Non Pharmaceutical Interventions “NPIs”, Hospital Overload And excess mortality

Statistical analysis and mathematical study of the NPIs in "Covid 19" outbreak

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Summary

This study observes the results of epidemic spread and mortality in three comparable countries in demographics and GDP, also affected by the spread of SARS COV-2 and COVID-19 disease: Belgium, the Netherlands and Sweden. These three countries have taken three levels of non-pharmaceutical interventions (NPI within the meaning of WHO) from hard to soft. They have three different health systems, from the most equipped to the least equipped. And their results are significantly different.

Predictive scenarios with a SEIR model for Belgium and Sweden do not verify hypothesis that an epidemiological model could predict a hospital load and mortality, neither in Belgium nor in Sweden. On the contrary, Lock down (Belgium) or Shut down (Netherlands), does not "delay" the peak of new cases or the peak of mortality, on the contrary, it makes it happen faster, and does not "flatten" the curve of new cases, nor the mortality curve, on the contrary, it "swells" it.

The hypothesis that NPIs have a direct impact on the R indicator of epidemic spread is not demonstrated in mathematics. NPIs have a direct impact on the contact rate per period, which is one of the R calculation parameters.

Assumptions in which epidemiological models are used to select the R value generating a hospital load compatible with the capacity of the health system are not true. These assumptions take the models upside down: the “R” indicator becomes the parameter with which one "plays" to deduce an NPI at the moment t. Models are no longer relevant to this use.

We assume that changing the contact rate by NPI also requires changes in proportion to other parameters, such as the recovery rate, creating perverse effects. In the case of the strictest NPIs, where the contact rate is asymptote, we assume an overload of hospital capacity and excess mortality.
1. Introduction

Measures of social distancing, isolation and containment to manage the development of a pandemic are within the meaning of the WHO "NPI" for "non pharmaceutical intervention": they are not a matter of medical, but of public freedom and public health policies. Their effectiveness is easily analysed by figures, statistics and can be explained or predicted by mathematics. They belong to many fields of the humanities, economics, sociology, anthropology, social psychology, etc.

During the SARS epidemic in 2002, the issue of systematic "collective quarantine" in Toronto was already discussed. The results were inconclusive. [21], [22]

However, this “lock down” method was carried out on a huge planetary scale in many countries, during this Covid 19 epidemic. When the health crisis entered, some forecasts, pushing entire populations and their leaders towards this “lock down” solution. [2]

We are not qualified to give explanations in epidemiology, virology, immunology, or infectious diseases to the observed phenomena. We urge caution. Even if we criticize certain measures, we do not throw stones at anyone; and certainly not at political leaders, these measures have been widely acclaimed by people and a large part of the scientific community.

2. Method

This study focuses on the adverse effects of NPI "hard lock down" with a freeze of civilian rights.

We compare 3 countries: Belgium, the Netherlands and Sweden. These countries have experienced 3 different levels of NPIs from the strictest (Belgium) to the most flexible (Sweden) with an intermediate level (Netherlands). As an illustration we add France.

We exclude countries that have taken other measures such as targeted quarantine and massive testing (i.e. Germany, Austria). We used public datas collected by https://ourworldindata.org/

It is tempting to compare Sweden to its three Scandinavian neighbours. But Finland, Denmark, Norway, were not affected by the epidemic which developed in Scandinavia especially in Stockholm. And the Swedish counties bordering Finland, Denmark and Norway were not affected either.

