**Figure 1**) but were divided into two regions to reduce the sizes of the fittings, and for easier comparison with the 1994-2020 France data (**Figure 2**).

Within each such region (I through V), we fit the data with a linear summer baseline and model peaks for each of the winters. The model peak for a given winter (or a given anomalous peak, see section 3) was taken to be the sum of a variable number, N_{peak}, of Voigt lines. The Voigt lineshape is a convolution between the Lorentzian lineshape and the Gaussian lineshape, such that it can be varied to adopt any shape on a "Lorentzian-Gaussian continuum" of shapes. This is convenient because, for a given lineshape-area, the Lorentzian has broad wings (and a pointed head), whereas the Gaussian shape has a crisp delineation with little wings (and a broad head). The Voigt lineshape is symmetric about its center, whereas all-cause mortality peaks are not generally symmetric, and contain structure such as shoulders, sharp rises, and asymmetric or unequal decays on the two sides. We accommodate such structure by using as many (N_{peak}) Voigt lines in a given all-cause mortality peak as are minimally needed to reduce the residual (i.e. the difference between the data and the model function) to random noise. With the France 1946-2020 data, this requires between 1 and 3 Voigt lines per peak (N_{peak} = 1 to 3), excluding the anomalous peaks that each require their own Voigt line (one per anomaly, in this case).

Using this method, the winter-burden peaks are well represented and contribute little to raising the summer-trough bottoms above the linear summer baseline. Thus our model reliably captures the winter-burden deaths that occur above the summer baseline. In other words, the winter-burden deaths of a season correspond to the area under the winter-burden peak for that season.

The yearly all-cause mortality is calculated for two types of years: the cycle-year and the calendar-year.

Cycle-year: For a given winter-centered year (cycle-year), the all-cause mortality is equal to the summer baseline value of mortality per month evaluated at the weighted peak position (close to 1 January) times 12 plus the areas of all the N_{peak} Voigt lines in the winter peak.

Calendar-year: The all-cause mortality is obtained by direct counting for the 12 months in each calendar year.

Fitting and quantification are done with the Recoil spectral analysis software, adapted as needed for the epidemiological context (Lagarec and Rancourt, 1998; Rancourt, 2019).

3. Analysis and discussion

3.1. France 1946-2020 data

France maintains a high-quality demographic database, from 1946 to present (Insee, 2020d). **Figure 1** shows all-cause mortality by month for metropolitan France, from January 1946 to June 2020:

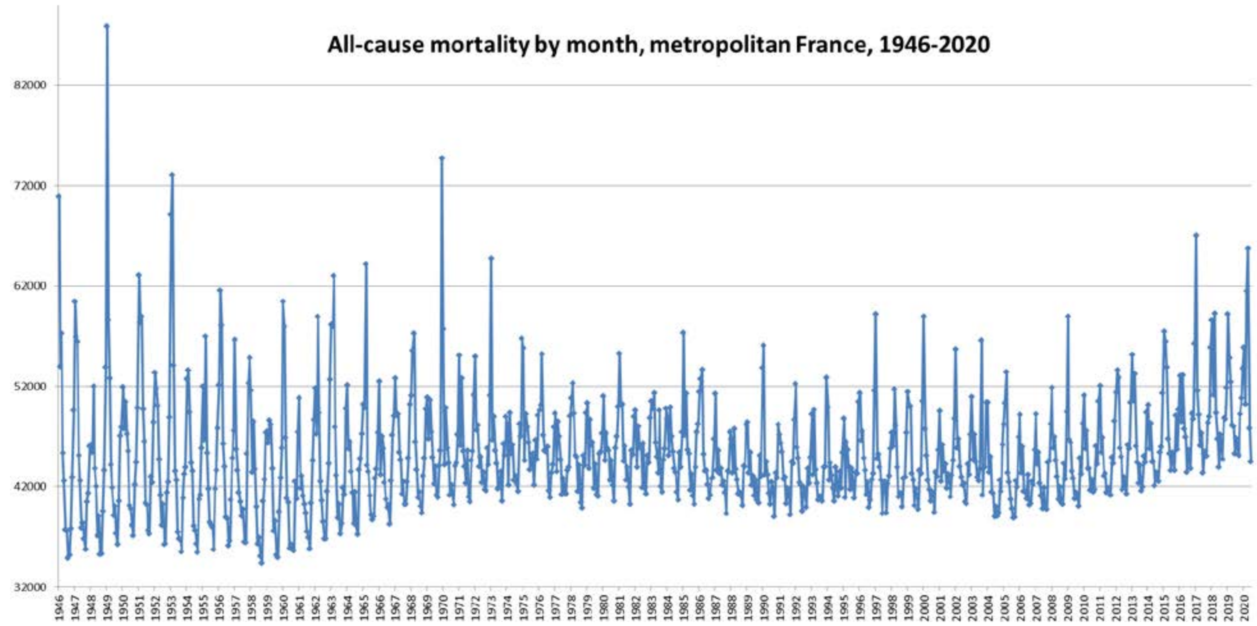

Figure 1. All-cause mortality by month in metropolitan France from 1946 to 2020. Data are displayed from January 1946 to June 2020. Data were retrieved from Insee (**Insee, 2020d)**, as described in **Table 1**.

The data shows the well-known and prominent winter peaks and summer troughs (Dowell, 2001; Marti-Soler *et al.*, 2014; Paules and Subbarao, 2017; Rancourt, 2020). Such seasonal patterns of all-cause mortality occur in all mid-latitude countries. The patterns are shifted by 6 months in the Southern-hemisphere mid-latitudes, where the peaks again correspond to winters in that hemisphere.

Visual inspection of **Figure 1** shows that the 2019-2020 winter mortality in France was not obviously anomalous, at first sight. This is not surprising to us: most provinces in Canada and most states in the USA have 2019-2020 winter-burden all-cause mortalities that are smaller than for each of at least two other winters in the last decade (unpublished).

Figure 1 is a sobering result, which is in contrast to the focus of media coverage since March 2020. There was not an extraordinary winter mortality in France in 2019-2020. In light of 75 years of all-cause mortality data, death has continued its seasonal variation without any remarkable event, remaining within the bounds of year-to-year statistical variation, at least on the large scale of this figure.

In France, there have been five seasons over the last 75 years with a higher maximum in all-cause mortality by month than the maximum of the 2019-2020 season: 1945-1946, 1948-1949, 1952-1953, 1969-1970 and 2016-2017 (**Figure 1**). The 2019-2020 seasonal epidemic was not the worst in a century, as claimed by French president Emmanuel Macron (see France 24, 2020, at 00:34).

