COVID-19 STATISTICS and ANALYSIS
Data as of 3rd May 2020
Cluster Analysis as of 26th April 2020

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Latest Statistics on the COVID-19 Pandemic and Related Discussions

This document summarizes the statistics on the COVID-19 pandemic. It is updated regularly, often daily, and is circulated to all interested parties. More charts, tables, text and opinions will be added over time as information becomes available.

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2. SCOPE OF THIS REPORT AND INTENDED USE

2.1. Data Source, Reliance, Limitations and Responsibility

The data contained in this report is publicly available through the John Hopkins University Center for Systems Science and Engineering (https://systems.jhu.edu). The data can also be corroborated against a multitude of other sources. Eckler and QED take no responsibility for the accuracy of the data. We have simply distilled the data and displayed it visually in various charts. Our source data currently contains approximately 80,000 datapoints.

2.2. Intended Users of This Report

This report is intended for professionals familiar with statistical analysis such as actuaries, statisticians, and business analysts. It is expected that such professionals will understand the limitations of statistical analysis such as the credibility of the data as a function of the number of datapoints observed. For instance, if the number of deaths in one country has increased in 24 hours from one to two, implying that the rate of death has doubled overnight would be the wrong conclusion.

2.3. Purpose of This Report

The amount of available data online and from other direct sources is vast. Very often, the data is simply delivered in raw format and not suitable for easy consumption to quickly discern its meaning. The main purpose of this report is to condense the available data into a format that is easy to understand and from which to make comparisons between countries and regions.

Since the data is only as good as its source and how it was gathered, readers should remain critical as to the reliability of the data. For instance, if Country A has relatively more confirmed COVID-19 cases than Country B, it does not necessarily imply that the real rates of infection are higher for Country A. It may be that Country A has done twice as many COVID-19 tests than Country B, and that consequently the real rates of infection are in fact closer to one another than first thought.

The same caution should be extended to the Case Fatality Rate (CFR). The CFR is defined as the number of deaths due to COVID-19 to the number of confirmed COVID-19 cases. If Country B under-reports its confirmed COVID-19 cases because it has conducted fewer COVID-19 tests, the CFR will of course appear to be larger than what it should be had all cases been reported accurately and in a consistent matter as other countries.

Current data does not give any indication of the extent of under-reporting.

2.4. Assumptions and Methodology, and Rationale

This is not an actuarial report, such as a pricing or valuation report. There are no actuarial assumptions made to derive the results. The methodology is simple in that the data are simply analyzed and displayed in graphical form. We make no projections of future rates of infection, crude death rates, or CFRs, unless it is clearly defined. The latter would require a certain and defined methodology.
2.5. Use of this Report

This report and the information it contains should not be used in isolation of other findings and research. The COVID-19 pandemic is continuing to evolve and will likely be with us as a Pandemic for a few more months, at which time it may be under control but still present a threat in one form or another. Until the general population develops some natural immunity to it or the health services develop a vaccine and an effective cure for the virus, we will need to consider this risk in life and health insurance.

The findings in this report cannot be used blindly to develop insurance products. They may form the basis to develop insurance products, but this endeavour must be performed by qualified actuaries. Eckler and QED have qualified actuaries on staff to help insurance organizations to develop a deep understanding of the findings and use them to design and price insurance products. In fact, in April 2020, Eckler has already developed such a product for one of its life insurance clients.
3. INTRODUCTION

The COVID-19 pandemic is an event that most of the 7.8 billion people on earth will remember for the rest of their lives. It is unprecedented in that manner alone. The world of course has seen other pandemics, such as the Black Plague in medieval times and the Spanish Flu in 1918. There have been more recent pandemic events as well, including SARS, H1N1 and MERS-CoV.

So why is COVID-19 suddenly so scary? We are not epidemiologists and do not claim to make sense of the virus, how it spreads and so forth. We will leave this to the specialists. However, we are actuaries and we can scrutinize data to make sense of it and determine some truths and some misconceptions.