<table>
<thead>
<tr>
<th>Country</th>
<th>County</th>
<th>inhabitants</th>
<th>cas</th>
<th>ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden</td>
<td>Scania</td>
<td>1 362 000</td>
<td>1 026</td>
<td>0,08%</td>
</tr>
<tr>
<td>Denmark</td>
<td>Capital</td>
<td>1 846 023</td>
<td>5 041</td>
<td>0,27%</td>
</tr>
<tr>
<td>Sweden</td>
<td>Vastra Gotaland</td>
<td>1 710 000</td>
<td>3 378</td>
<td>0,20%</td>
</tr>
<tr>
<td>Norway</td>
<td>Viken</td>
<td>1 213 354</td>
<td>2 087</td>
<td>0,17%</td>
</tr>
<tr>
<td>Norway</td>
<td>Oslo</td>
<td>1 588 457</td>
<td>2 543</td>
<td>0,16%</td>
</tr>
</tbody>
</table>

We observe that the Scania Swedish county bordering the capital region of Denmark is less affected. However, every day, 30,000 Swedish inhabitants cross the Malmö bridge to go in Denmark. Some parts of Scandinavia were simply, to date, less affected by the epidemic. However, Scandinavia and its weather of a dry and cool spring should have known a significant propagation [16]

Most of the Swedish population is concentrated on the coastal strip between Stockholm and Malmö. 1/3 of Swedes live in the urbanized areas of Stockholm, Gothenburg, and Malmo. Sweden also differs from its neighbours by a high proportion of immigration in its population (20%), many elderly people in nursing homes, which gives it a demographic profile closer to Belgium, the Netherlands, France, Germany, or Great Britain.
Some regions in Europe are more affected than others. Similarly, in Belgium and the Netherlands the regions have been affected unevenly. Just like in Italy (South vs North) or France. In future studies it will probably make sense to compare region by region in Europe.

3. Results

Countries main datas

Belgium

<table>
<thead>
<tr>
<th>Data</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>12 million</td>
</tr>
<tr>
<td>GDP per capita 2018 Purchasing Power Standard:</td>
<td>118</td>
</tr>
<tr>
<td>Hospital beds per 100 000 p. 2018:</td>
<td>5,6</td>
</tr>
<tr>
<td>Intensive care beds at the beginning:</td>
<td>2000</td>
</tr>
<tr>
<td>Health System:</td>
<td>public</td>
</tr>
<tr>
<td>NPI:</td>
<td>« Lock down »</td>
</tr>
</tbody>
</table>

Netherlands

<table>
<thead>
<tr>
<th>Data</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>18 million</td>
</tr>
<tr>
<td>GDP per capita 2018 Purchasing Power Standard:</td>
<td>130</td>
</tr>
<tr>
<td>Hospital beds per 100 000 p. 2018:</td>
<td>3,3</td>
</tr>
<tr>
<td>Intensive care beds at the beginning:</td>
<td>1150</td>
</tr>
<tr>
<td>Health System:</td>
<td>private sector</td>
</tr>
<tr>
<td>NPI:</td>
<td>« Shut down »</td>
</tr>
</tbody>
</table>

Sweden

<table>
<thead>
<tr>
<th>Data</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>11 million</td>
</tr>
<tr>
<td>GDP per capita 2018 Purchasing Power Standard:</td>
<td>121</td>
</tr>
<tr>
<td>Hospital beds per 100 000 p. 2018:</td>
<td>2,2</td>
</tr>
<tr>
<td>Intensive care beds at the beginning:</td>
<td>540 =&gt; 1090</td>
</tr>
<tr>
<td>Health System:</td>
<td>public</td>
</tr>
<tr>
<td>NPI:</td>
<td>« social distancing »</td>
</tr>
</tbody>
</table>

Comments:

Belgium has the best hospital capacity

3.1 Excess Mortality

The first result to be observed is that of the Z-Score. This weekly indicator published by European Mortality Monitoring [https://www.euromomo.eu/graphs-and-maps/](https://www.euromomo.eu/graphs-and-maps/)

It is based on a Poisson law to smooth outliers and counting differences and calculated weekly to neutralize the weekend effect in publications. This model including an indicator of excess mortality compared to the usual chronological cycle considering seasonal excess mortality. Level 0 is the usual mortality. The dew period on the graph is the one in which the mortality figures can be corrected. (There is a lag time).