3.2. France 1994-2020 data

France has also released "all-France" mortality data, which includes metropolitan and overseas France, for the last nearly three decades (Insee, 2020e). **Figure 2** shows all-cause mortality by month for the whole of France, from January 1994 to June 2020:

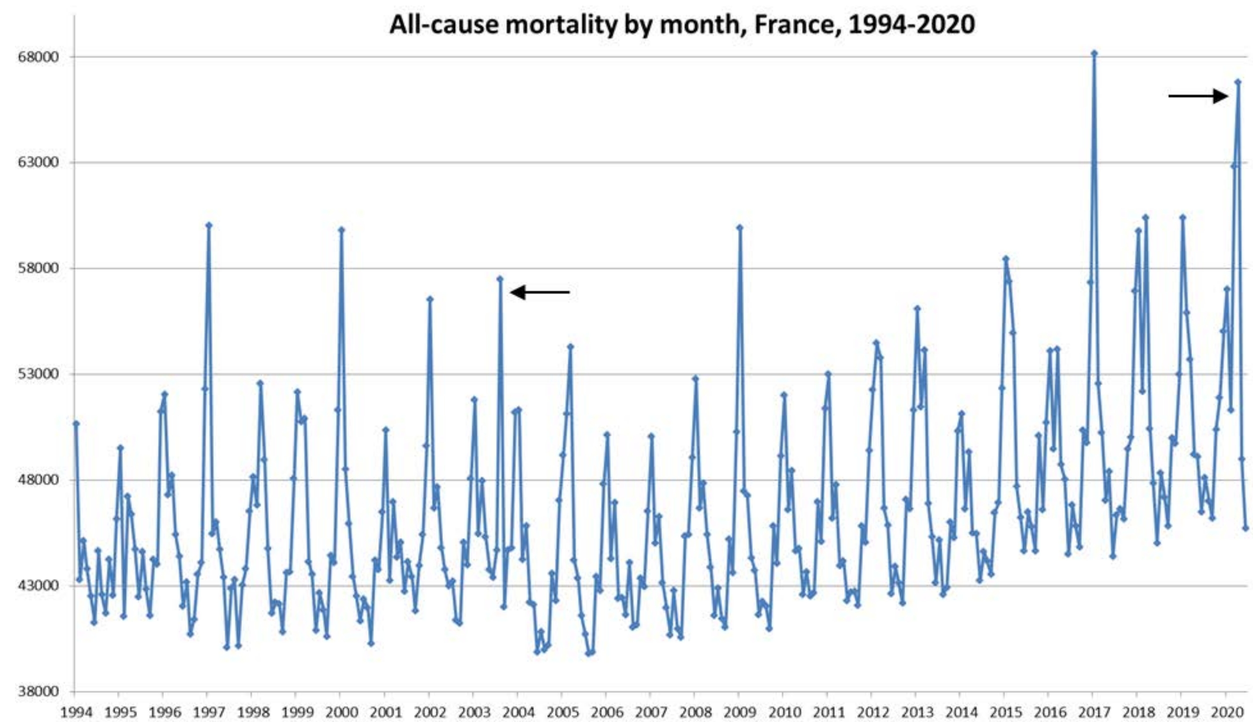

Figure 2. All-cause mortality by month in France from 1994 to 2020. Data are displayed for "all-France", which includes metropolitan and overseas France, from January 1994 to June 2020. The arrows show the two anomalous peaks discussed in the text. Data were retrieved from Insee **(Insee, 2020e)**, as described in **Table 1**.

At this resolution (1994-2020, by month), two anomalies are recognized, which do not conform to known seasonal-variation patterns for mid-latitude countries in the Northern hemisphere: the August-2003 heat wave anomaly and the March-April-2020 anomaly, which we name the "COVID-peak" (following Rancourt (2020)) and describe in the next sections.

3.3. France August-2003 heat wave anomaly

The first anomaly is a single-month spike that occurred in August 2003 ("2003-08"), which would normally be part of a trough in all-cause mortality by month, which rises near the 58 K deaths/month mark in 2003 (**Figure 2**). This anomaly has conclusively been attributed to an exceptional heat wave that hit nearly all of France in that month and that killed approximately 15 K people (Evin *et al.*, 2004; Hémon and Jougla, 2004). It is an example of deaths that cannot be attributed to a pathogen acting on a population in normal circumstances.

3.4. "COVID-peak" anomaly

The second anomaly is a narrow peak, having a width of approximately 1 month, occurring at (centered on) the end of March 2020, which would normally be the decaying shoulder of the recent winter peak. Winter peaks are always centered at the beginning of January and by March are always in decay towards the next summer trough in all-cause mortality. Rancourt has called the second anomaly the "COVID-peak" and he has postulated that it was caused by the government responses that followed the 11 March 2020 WHO declaration of the pandemic (Rancourt, 2020).

The all-cause mortality by day (**Figure 3**) shows that the said "COVID-peak" occurs on the March-side decay of the preceding winter peaks. **Figure 3** shows the all-cause mortality by day for France, for the years 2018, 2019 and 2020, from 1 March through 30 June:

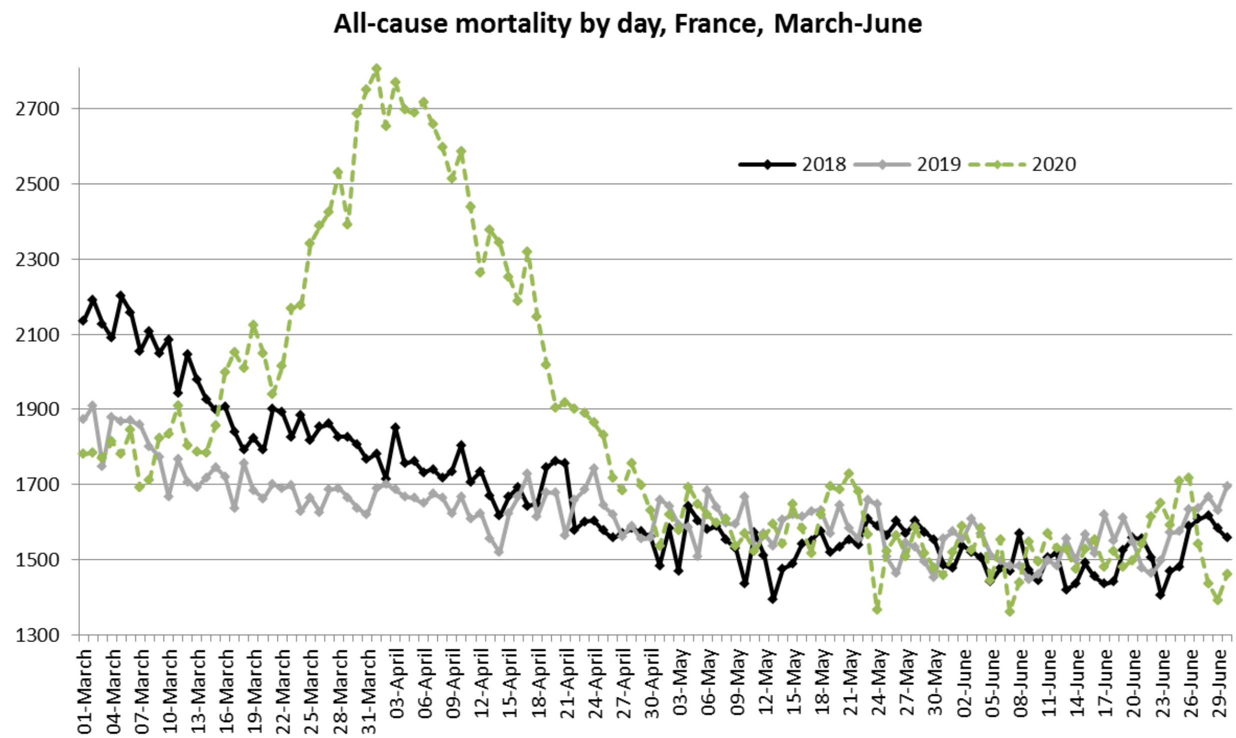

Figure 3. All-cause mortality by day in France from March to June 2018, 2019 and 2020. Data are displayed for "all-France", which includes metropolitan and overseas France, from 1 March to 30 June of 2018, 2019 and 2020. The black line is the data for 2018. The grey line is the data for 2019. The green dashed line is the data for 2020. Data were retrieved from Insee **(Insee, 2020b)**, as described in **Table 1**.

There has never previously been a sharp (1 month width) prominent peak in all-cause mortality, occurring at the end of March, such as this "COVID-peak", in the 75 years of all-cause mortality records for France, nor for available records for Canada and its provinces, the USA and its states, England and Wales, and European countries (Rancourt, 2020 and to be published).