To start this discussion, we will make a comparison between various pandemics or pandemic-like situations. When exact statistics were not available, we used averages. The exact number is not really that important because the scale of the differences is so large.

The graphs on the next page show the comparison of the infection rates and the crude death rates per million, respectively. The crude death rate per million is simply the number of deaths divided by the world population at the time, and similarly for the infection rates.

The data in this section, as well as the subsequent sections until we report specifically on the Americas and other regions, are not necessarily the latest data available. They were taken at one point in time in order to illustrate the data in a graphical format to explain how to read the graphs.

[B] COVID-19 - CRUDE DEATH RATE /1,000,000 (03-May-2020 - Day 123) - Eckler-1 — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd
Again, the data presented in these first few charts is intended for demonstration purposes only and may not always reflect the most current data available.

The overall infection rate of COVID-19 as of the date shown on the graph (Chart 1) is 0.045% (As of April 13th, it was 0.0246%). Comparatively, the Swine Flu in 2009-10 had an infection rate of 15.4% or 342 times greater. Of course, the COVID-19 pandemic is not over yet, and has not reached its peak. Nonetheless, matching the Swine Flu infection may be a tall order, especially given the extent of government reactions, such as lockdowns, intended to limit the spread of the virus.

The crude death rate per million (Chart 2) compares at 31.75 per million for COVID-19 (15.33 as of April 13th) versus 53.31 per million for the Swine Flu, a factor of only 1.7. Compared to the Hong Kong Flu at 281, it is a factor of 8.9. The Avian Flu has a comparative factor of 690. On the other hand, the final death rates for COVID-19 are still unknown. So, one might wonder, why does the world need to shut down due to COVID-19?

3.1. Case Fatality Rate

The culprit is the Case Fatality Rate or CFR. The CFR is basically the death rate “if” you get infected in the first place. The following graph shows us the comparison:

If we use the Spanish Flu pandemic as a comparison of something that can be considered dramatic, worldwide, and recent enough to have reliable date, we can relate the COVID-19 state to the Spanish Flu.
In terms of rates of infection, COVID-19 is currently 1/6 of the Spanish Flu level. In terms of death rate per million, COVID-19 is currently 1/12 of the Spanish Flu level, or coincidentally 50% of the ratio of infection rates. In terms of case fatality rate, COVID-19 is currently equal to 50% of the Spanish Flu level.

Based on these observations, COVID-19 is only a small portion of the Spanish Flu with respect to rates of infection and rates of death. Without diminishing the impact of the COVID-19, the rates of infection and rates of deaths are only a fraction of those of the Spanish Flu. However, the case fatality rate is very high in comparison at 50% of that of the Spanish Flu.

On average, across all countries, 7% of reported cases have subsequently died (it was 5% on April 1st). The Swine Flu, the Hong Kong Flu, and the Avian Flu had a corresponding average death rate of 0.03%, 0.20%, and 0.21%, respectively. The ones who died may have already been compromised from a health standpoint, but this is true for all ages under all conditions. The CFR for SARS was large at 9.56%, but the infection rate was actually 0.0001% (1 in a million). MERS-CoV was deadly at 34%, but it was not a global pandemic and localized in the Middle East, and with an infection rate of 0.00003% (0.3 in a million). In comparison, the Spanish Flu CFR was 14% and the estimated Black Plague CFR was estimated at above 50%.