The graphs run from January 1, 2020 (week 1) to May 10, 2020 (week 19). The NPIs were taken in Belgium and the Netherlands in week 11 and 12.

In weeks 14, 15 and 16 we observe that the difference in excess mortality in Belgium is double that of Sweden. We observe that the excess mortality in the Netherlands is higher than that of Sweden.
3.2 Testing and positive cases
Total COVID-19 tests per 1,000: how are testing rates changing?

Total tests for COVID-19 per thousand people of the country’s population since the daily new confirmed deaths reached 0.1 per million people.

All trajectories are lined up to the day at which the death rate reached 0.1 per million – this is the vertical line at the center of the chart.

Source: Official data collated by Our World in Data, European CDC – Situation Update Worldwide – Last updated 20th May, 16:30 (London time)

Note: For testing figures, there are substantial differences across countries in terms of the units, whether or not all labs are included, the extent to which negative and pending tests are included and other aspects. Details for each country can be found at the linked page. OurWorldInData.org/coronavirus • CC BY

Daily confirmed COVID-19 cases per million people

Shown is the rolling 7-day average. The number of confirmed cases is lower than the number of actual cases; the main reason for that is limited testing.

Source: European CDC – Situation Update Worldwide - Data last updated 21st May, 11:48 (GMT+02:00)
Total confirmed COVID-19 cases per million people

Shown is the rolling 7-day average. The number of confirmed cases is lower than the number of actual cases; the main reason for that is limited testing.

Source: European CDC – Situation Update Worldwide - Data last updated 21st May, 11:48 (GMT+02:00)  CC BY

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Source: European CDC – Situation Update Worldwide - Data last updated 21st May, 11:48 (GMT+02:00)  CC BY
**Observation:**

- The more we track, the more cases we find.
- It takes a minimum 5/15 days to be detected positive.
- In lockdown country, new cases increasing faster than in no lockdown country (Sweden)

**Comments:**

In the hypothesis of NPI shifting the peak and flattening the curve, Sweden should have experienced a higher peak, before Belgium and the Netherlands. NPIs do not "shift" the peak of mortality and "do not flatten" the mortality curve of Belgium and the Netherlands.

### 3.3 Mortality
Total confirmed COVID-19 deaths per million: how rapidly are they increasing?

Shown are the total confirmed deaths per million people. Limited testing and challenges in the attribution of the cause of death means that the number of confirmed deaths may not be an accurate count of the true number of deaths from COVID-19.

Source: European CDC – Situation Update Worldwide – Last updated 20th May, 16:30 (London time)  OurWorldInData.org/coronavirus • CC BY

Total confirmed COVID-19 deaths per million people

Limited testing and challenges in the attribution of the cause of death means that the number of confirmed deaths may not be an accurate count of the true number of deaths from COVID-19.

Source: European CDC – Situation Update Worldwide - Data last updated 21st May, 11:48 (GMT+02:00)  CC BY
Daily confirmed COVID-19 deaths per million people

Shown is the rolling 7-day average. Limited testing and challenges in the attribution of the cause of death means that the number of confirmed deaths may not be an accurate count of the true number of deaths from COVID-19.

Source: European CDC – Situation Update Worldwide - Data last updated 21st May, 11:48 (GMT+02:00)

Case fatality rate of the ongoing COVID-19 pandemic

The Case Fatality Rate (CFR) is the ratio between confirmed deaths and confirmed cases. During an outbreak of a pandemic the CFR is a poor measure of the mortality risk of the disease. We explain this in detail at OurWorldInData.org/Coronavirus

Source: European CDC – Situation Update Worldwide – Last updated 20th May, 16:30 (London time)

Note: Only countries with more than 100 confirmed cases are included.
Mortality observation:

- The excess mortality is bigger and sooner in hard lock down period in Belgium than in Netherlands and Sweden.
- A positive test result COVID-19 is not always required for a death to be registered as COVID-19.
- Delays between infection, admission to resuscitation and death reported COVID-19 are 2 to 8 weeks: mortality as of April 25 gives an idea of the spread between February 25 and April 10.
- The Case Fatality Rate “CFR”:
  1/ Under-estimated at the beginning of an epidemic: the time between infection and death (supra),
  2/ Over-estimated at epidemic peak: the number of undetected "false positives" and the number of immunized by other nearby viral strains are not counted. This increase the feeling of panic.
- The Infection Fatality Rate "IFR" that would be the relevant indicator is not computable [26],
- Mortality depending on the population's immune response, public health measures, hospital capacity.
- The "hidden mortality" Covid 19 in Sweden is estimated at 10%, in Belgium the counts are wider than in the Netherlands and Sweden.

Comments:

In the hypothesis of NPI shifting the peak and flattening the curve, Sweden should have experienced a higher peak, before Belgium and the Netherlands. NPIs do not "shift" the peak of mortality and "do not flatten" the mortality curve of Belgium and the Netherlands.
4. Discussion

We observe results that are not in real time (latency of detection and mortality delays) leading to NPIs which can only be late. We observe a perverse effect of the level of NPI on the growth of new cases and a perverse effect of excess mortality, even with a hospital capacity twice higher (Belgium).

Why?

We will discuss below in two points: statistics and mathematics

4.1 Statistical Analysis

In this part we use a basic SEIR model. [http://gabgoh.github.io/COVID/index.html](http://gabgoh.github.io/COVID/index.html) They are not aimed at being precise but to illustrate the bias with which they were used. All of these models were used on the assumption that R(t) could be reduced by NPI.

We model an average scenario with the following parameters [17], [18]:

**First infected:** We assume it is present on 15 January 2020 in Belgium and Sweden (In Sweden the first case is detected on 31 January, in Belgium on 4 February) **R0:** 3.2

"Total lock down" hypothesis: R(t) = R(0)-75%

"Social distancing" hypothesis: R(t) = R(0)-25%

**Incubation period:** 5.8 days

**Infectious period:** 2.6 days

**Hospitalization rate:** 11.6% (20% out of 42% of symptomatic cases in median with between 20% (German study) and 78% ([https://www.bmj.com/content/369/bmj.m1375](https://www.bmj.com/content/369/bmj.m1375)) even though it was actually less (4 to 5%) [3]

**Average length of hospitalization:** 7 days

**Benign case recovery time:** 8 days

**Time before hospitalization:** 9 days

**Time before mortality:** 30 days

**CFR:** by country as of the date of the measures taken (this naturally increases to t)
We can question different parameters, especially the most difficult to obtain such as the average length of hospital stay, recovery from mild cases, before hospitalization or before mortality.

But under study we see that these durations have only a marginal impact on the modeling which is mainly based on $R(0)$ and $R(t)$.

We enter in the model the parameters below:
4.1.1 Belgium

Without NPI

Belgium would have nearly 300,000 hospitalizations at the peak (April 15) and 80,000 cumulative deaths by July 31, 2020.

Modeling with reduction of $R(t) = R(0) - 75\%$ at $D + 60$ (lock down between March 13 and 20, 2020)

With a strict social isolation NPI ($D + 60$) Belgium would have 3,300 dead on May 7, 2020 and 5,700 dead on July 31, 2020 (end of the epidemic).
Let us observe the theoretical effectiveness of a NPI “total lock down” taken early enough:

Modeling with \( R(t) = R(0) - 75\% \) at \( D + 35 \) (1st death)

According to this model, if Belgium had confined its population strictly very early, from February 20, its death toll would have been 54 deaths with a peak of 112 hospitalizations.
4.1.2 Sweden

Without any NPI, an apocalyptic scenario awaited Sweden; 41,000 dead as of May 7, 2020; 270,000 hospitalizations and 72,000 deaths as of July 31, 2020. Our simulation is in the order of magnitude of the scenario announced by the University of Uppsala, using the model of Imperial College on April 11, 2020, which predicted 96,000 deaths in Sweden [23]

\[ R(t) = R(0) \]