In addition, the "COVID-peak" anomaly not only occurs at a unique time in the epidemiological cycle but also varies widely in magnitude, from zero (e.g. California) to overwhelmingly large (e.g. New York State), in going from one mid-latitude Northern-hemisphere jurisdiction to another (manuscript in preparation). This is illustrated for Canada, as follows. **Figure 4** shows all-cause mortality by week (number of deaths per week vs standard CDC weeks) from week-1 (first week of January) of 2014 to week-22 (last week of May) of 2020, for the provinces of Ontario and Quebec:

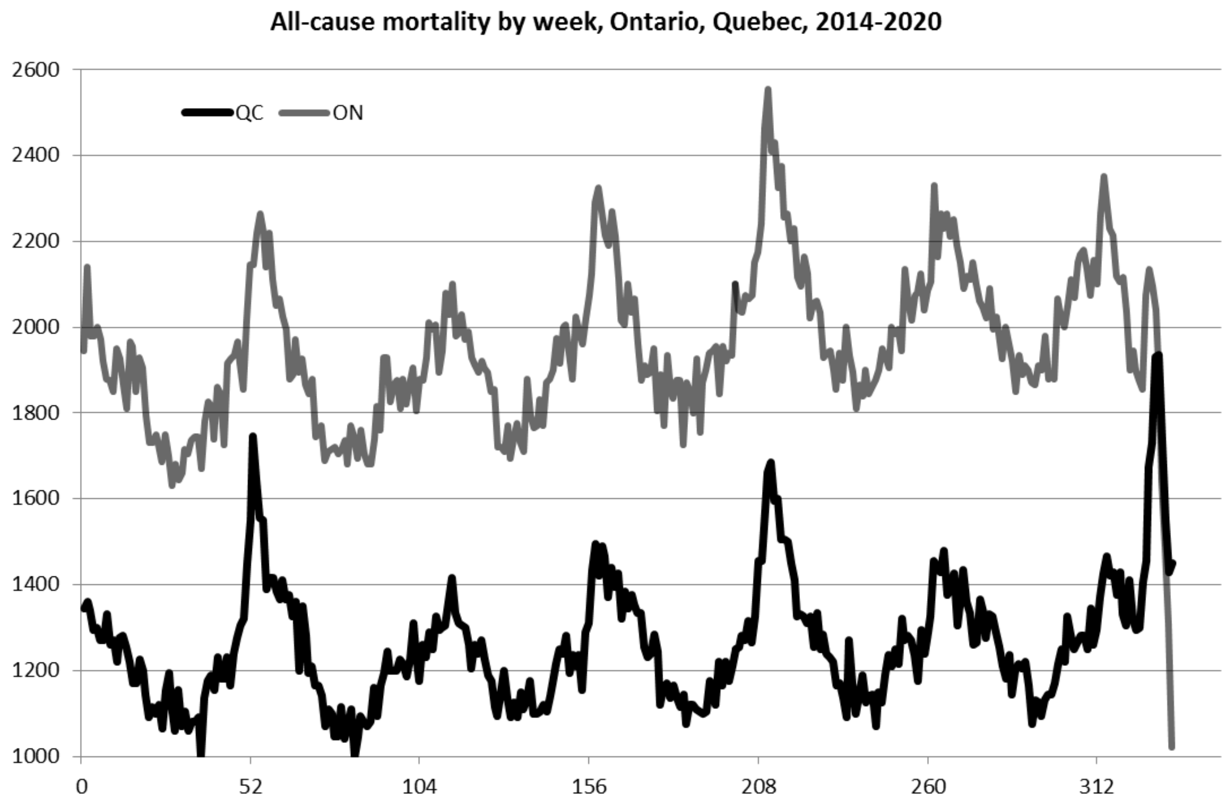

Figure 4. All-cause mortality by week in Ontario and Quebec, from 2014 week-1 to 2020 week-22. The grey line shows the data for Ontario. The black line shows the data for Quebec. Data were retrieved from Statistics Canada **(StatCan, 2020)**, as described in **Table 1**.

Ontario and Quebec are similarly populous East-West adjacent provinces of similar sizes, having distinct medical systems (health is a provincial jurisdiction in the Canadian constitution). As with virtually all mid-latitude Northern-hemisphere countries, the epidemiological cycles (all-cause mortality curves) of Ontario and Quebec are virtually identical, except for the “COVID-peak” anomaly. The “COVID-peak” is much larger in Quebec than in Ontario, where Quebec was the first province to impose an aggressive lockdown and close its provincial borders.

For decades the epidemiological cycles (all-cause mortality curves) in all mid-latitude Northern-hemisphere jurisdictions have been virtually identical, and have never displayed any peak centered at the end of March, until after 11 March 2020 when a “COVID-peak” anomaly occurred in certain jurisdictions, which is widely variable in magnitude. Therefore, the “COVID-peak” cannot be due to a natural progression of a viral respiratory disease (regardless its virulence), in unperturbed societal structures. Indeed, if this anomaly was due to virulence, it would be difficult to understand the large time-lag between the first reported case in France (27 December 2019 according to Deslandes *et al.*, 2020) and the anomaly’s sudden rise starting in mid-March of the “COVID-peak”. We postulate that the excess all-cause mortality captured by the “COVID-peak” anomaly was caused by government responses to the declaration of the “pandemic” by the WHO on 11 March 2020. It is not a natural epidemiological event, irrespective of the underlying pathogenic and co-morbidity circumstances.

Indeed, the said “COVID-peak” is remarkable in epidemiological terms in that it is entirely absent for many jurisdictions, where the absence appears to be tied more to jurisdictional politics and policy rather than any epidemiological logic. For example, the “COVID-peak” is entirely absent in 34 of the USA States, and varies dramatically in intensity from state to state for those States in which it is present (manuscript in preparation). **Figure 5** shows a colour-coded map of the USA for “COVID-peak” intensity. Darker green is increased degree of absence of the “COVID-peak”, and darker grey is increased intensity of a discerned “COVID-peak”:

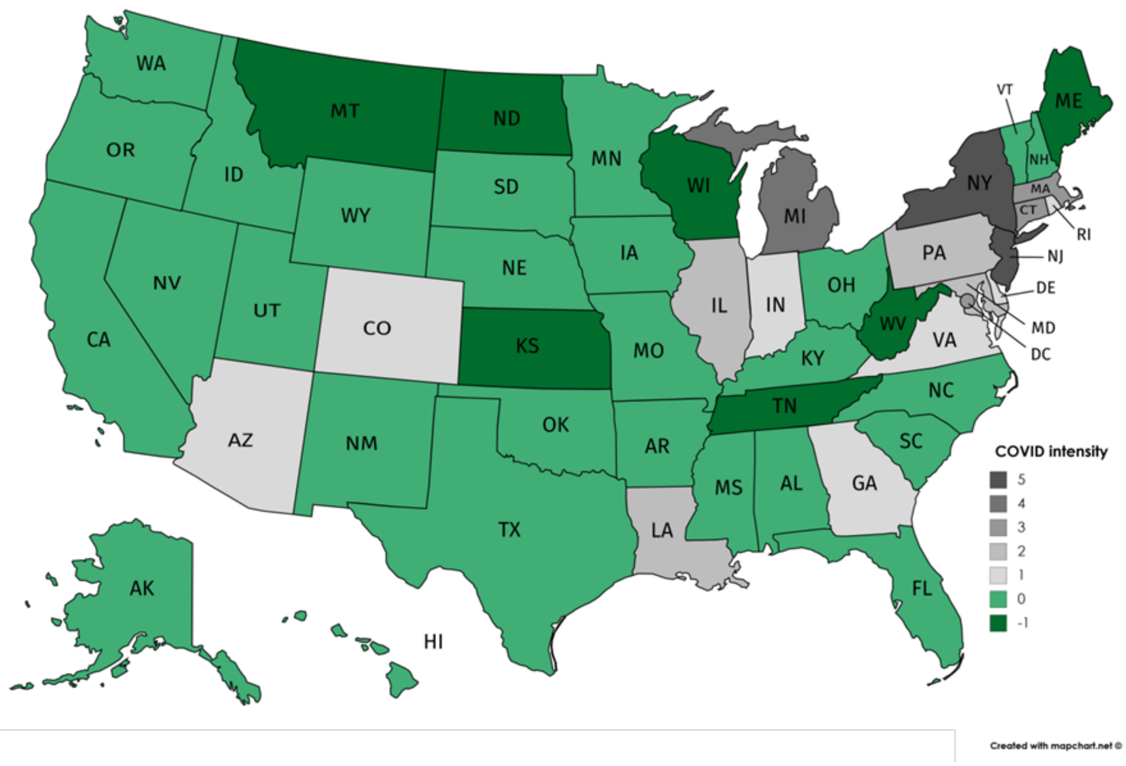

Figure 5. “COVID-peak” intensity map of the USA. States in green are the states where the “COVID-peak” is absent. The darker the green, the more intense the absence. States in grey are the states where the “COVID-peak” is present. The darker the grey, the more intense the presence. Data were retrieved from CDC **(CDC, 2020)**, as stated in **Table 1**.

Here, all the USA States have comparable infection rates, according to reported mass testing results (Ioannidis, 2020). Such geographical variation in an all-cause mortality peak that occurs simultaneously in various localities on two continents is unprecedented in the natural history of human epidemiology.

Either SARS-CoV-2 is such a unique viral respiratory disease pathogen, unlike any previously seen, that it can naturally cause a mortality peak at the end of March, across the mid-latitude Northern-hemisphere world, solely in certain jurisdictions where it occurs, or synchronous and local external (non-pathogenic) factors played a major role. We conclude the latter.

3.5. Quantitative analysis of the all-cause mortality data

Next, we made a quantitative analysis of the all-cause mortality by month for metropolitan France from January 1946 to June 2020 (**Figure 1**), as described in section 2.3.

Figure 6 shows our fit, and its residual, for region-II (1994-January through 2005-September):

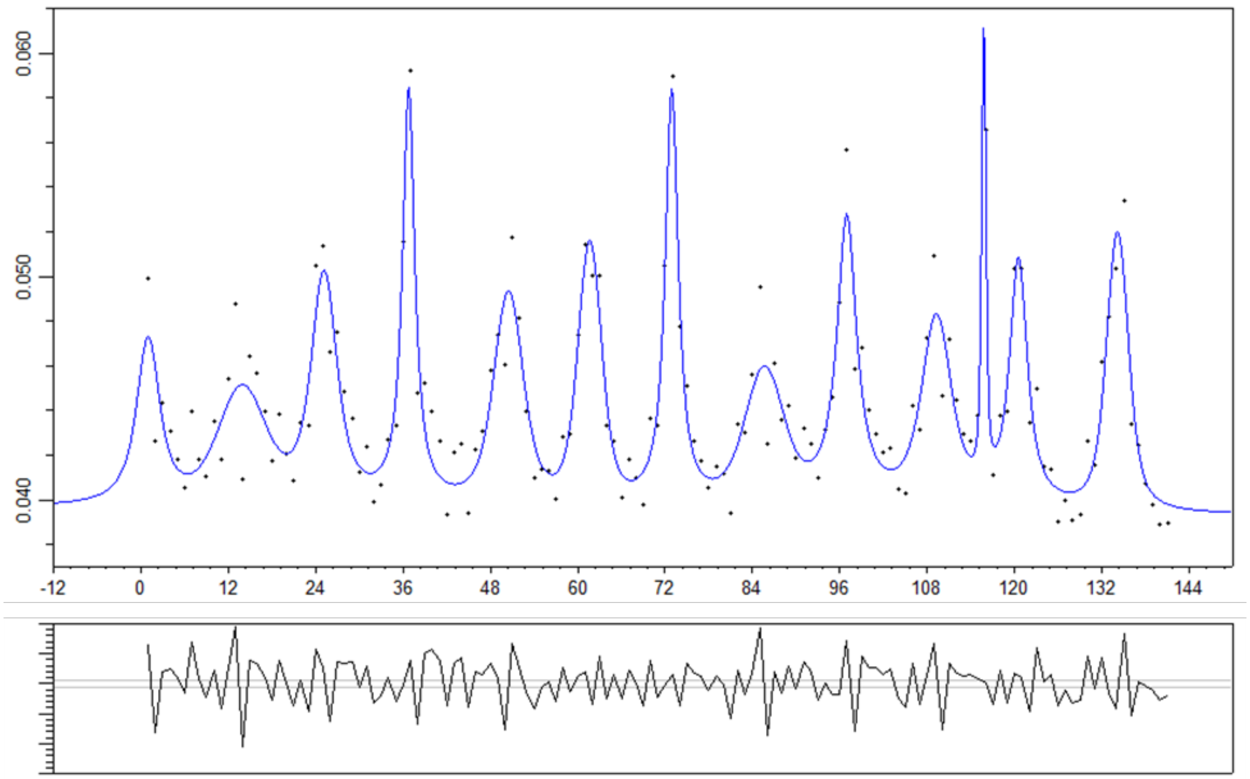

Figure 6. Fit of the monthly all-cause mortality data of metropolitan France 1946-2020, region-II. Region-II corresponds to the period between January 1994 and September 2005, as defined in section 2.3. The y-scale is millions of deaths per month. The x-scale is in months. The blue line is the fitted function. The residual is shown at the bottom.

The single-month spike that corresponds to the August-2003 heat wave is seen at month number 116, and, in our fit, corresponds to a spike area (heat wave deaths) of 19 K deaths. Note that our goal here was not to determine an accurate number of deaths for the heat wave itself but rather to correctly represent the total mortality profile in this period. We obtain a more accurate value of 15.3 K deaths for this heat wave by our analysis of the higher resolution all-cause mortality by day (Insee, 2019) (not shown). The difference (19 K versus 15.3 K) occurs because higher resolution data provides greater power to separate overlapping contributions in a given region of the data.