Moreover, the COVID-19 CFR shows huge differences between countries and continents. For example, the CFR in Belgium is almost 16%, 15% in France and the UK, compared to Luxembourg at 2.5% or Germany at about 4%. The difference is hard to explain and many theories are circulating on the Internet. One recent theory involves the prevalence of vaccinations for other diseases, or the possibility of different strains of the virus. Other possibilities are different age structures of the population, with Italy being noted as having a relatively high average age, or the speed with which a country’s public health officials intervened. The average CFR for Europe is 10%; this is a poor prospect.
Chart 4


CASE FATALITY RATE
3.2. The Ultimate Risk

The ultimate risk in a pandemic scenario such as COVID-19 is death. Beyond death there is no return. If the infection rate is high and the CFR is low, then it is mainly an annoyance, like having the common flu every year, or a simple cold. If infected individuals are expected to be cured in a reasonable period of time, it may still be serious but not fatal in most cases. If the infection is very low and the CFR very high, like SARS with an infection rate of one in a million and a CFR of 9.56%, it is bad odds for those infected but is not a worldwide pandemic.

However, if the infection is reasonably high, like COVID-19 at about three times of infecting others than the common flu is, and the CFR is high at least in countries like Italy, Spain, and France, then this results in rational and reasonable panic. Hence, the movement by countries to initiate social distancing. Social distancing and containment are implemented to flatten the curve of infection. This means the total infections will be somewhat longer in emerging but potentially lower in severity, helping to reduce the strain on the health care systems and hopefully allowing them to cure more people to reduce the CFR.

This is where the following graph comes in. It shows the severity of the infections in function of the number of days it took to get there.

![Chart 5](image)

This graph shows that China was able to flatten the curve at about day 30 after the number of infections reached 10. South Korea managed it as well around day 40, albeit at a much lower level. However, the rest of Asia continues to increase mainly due to Singapore, Japan and Indonesia.
Let us examine the situation in Europe?

After a massive and fast increase in the number of infections, virtually all of Europe has now flattened the curve. However, in the Americas, the curves are still going up, certainly for the US.
The response from the US has been relatively slow when compared to most European countries. The rate of infection is also increasing exponentially. Because of its large population, the number of infected people has now exceeded 1.15 million. Canada has not yet reached the same exponential growth. And the rest of the countries in the Americas have not see large levels yet.

3.3. Some of the Other Risks

Some researchers have found that people who have recovered from COVID-19 have lung damage, which could turn out to be permanent. Others have observed that some patients may have neurological symptoms such as loss of taste or smell.

For life insurers, there may be potential for long-term financial risks related to morbidity risks rather than mortality risks.
4. RELIABILITY OF DATA AND PROJECTIONS

There have been many efforts to project the infections and deaths under COVID-19, generally with very large confidence intervals around the best-estimate. For instance, on April 3rd, the Ontario government released projections of anywhere from 3,000-5,000 to 80,000-100,000 deaths before the end of the pandemic. As of May 4th, there have been 1,322 deaths in Ontario. Although the pandemic is not over, the upper end is very unlikely to occur.

Whereas projections such as these might invoke public health responses, from an actuarial point of view, making projections that will be more than ±10% to ±20% is highly speculative, and in our view, not yet fit for purposes such as solvency projections or own risk analyses. In fact, we would rather recommend scenario analysis. Public health experts, and others with epidemiological modelling skills, do not know exactly how this will pan out at the end. Nor do we. We can take Europe as an example, where the virus may have peaked and consider the efficacy of mitigation strategies such as lockdowns:

The infection rate goes from a low of 0.0252% for Greece and 0.0362% in Poland to a high of 0.6109% in Luxembourg and around 0.45% for Belgium, Ireland, and Spain. There might of course be some under-reporting. But even so, there is a large difference.
Here we speculate on what we believe to be “true” reporting, albeit arbitrary reporting, and examine the “ratios” of the infection rates in Europe shown in the following graph, compared to Europe as a whole (the y-axis shows this ratio).

Chart 9

Let us assume that we trust the reporting of some countries more than others, in particular the European countries shown above.