Sweden acted on March 16 which is assumed to reduce \( R(0) \) to \( R(t) = R(0) - 25\% \)

It remained in a terrifying scenario of 27,000 deaths on May 7, 2020, with 211,000 hospitalizations at peak and 48,000 deaths on July 31, 2020. However, Sweden was at 500 resuscitations and 3,000 deaths on May 7, 2020.
Which leader would take the risk of 70,000 deaths if a quick lock down measure would perhaps have only a few dozen?

If a model gives us between 5 0 deaths and 80 000 deaths, in fact it tells us nothing at all.

In the same way these models gave a terrific volume of hospitalizations. Deducted an R (t) to reach to have a volume of hospitalization that health systems would be able to absorb, and impose as a result of " Not Pharmaceutical Interventions ".

The observation of reality has, for Belgium, France, Spain, Italy, and fortunately for Sweden, nothing to do with these forecasts.

So what has happened in using these models to mislead the scientific community and political leaders?
4.2 A wrong method

We based our work on the analysis of figures from the confined province of Hubei in China and on the study published by The Lancet on February 29, 2020 on the situation in China [1]. Chinese authorities placed 56 million residents of Hubei Province under complete confinement on January 23 and 24, 2020.

Scientists published by "The Lancet" [1] had initially forecast an epidemic peak in Wuhan for mid-March "if nothing was done" and modeled the spread with a delayed peak in May, reduced by 50% of its magnitude if the transmissibility were reduced by 25%. If we reduced the transmissibility to 50% we got a completely crushed spread. In their model, mobility had no impact on the spread (which is contradicted by a study of March 25, 2020 [20]):

![Epidemic forecasts for Wuhan and five other Chinese cities under different scenarios of reduction in transmissibility and inter-city mobility](image)

This study estimated that there were 75,815 people infected in Wuhan on January 25, 2020; 1st day of confinement. China is reporting 81,907 cases today = 6,092 new cases after confinement.
According to NHC figures, the epidemic peak occurred between February 16-19 in Wuhan, but it could not already be observed at the time of the The Lancet study.

Two remarks are possible:

1. NHC figures are truncated (they represent good dynamics but not good values and good dates)

   And/or

2. The hypothesis that confinement shifts the peak and reduces it in volume is not verified

It is possible that we are only in front of the tip of the Chinese iceberg. That the epidemic started earlier, and affected more people, causing far more deaths. If the Chinese balance sheet is reduced, the losses would be heavier and the balance sheet catastrophic.

But the figures presenting a fraction of the province of Hubei give a sufficient observation panel and release a clear dynamic of the phenomenon on the crest line. This graph shows that viral growth slowed down significantly between February 4 and 12 (D + 10 and D + 17) with an epidemic peak on February 18 (maximum number of people in care).

We know that these sub-panels largely represent the reality of the infection in the countries (screening of symptomatic cases, size of the panels, standardization of the tests, false negatives, etc.) We know that some countries do not count all deaths, that not all symptomatic positive cases are hospitalized.

We consider that the figures available by country describe at least a panel of cases treated by the hospital services of the different countries, and at least a panel of symptomatic or suspect cases, reflecting in proportion the real volumes in the population. The panel of hospitalized people represents a fraction of the population. Much like in an opinion poll it gives the trend of what is happening in the population.

A Scaling error

What motivated the decision to confine half the world's population was the Chinese example of the confined Hubei province.