Figure 7 shows our fit, and its residual, for region-I (2005-August through 2020-June):

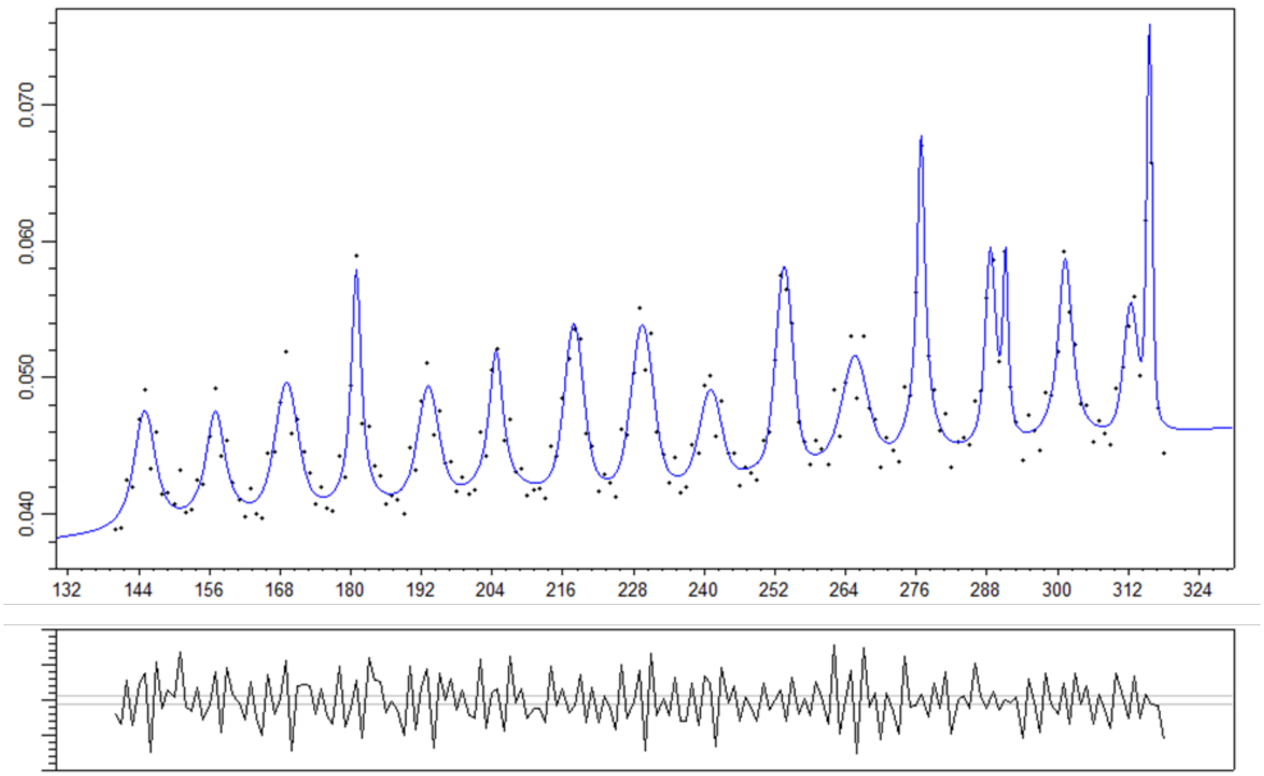

Figure 7. Fit of the monthly all-cause mortality data of metropolitan France 1946-2020, region-I. Region-I corresponds to the period between August 2005 and June 2020, as defined in section 2.3. The y-scale is millions of deaths per month. The x-scale is in months. The blue line is the fitted function. The residual is shown at the bottom.

The month-wide "COVID-peak" is seen, centered at the end of March 2020, straddling March and April, as seen in **Figure 3**. In this fit (**Figure 7**), the "COVID-peak" has an estimated area of 41 K deaths. This estimate is limited in accuracy by two main factors: (i) the low temporal resolution of the mortality by month data, which limits the power to separate overlapping contributions, and (ii) the missing mortality by month data beyond June 2020. These problems are resolved in our analysis of the mortality by day data, as follows.

Accurate quantification of the deaths in the complete “COVID-peak” is obtained by fitting the all-cause mortality by day for France for 1 March 2020 through 30 June 2020, shown in **Figure 3**. The fit uses a linear sloped background for the non-COVID-peak components and two Voigt lines (N_{peak} = 2) for the “COVID-peak”, as shown in **Figure 8**:

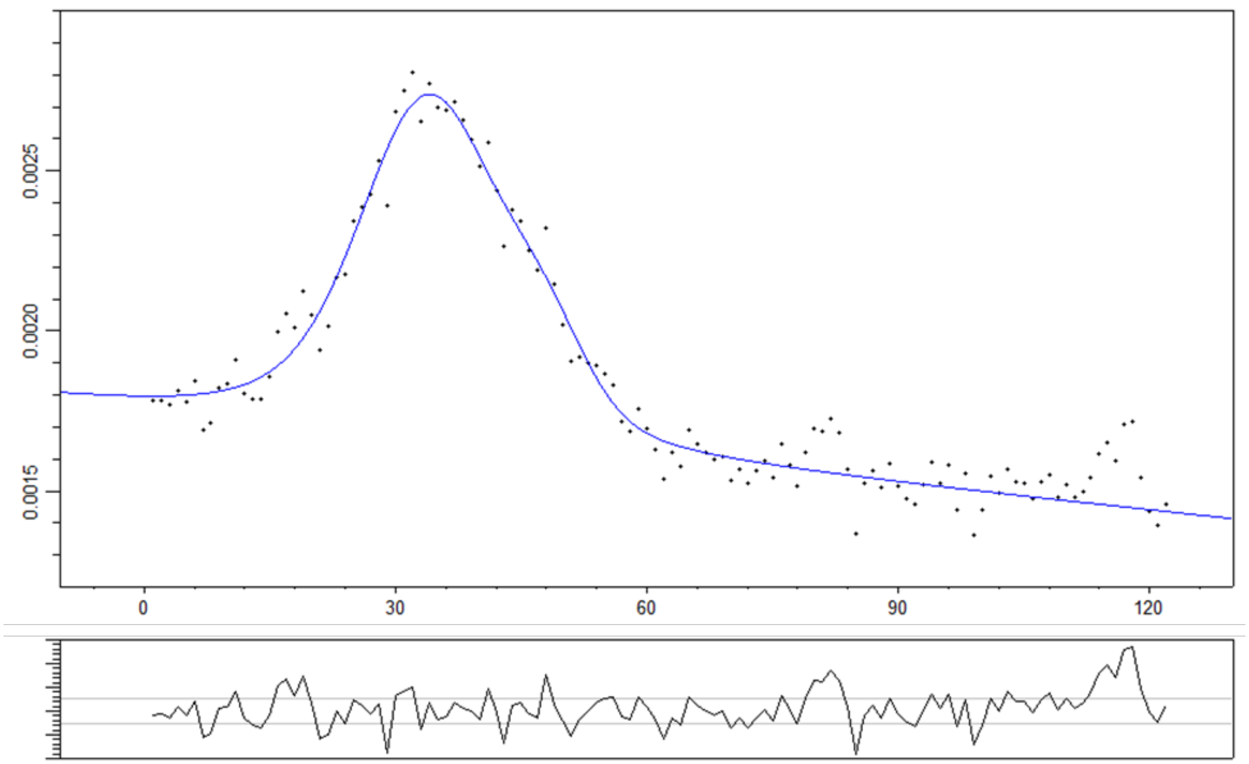

Figure 8. Fit of the daily all-cause mortality data of France (metropolitan + overseas), from 1 March to 30 June 2020. The y-scale is millions of deaths per day. The x-scale is in days. The blue line is the fitted function. The residual is shown at the bottom.

This fit gives an accurate “COVID-peak” area equal to 30.2 K deaths, which is approximately double the deaths from the August-2003 heat wave in France, and which we attribute to the total deaths in France due to government interventions responding to the declared “pandemic”.

3.6. Graphical analysis of the model-fitting results

In examining our fit results for metropolitan France 1946-2020, we first calculate the all-cause mortality per cycle-year, as defined in section 2.3.