The above numbers, excluding Europe as a whole, have an average of 1.33 infection rate and a standard deviation of 0.48. With this type of relationship, the data cannot be relied upon to represent Europe as a whole. It is clearly not a matter of the virus alone but more importantly the countries’ readiness and reaction to the virus. Consequently, at this stage, we reckon that it is impossible to reliably project the infection rates, let alone the CFR, without taking into account some kind of multiplier or index based on the country. This multiplier or index has, at this stage, not been identified.
Turning to death rates, some observers have noted that the increase in deaths occurring in recent weeks cannot all be attributed to COVID-19. Instead, in some cases, more general respiratory ailments may be the cause. Thus, even the death rate figures presented should be treated with some caution by anyone who wishes to use these figures.

The COVID-19 pandemic is being tracked in a huge amount of detail. We try to make sense of it in the next sections, but before the data is put to use, some potentially serious shortcomings must be acknowledged.

The following sections contain analyses of the COVID-19 data using clustering analysis and regression modelling. The document then provides charts for different regions, namely The Americas, The Caribbean, Europe, Asia and Africa.
5. CLUSTERING ANALYSIS

A relatively large amount of data covering infection rates and Case Fatality Rates for many countries is now available. How can we make sense of this mass of data? In this section, we try to provide some answers based on clustering analysis. Clustering analysis tries to group similar observations into the same groups, and then by understanding the general characteristics of each group, we can get a better sense of the underlying data, and compare similar (and different) countries.

We present two sets of analysis in this section. The first analysis considers the last 20 days of the pandemic and clusters together countries with similar rates. The second analysis considers the data since countries first recorded 10 infections, which, in some countries, was over two months ago. For the technical details of how this analysis was produced, please contact the authors of this report.

5.1. Analysis 1

In Chart 10, we present an analysis of the infection rates for the past 20 days. The infection rates were “distilled” in a simpler two-dimensional representation. These points are then clustered into groups which contain nearby observations. Representative infection rates for each cluster are shown in Chart 11 and the mean for each cluster is shown by a dashed line. See the annotations on the plots for interpretation.
Chart 10

PCA and K-means analysis of last 20 days of infection rates

See caption for interpretation

As one moves from the left of the chart to the right, the countries represented have reported more cases per 1 million people.
As one moves from the top of the chart to the bottom, the countries represented have increasing cases over the past 20 days.
Chart 11

Mean infection rates and representative country infection rates in each K-mean cluster

See caption for interpretation

K-mean cluster

1

2

3

4

5

6

7

8

Of note are clusters 3 and 6, which contain countries with the most advanced spread of COVID-19 among all countries. Cluster 6 contains countries with the highest infection rates. Other clusters contain countries with lower infection rates than clusters 3 and 6.
5.2. Analysis 2

In Chart 12, we present an analysis of the infection rates for all countries that have registered 10 or more infections. Similar to Analysis 1, the infection rates were “distilled” into a simpler two-dimensional representation. These points are then clustered into groups which contain nearby observations. Infection rates for each country are shown in Chart 13, split by the clusters shown in Chart 12, with representative countries labelled in this chart. Chart 12 is harder to interpret by itself, but we can gain some insight from Chart 13. See the caption of Chart 13 for this interpretation.
Chart 13
Country infection rates and representative labels in each K-mean cluster since 10 infections were recorded
See caption for interpretation

K-mean cluster
1 2 3 4 5 6

1
Montenegro New Zealand

2

5

3
Panama Slovakia

6

4

7

5

8

Days since 10 infections

Group 5 show countries that have had an extended period of sluggish growth in cases, including the United States, but have subsequently been experiencing higher growth.

Group 2 and 3 show mainly developing countries with renewed cases for at least a month, that are on a similar trajectory to countries with a longer history.

Group 2 also includes some Asian countries that have seemingly controlled the spread of infection well.

Groups 4 and 7 correspond to countries that have seen a steady rise in cases from day 1 and are now leveling off somewhat (remember that this is a log scale, so small increases mean a lot more cases).