China has not confined the entire population, but a tiny fraction. The general confinement of Hubei province prevented the epidemic from spreading throughout China: the 97% of other inhabitants. The Chinese government has asked 3% of its population to sacrifice two months of freedom to save the rest of the country.
Three back testing errors

Epidemic spread models are designed to predict epidemic evolution. They represent the epidemic progression in a population. They calculate the immunization threshold in a population, the speed of propagation, by giving an indicator "R": the average number of individuals infected by an infected individual. R (0) at the first infected, becomes R (t) at time t + during the course of the spread. Calculating an R0 is used to predict the epidemic and organize the health response; for example organizing a vaccination campaign or measuring the effectiveness of a treatment. This R0 varies over time over the propagation. [5], [6], [8], [10], [13]

- If R0 is greater than 1, the epidemic spreads (the curve of new cases is increasing);
- Si R0 = 1 then the epidemic is in an inflection zone (the curve of new cases is on a "plateau");
- Si R0 <1 then the epidemic ends. (The curve of the new case is of écroissante).

We do not directly "control" R but some of the parameters of its calculation such as the contact rate between people in a population. However in the use that was made we noted the following points:

1. The models have been extended to predict hospitalizations. We did not find in literature mathematical demonstration that such models can give prev fusion of art volumes of hospitalizations.

2. In the use of the models we observed a constant error: the confusion between the R indicator and the contact rate.

According to this little visual and the common idea spread, dividing contacts by 4 (75% fewer contacts) would divide the R0 by 4 (going from 2.5 to 0.625 infected people).

The NPI act on the contact rate, not directly on R. R is calculated (infra) by combining several parameters to give an indicator on the epidemic stage and the speed of propagation, knowing that it will tend towards 0 at the end of the cycle epidemic. The assumption that the NPI would act directly on R is not valid in mathematics (infra). They “played” with the R indicator to make the model say roughly what they want. This amounts to a back test: we are modelling another epidemic than the one that is unfolding.

3. In these studies, the reverse models are used to define a hypothetical contact rate in the population that produces a number of cases that hospital capacity can absorb. We are concerned about this bias with which models are used. The “discipline” of the population is “evaluated” there according to arbitrary criteria, which seems, in itself, dangerous. We read that the populations would be more or less "disciplined" here and there, and that it is this degree of "discipline" that would vary the hospital charge. We heard the head of Paris Police declaring that those in intensive care were people who had not been disciplined. Epidemiological models have not been designed to assess the degree of "discipline" to be imposed on a population based on a given hospital capacity.
It is possible to “speed up” with these models (ie increase the population of immunized by vaccination), it has not been demonstrated that we can “slow down” to deduce a contact rate to be obtained in the population. These studies are back tests. And predictive use “backwards” can generate perverse effects.

Save Lives by lockdown?

The error has been pushed even further with some studies claiming to quantify the "number of lives saved" by the strictest NPIs. What the Neil Ferguson teams at Imperial College [3] and the EPICX LAB [4] claimed to do.

This kind of demonstration seems to us to be imbued with intellectual laziness, even dishonesty. To compare a real situation to the worst forecast is the certainty of being eternally right. There is always a worse scenario than the real one. This is the story of the child who returns with a bad grade and presents it as much better than that of the last in the class, without giving either the average of the class or that of the first.

Intellectual honesty requires comparing the results obtained by countries and comparing them with forecasts of their level of containment.

- In the case of Belgium, the containment report does not meet the objective which was to limit to 3300 deaths on May 7. On this day there is almost 3 times more than what was hoped for by the level of confinement of Belgium.

- In the case of Sweden, on the contrary, there are fewer deaths than what was expected by its level of NPI: 3000 vs 27000. Almost 10 times less.

In both cases, the forecasts were not valid.

As we can see, the use of these models, under pressure in a time of crisis, moved away from scientific rigor at high speed. In the next part we will study the mathematical errors which led to these undesirable perverse effects of hospital overload and excess mortality noted in Belgium in our results.