Figure 9 shows the all-cause mortality per cycle-year for metropolitan France 1946-2020, compared to the all-cause mortality per calendar-year for the same data:

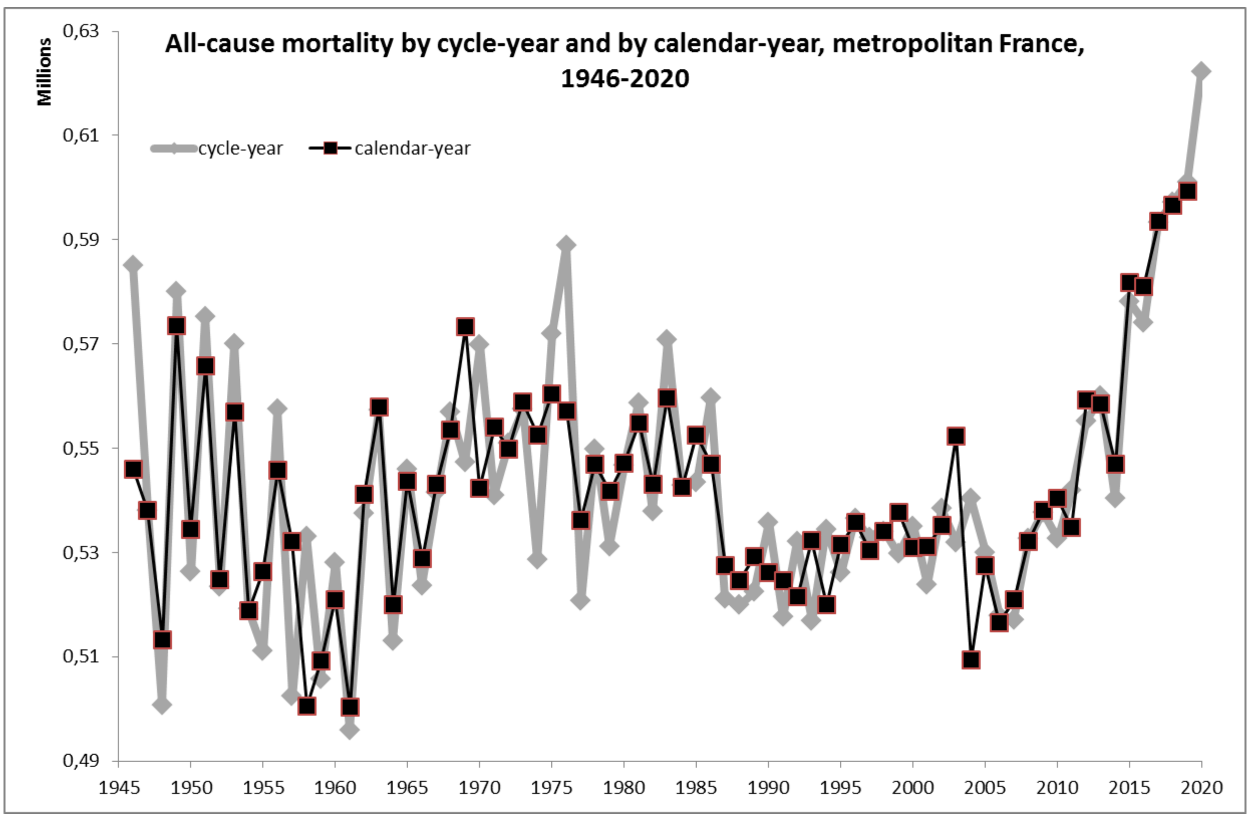

Figure 9. All-cause mortality by cycle-year and by calendar-year in metropolitan France from 1946 to 2020. The grey line shows the data per cycle-year (centered in January), meaning that the year of the month of January in the winter peak is used on the x-axis. The black line shows the data per calendar-year (direct sum). The cycle-year values were obtained by fitting, as described in section 2.3.

The break that occurs between 1986 and 1987 is probably an artifact of the data collection method. There may be another such break between 1961 and 1962. Overall, there is a decline of mortality per year after the Second World War and up to 1961, plateaus in mortality per year for the periods 1962-1986 and 1987-2008, and a steady and steep increase starting at approximately 2008 through to the present. The latter steady and steep increase is essentially the same as reported by Insee (2020a) for the yearly mortality data for France, 1982-2019.

The latter 2008-present rise in all-cause mortality per year is remarkable, approximately double than can be accounted for by the increasing population with a constant age structure. How is this dramatic break and increase, which also occurs in Canada and the USA, not a “pandemic”? It has not attracted any media attention, to our knowledge. Was it caused by the global economic crash of 2008, which many economists compare to the Great Depression (Bordo and James, 2009; Shaikh, 2010; Chang *et al.*, 2013; O’Brien, 2018)? There is a surprising media and academic-research relative silence regarding this compelling public health phenomenon (**Figure 9**), although some research for other countries is tangentially relevant (e.g., Falagas *et al.*, 2009; Stuckler *et al.*, 2009; Ruhm, 2016).

Figure 10 shows the all-cause mortality in metropolitan France per cycle-year (as defined in section 2.3), as a percentage of the population of metropolitan France evaluated on 1 January of each year, for the 1946-2020 period:

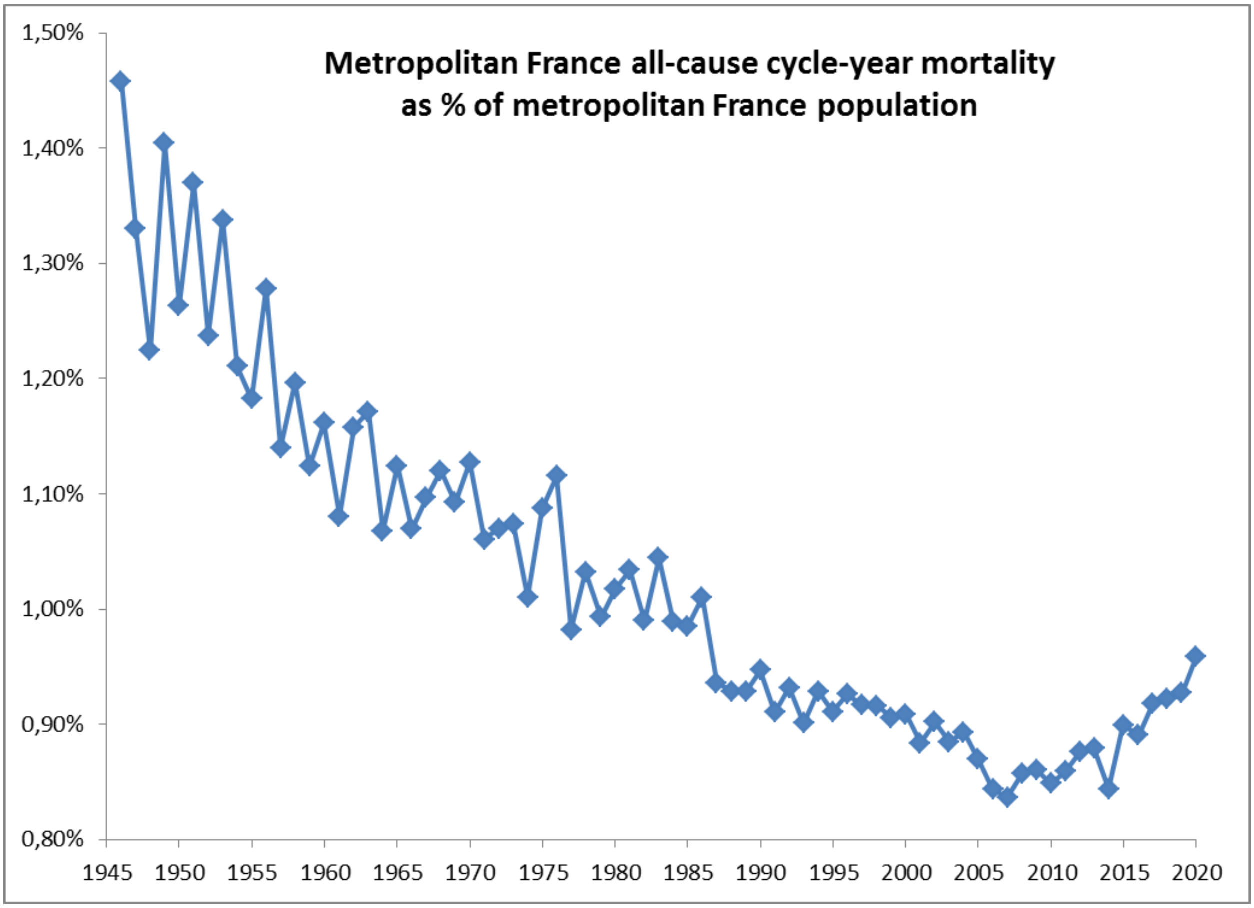

Figure 10. All-cause mortality by cycle-year in metropolitan France from 1946 to 2020, as a percentage of French metropolitan population over the same period. The x-axis year is the year of the January in the cycle-year (the January of the winter season). The population is for 1 January of each year. The population data was retrieved from Insee **(Insee, 2020c)**, as stated in **Table 1**.