Groups 1, 3 and 8 are quite similar and represent countries with an intermediate spread of infection.
6. \textbf{CORRELATION ANALYSIS}

6.1. \textbf{Infection Rates and Case Fatality Rate}

Let us consider the correlation between infection rates and CFRs. In other words, if a country reports more infections, does that imply that more deaths will follow? Although intuitively the answer is yes, the numbers say otherwise. If we examine closely the infection rate and CFRs datasets, it is likely that reporting of death rates is relatively more accurate than infection rates. For example, an unintentional under-reporting of infection rates could occur in a country that has performed a large number of COVID-19 tests, focusing on people with symptoms of COVID-19. Considering that many cases are reported to be asymptomatic or with only mild symptoms, the persons affected may just stay at home and not report their case. In short, if you do not test, you cannot report.

On the other hand, if a person dies due to complications of COVID-19, it is more likely that they would have been diagnosed and in a hospital, or were diagnosed after the fact. Although, even then there are reports that some deaths due to respiratory ailments similar to COVID-19 have not been reported. In a sense, death rate reporting may be less misleading than infection rate reporting which probably varies from relatively accurate in some cases to quite inaccurate in others. The following chart illustrates clearly the lack of correlation, in this case for Europe with a $R^2$ factor of only 0.0336, showing that reported death rates are not easily predicted by reported infection rates.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{chart.png}
\caption{Correlation Analysis between Case Infection Rate and Case Fatality Rate for (14-Apr-2020 - Day 87) - Europe — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd}
\end{figure}
6.2. Infection Rates and Testing Rates

The following chart shows a similar relationship, but between infection rates and testing rates. For this illustration, we chose the Americas as the region to analyze.

![Chart 15](image)

This shows a relatively strong relationship with a $R^2$ factor of 0.7008. Unfortunately, the testing data is still not as reliable as the infection rates or death rates. So there are many countries where the data is not available, like Spain, or may be even unreliable because it is not reported frequently. Some countries, like France, are reporting on a weekly basis, so the curves are not as smooth as they would be in a perfect world.

We can make some other observations, at least with respect to the above chart, the Americas. It should be expected that Canada and the US will have a similar profile. While Canada is has a testing rate of 12/1000 and an infection rate of 0.72/1000, the US has a much testing rate of 9.31/1000 and a higher infection rate of 1.84/1000.

On the other hand, the selected South American countries have both very low testing rates and lower infection rates than that of Canada (except Panama, marginally). There may be a strong correlation there. However, we should be critical of other possible factors that may be involved and that we have not yet discovered.
7. COUNTRY TO COUNTRY ANALYSIS

We can also analyze the various metrics by comparing a number of countries from the highest level to the lowest (limited to 70 countries for display purposes). In the following charts, the States of the US are considered individually as if they were countries, as well as the Provinces of Canada.

The list is numbered from 1 to 70. For the rates of death per million comparison, we have added in square brackets the approximate age of a person equivalent to the rate of death per million. For instance, in the case of New York State, the rate of death is equivalent to a 38-year old. For this approximation, we have you the US 2015 VBT Aggregate table, ultimate mortality, 50% male rates plus 50% female rates. This comparison is not to say that the two situations are equivalent. It is simply to try to put the rates in perspective of a normal expected mortality table.

For Belgium, currently with the 4th highest rate of death, the mortality rate equivalence is a 31-year old person. Europe as a whole has the 24th highest rate with a mortality rate equivalence of a 14-year old.

When it comes to the number of infections and deaths, and the rates of infection and death, there is a high level of consistency across the countries. The top level is made up mostly of the US states and European countries.

However, when we examine the CFR, that is the rate of death for those who are effected, we have a slightly different profile of the countries experiencing the highest levels. We have eliminated the countries with less than 25 deaths in this analysis.

Here, the top level is made up mostly of Latin Americas and the Caribbean, Africa, and to a smaller extent still Europe. This can be observed in the 5th chart in this series.