4.3 Mathematical analysis

Epidemic propagation models in mathematics are quite similar to the other models known and used in engineering that we have practiced with our teams for years; such propagation models of radio waves, financial models, are all everyday tools to calculate and predict. We find there the same mathematical material: stochastic calculations, complex differential equations, etc. So others that we have invested in the field of epidemic propagation, in a classic approach. These are first statistics and mathematics, then applied in epidemiology. [11], [12]

We will notice that the models used in other disciplines are not entitled to error. A construction engineer who misuses a model and the structure collapses. A telecommunications engineer who makes a calculation error and the network falls. A financial engineer who makes a mistake in a stress test and the bank is failed. Some teams of engineering and research ignore their results in real life. If their model is wrong, they will not lose their budget or their jobs. Thus, descriptive epidemiology, a non-medical, statistical discipline, until now was not exposed to the cruelty of reality.

After reading the study The Lancet [1], we have made the demonstration that the hypothesis of the effectiveness of NPIs generally poses a mathematical fallacy.

**Contact rate (TC):** for a person the number of contacts over a period

**Recovery rate (TG):** for a population, the number of cured vs the number of patients over a period.

To simplify the demonstration, let us consider a population in equilibrium with mortality rate = birth rate and a non-lethal infection which produces no deaths. Healthy, infected individuals are in contact and heal at a contact rate and a recovery rate. This relationship is:

\[ R_0 = \frac{TC}{TG} \]

In other words \( TC = R_0 \times TG \)

If by an NPI we do \( TC / 4 \) then we have \( R_0 \times TG / 4 \).

What the formula \( R_0 = TC / TG \) says is that dividing the contact rate by 4 divides the product of \( R_0 \) by the recovery rate by 4.

This means that in the hypothesis of an \( R_0 = 2.5 \) and a NPI dividing the contact rate by 4 to obtain an \( R_0 = 0.625 \) then the recovery rate was divided by 1.6. If \( R_0 = 2.5 / 4 \) then \( TG / 1.6 \)

Divide the recovery rate by 1.6 corresponds to the gap mortality and excess mortality observed in Belgium vs the Sweden (see above).

With a decrease in contacts, we decrease the recovery rate and we get a perverse effect: the overload of hospitals and the increase in deaths.

The hen CMMID Covid-19 working group evaluates the impact of the reduction in the contact rate on the reproductive number \( R \) it ignores the impact the rate of contact can have on the recovery rate. [19]

2. Kermack and McKendrick [7], [11], [12] have shown that \( R_0 \) is the product of the probability of transmission by contact (PT), the contact rate per period (TC) and the contagious period (PC).

\[ R_0 = PT \times TC \times PC \]

In other words, in this formula, to be able to write \( R_0 / 4 \) it is necessary:

- Divide the contagious period by 4
- Divide the contact rate by 4 with the risk of reducing the recovery rate
- Divide the probability of transmission by 4 : we do not know how to do it , even if the probability of transmission is proportional to the contact rate [15]

However, the probability of transmission can be reduced by dividing the population into different compartments, each with a different probability of transmission, lower than the overall probability.

The basic SI model can be refined with more compartments : “R” for the Restored, “E” for the exposed individuals, “Q” for the quarantines, “M” for the immunized from birth, “C” for the asymptomatic carriers and we subdivide “I” according to the different viral loads requiring various treatments. Individuals move from one compartment to another according to parameters such as the contact rate, the recovery rate, the probability of transmission, the rate of contagion, the weather, the behaviour of populations. China created a giant Q compartment, Hubei province. Each compartment obeys rules: for example, individuals E wear a mask or are confined. Individuals I wear a mask, are hospitalized, or are confined, depending on their viral load. Individuals S wear a mask or not. Each compartment has a different probability of transmission. For example, individuals in compartment Q in quarantine...
have an incredibly low probability of transmission. Individuals M too. Individuals E and C have a higher probability which can be limited.

3. Van den Driessche and Watmough [14] specify that in the case of a single infected compartment, $R(0)$ is simply the product of the infection rate and its average duration. So with a general lockdown the global population is a reduced to a single compartment and the epidemic spreads according to its rhythm from $R(0)$. In this theory, general confinement amounts to no confinement.