Again, we note the dramatic upturn at approximately 2008. Mortality on a per capita basis decreases steadily after the Second World War, and then the trend is reversed to increasing mortality, starting at approximately 2008.

The estimate of cycle-year mortality for nominally 2020 is expected to be fairly good because the fit (**Figure 7**) reasonably completes the 2019-2020 winter peak, down to the expected 2020 summer trough (and see **Figure 3**).

With **Figure 10**, it is difficult to see the latest winter cycle that includes the "COVID-peak" as extraordinary. The value does not appear to warrant any extreme reaction, in the context of the entire 1946-2020 trend and its both regular and statistical variations.

By comparison, the upturn in yearly all-cause mortality, which is initiated at approximately 2008, is real and does warrant public concern and a public-health investigation. It seems unreasonable to concentrate on an external-event disaster ("COVID-peak"), while ignoring a massive and systematic health issue easily detected after analyzing all-cause mortality data.

Figure 11 shows the numbers of winter-burden deaths for metropolitan France 1946-2020, which result from our fits of the data for all-cause mortality by month:

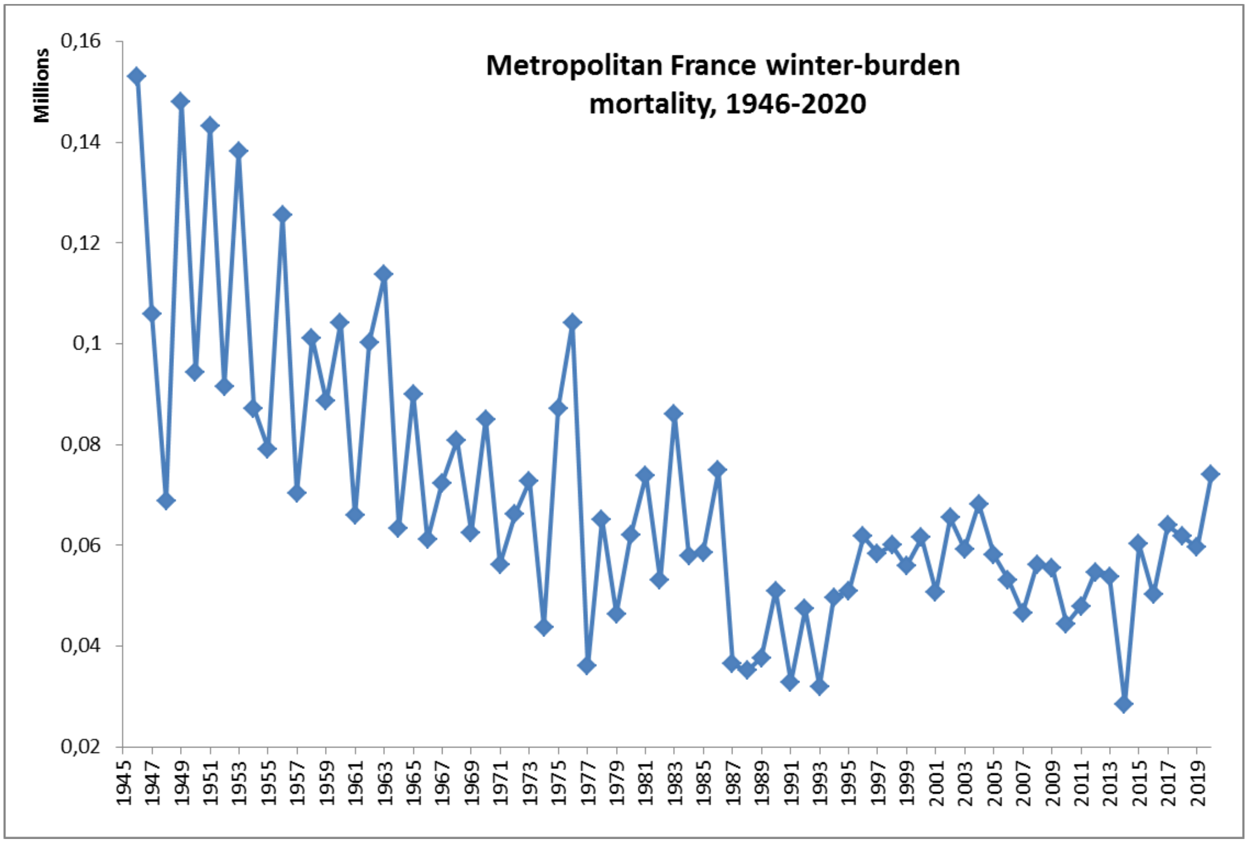

Figure 11. Winter-burden mortality in metropolitan France from 1946 to 2020. The data results from the fit of monthly all-cause mortality in metropolitan France, 1946-2020. The x-axis year is the year of the January in the cycle-year (the January of the winter season).

In **Figure 12**, the same numbers of winter-burden deaths for metropolitan France 1946-2020, which result from our fits of the data for all-cause mortality by month, are expressed as percentages of the total all-cause mortality per cycle-year, for each given cycle-year having its own winter-burden mortality:

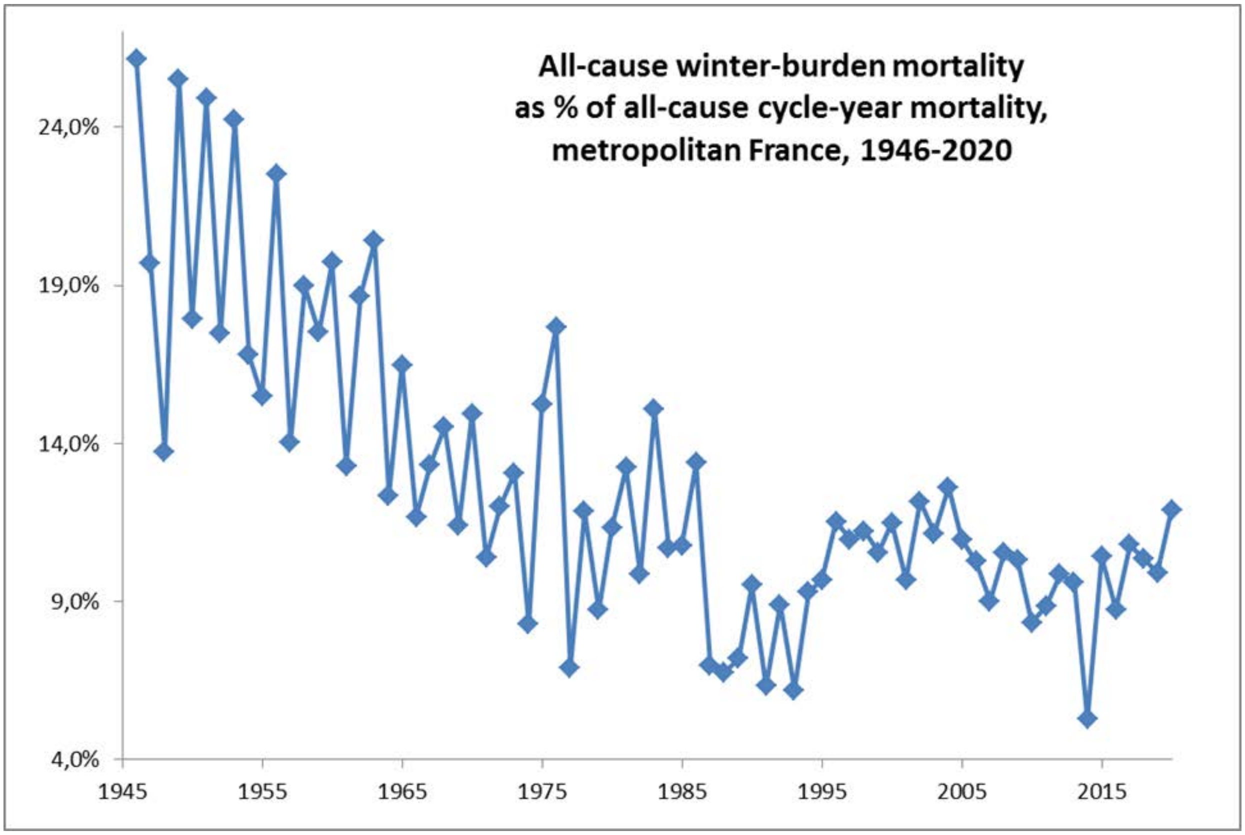

Figure 12. All-cause winter-burden mortality as a percentage of yearly all-cause mortality in metropolitan France from 1946 to 2020. The data are cycle-year based (see section 2.3). The x-axis year is the year of the January in the cycle-year (the January of the winter season).

The anti-correlation in time for year to year values (a low year is followed by a high year, and a high year is followed by a low year), especially prominent in the early years following the Second World War, seen in both **Figure 11** and **Figure 12**, is real and can be interpreted as follows: winter-burden mortality is a convolution between the prevailing pathogenic conditions and the population of immune-vulnerable individuals (i.e. population of fragile mostly elderly persons). A winter that relatively devastates the fragile-person population leaves a relatively small such population for the following winter, and *vice versa*. The year-to-year effect is greatest to the extent that the mean lifetime of a concerned fragile person is one year. In other words, the one-year time anti-correlation is predominantly from the number of individuals having a one-year mean lifetime or life expectancy.

This shows that it would be ill-advised to assign such year-to-year variations in winter-burden mortality to virulence of the particular year's seasonal viral pathogens. The changes are more a function of the general health status of the population, and the population numbers of the most vulnerable individuals, rather than virulence of a particular pathogen. It would be incorrect to postulate that viral virulence progressively decreased after the Second World War in France, just as it would be incorrect to interpret relatively small variations occurring in recent decades as being due to year-to-year changes in virulence of the seasonal pathogens.

Figure 12 shows that 2019-2020 was not a statistically unusual cycle-year in France, in terms purely of the total number of winter-burden deaths, which include the anomalous "COVID-peak" deaths. Is this because mitigation measures were effective in the presence of an exceptionally virulent pathogen? On the contrary, as explained above, the "COVID-peak" anomaly must be interpreted as the result of an exceptional imposed perturbation in the society. The "COVID-peak" would not have occurred in the absence of the said perturbation, and some 30.2 K lives would have been saved in France.

4. Mechanistic causes for “COVID-peak” deaths

In light of epidemiological history, we have proven that the “COVID-peak” feature that is present in the all-cause mortality data of certain mid-latitude Northern hemisphere jurisdictions, including France, cannot be a natural epidemiological event occurring in an absence of an external non-pathogenic perturbation. This is true because the “COVID-peak”:

i. occurs sharply (one-month width) at an unprecedented location in the seasonal cycle (centered at the end of March),
ii. is absent in many jurisdictions (34 of the USA States have no “COVID-peak”), and
iii. varies widely in magnitude from jurisdiction to jurisdiction in which it occurs (such as the example of Ontario and Quebec, **Figure 4**).

Such a feature in all-cause mortality by week or month has never previously occurred in known epidemiological data, except with exceptional events such as the August-2003 heat wave in France, or regional earthquakes. Barring such exceptional events, the known all-cause mortality curves for populations in the entire mid-latitude Northern hemisphere are remarkably the same; without disappearing or appearing peaks in different geographical locations, and without peaks occurring at unusual times in the seasonal cycles.

We end this article by outlining a mechanism wherein one aspect of government responses could have caused the excess 30.2 K deaths in the “COVID-peak”.

We believe that the unprecedented strict mass quarantine and isolation of both sick and healthy elderly people, together and separately, would have killed many of them, and is the main cause of the “COVID-peak” event that we have identified.

By the said mass quarantine in care homes and establishments, the State isolated vulnerable elderly persons from their families, limited movements within establishments, often confining individuals to their rooms or beds for days and weeks if not months, reduced the staff and allowed staff to take extended or frequent sick leaves, forced staff to adopt extreme measures such as masks, shields and gloves, which can induce a measure of fear or terror, created a general atmosphere of danger, and prevented air circulation by locking doors and windows, and by preventing ingoing and outgoing traffic except for essential services (Campbell, 2020; Comas-Herrera, Fernandez, *et al.*, 2020; Wu, 2020).

This would have both: retained the pathogen-bearing aerosol particles suspended in the air without their evacuation (Morawska and Milton, 2020); and induced psychological stress in the residents.

Psychological stress is known:

i. to be a major factor causing diseases, including immune response dysfunction, depression, cardiovascular disease and cancer (Cohen, Janicki-Deverts and Miller, 2007),

ii. to be a dominant factor in making an individual susceptible to viral respiratory diseases, in terms of intensity of the infection (Cohen, Tyrrell and Smith, 1991), and

iii. to have more deleterious effects in elderly persons than in younger persons (Prenderville *et al.*, 2015).

Furthermore, social isolation itself, in addition to individual psychological stress, is known to have an added impact on the said susceptibility to viral respiratory disease (Cohen *et al.*, 1997).

In addition, there is a longer term “abandonment of life” phenomenon that occurs with imposed extended isolations of elderly persons, the so-called “glissement” syndrome (or “slipping away syndrome” or “geriatric failure to thrive”), which is analogous to depression (Robertson and Montagnini, 2004; Clegg *et al.*, 2013; Steptoe *et al.*, 2013; Ong, Uchino and Wethington, 2016).

The suddenly applied national policy of forced quarantine and the psychological stress it generated on fragile elderly people was certainly a major contributor in the decrease of efficiency of immune system response to a viral respiratory disease (Comas-Herrera, Zalakaín, *et al.*, 2020) and this is today the most probable explanation for the most part of the sharp and narrow mass excess death peak that occurred in March-April 2020 in France. The same mechanism would operate in any setting (facility, group home, home, hospital) where persons with health vulnerabilities are isolated and susceptible to psychological stress.

We claim that this mechanism is what occurred, as first suggested by Rancourt (2020), and that this caused some 30.2 K deaths in France in March and April 2020, not any viral respiratory disease or combination of such acting naturally in an unperturbed society.

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