It is counter intuitive, but these three mathematical formulas explain the good figures of the non-confined and compartmentalized countries vs the simply confined countries (Hubei province, Italy, Spain, France, etc.)

We do not know how to give medical explanations, but perhaps we must study the impact of strict confinement on the immune systems of the population, or the impact of confinement on the marginal contact rate of populations at risk. For example, in France the EHPAD experience a slaughter. They are confined but together, like the passengers of the Diamond Princess. The overall contact rate drops at the population level, but not in marginal populations at risk. The overall recovery rate is affected.
5. Conclusion

1. Lock down (Belgium) or Shut down (Netherlands), strict or flexible, does not "delay" the peak of new cases or the peak of mortality, on the contrary, it makes it happen faster.

2. Lock down (Belgium) or Shut down (Netherlands), does not "flatten" the curve of new cases, nor the mortality curve, on the contrary, it "swells".

3. Hard lock down (social isolation) achieves an undesirable perverse effect of hospital overload and increased death. The opposite of the imagined effect.

4. The reasoning that NPIs directly influences the "R0" of epidemic spread is false. NPIs does not directly impact the R0 but one of its parameters: the contact rate. And the contact rate is inverse to the recovery rate.

5. The mathematical and statistical models have been developed on non-scientific "hypothesis" and a deviation from the models:
   - Use of “R” as a parameter even if it is an indicator,
   - Appreciation at the time of a level of "discipline" of the population,
   - A “twisted” model in which on the R (t) modified at an instant t by a “Non-pharmaceutical intervention”,
   - A forecasting of hospitalizations not demonstrated,
   - Back testing but no predictive modeling.

We remain modest but reinforced in our conviction (for 9 weeks now). Strict and undifferentiated general confinement has no significant impact [24],[25] and we assume can even have undesirable effects. We could see it by studying how these models work. We could see this by studying the first publications about Hubei [1]. An incredible measure that has not been the subject of any scientific debate, naturally imposing itself “we have no choice”.

In all the countries where this single measure has been taken (without being accompanied by massive screenings with targeted quarantine) we observe that the pandemic has continued to develop. And this regardless of the level of NPI of the countries or the date on which the measures were taken. In countries which have not applied confinement, the results are similar to those in confinement (Swedish benchmark).

The conclusion is counter - intuitive, clashes with fast thinking ideas, and touches the deep springs of collective psychology. The more massive an investment, the more the tendency is to invest further. The greater the sacrifice, the more difficult it is to admit that it was unnecessary. What would have been the fate of those who tried to explain to the Incas that their sacrifices have no influence on the course of the sun?

More generally, we believe that the race for scientific communication in real time, with more and more numerous, hierarchical, equipped, and internationalized teams is becoming more and more homogeneous in its production. Focused on the same subjects with the same approaches, modern scientists can reproduce the same biases endlessly.
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Bibliography


[3] Expected impact of lockdown in Île-de-France and possible exit strategies Laura Di Domenico1, Giulia Pullano1,2, Chiara E. Sabbatini1, Pierre-Yves Boëlle1, Vittoria Colizza 1, * 12/04/2020


[25] Physical interventions to interrupt or reduce the spread of respiratory viruses. Part 1 - Face masks, eye protection and person distancing: systematic review and meta-analysis Tom Jefferson, Mark Jones, Lubna A Al Ansari, Ghada Bawazeer, Elaine Beller, Justin Clark, John Conly, Chris Del Mar, Elisabeth Dooley, Eliana Ferroni, Paul Glasziou, Tammy Hoffman, Sarah Thorning, Mieke Van Driel medRxiv 2020.03.30.20047217; doi: https://doi.org/10.1101/2020.03.30.20047217

[26] The infection fatality rate of COVID-19 inferred from seroprevalence data John Ioannidis medRxiv 2020.05.13.20101253; doi: https://doi.org/10.1101/2020.05.13.20101253
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