The first 6th chart in the series shows the rates of recovery. This is of course highly influenced by how long the pandemic had been present in the countries. That explains why many of the top recoveries are for Asian countries.
Chart 16

1—Europe 1,417,004.0
2—Northern America 1,218,544.0
3—US 1,158,040.0
4—Asia 558,444.0
5—US New York 316,415.0
6—Latin America and the Caribbean 258,582.0
7—Spain 217,466.0
8—Italy 210,717.0
9—United Kingdom 187,842.0
10—France 186,025.0
11—Germany 168,925.0
12—Russia 165,664.0
13—US New Jersey 134,687.0
14—Turkey 126,744.0
15—Brazil 126,045.0
16—Iran 101,826.0
17—China 97,424.0
18—US Massachusetts 68,087.0
19—US Illinois 61,499.0
20—Canada 60,504.0
21—US California 54,903.0
22—US Pennsylvania 51,225.0
23—Belgium 49,906.0
24—Peru 45,928.0
25—Africa 44,291.0
26—US Michigan 43,801.0
27—India 42,505.0
28—Netherlands 38,769.0
29—US Florida 38,078.0
30—US Texas 31,998.0
31—Canada Quebec 31,873.0
32—Switzerland 29,538.0
33—Ecuador 29,538.0
34—US Louisiana 29,340.0
35—US Connecticut 29,287.0
36—US Georgia 28,665.0
37—Saudi Arabia 27,011.0
38—US Maryland 25,462.0
39—Portugal 25,282.0
40—Mexico 23,471.0
41—Sweden 22,317.0
42—Ireland 21,506.0
43—Pakistan 21,084.0
44—US Indiana 19,933.0
45—US Ohio 19,914.0
46—Chile 19,663.0
47—US Virginia 18,672.0
48—Canada Ontario 18,574.0
49—Singapore 18,205.0
50—Belarus 16,705.0
51—US Colorado 16,635.0
52—Israel 16,208.0
53—Austria 15,597.0
54—Qatar 15,551.0
55—US Washington 15,185.0
56—Japan 14,877.0
57—United Arab Emirates 14,163.0
58—Poland 13,693.0
59—US Tennessee 13,177.0
60—Romania 13,163.0
61—Ukraine 11,913.0
62—US North Carolina 11,770.0
63—Indonesia 11,192.0
64—Korea, South 10,801.0
65—Denmark 9,721.0
66—US Rhode Island 9,477.0
67—Serbia 9,464.0
68—Bangladesh 9,455.0
69—Philippines 9,223.0
70—US Iowa 9,175.0

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<tr>
<td>Indiana</td>
<td>1,132</td>
</tr>
<tr>
<td>Portugal</td>
<td>1,043</td>
</tr>
<tr>
<td>Ohio</td>
<td>1,039</td>
</tr>
<tr>
<td>Texas</td>
<td>878</td>
</tr>
<tr>
<td>Indonesia</td>
<td>845</td>
</tr>
<tr>
<td>Colorado</td>
<td>842</td>
</tr>
<tr>
<td>Washington</td>
<td>834</td>
</tr>
<tr>
<td>Romania</td>
<td>790</td>
</tr>
<tr>
<td>Poland</td>
<td>678</td>
</tr>
<tr>
<td>Virginia</td>
<td>600</td>
</tr>
<tr>
<td>Philippines</td>
<td>607</td>
</tr>
<tr>
<td>Austria</td>
<td>598</td>
</tr>
<tr>
<td>Japan</td>
<td>487</td>
</tr>
<tr>
<td>Denmark</td>
<td>484</td>
</tr>
<tr>
<td>Algeria</td>
<td>463</td>
</tr>
<tr>
<td>Pakistan</td>
<td>457</td>
</tr>
<tr>
<td>North Carolina</td>
<td>434</td>
</tr>
<tr>
<td>Egypt</td>
<td>429</td>
</tr>
<tr>
<td>Minnesota</td>
<td>418</td>
</tr>
<tr>
<td>Missouri</td>
<td>381</td>
</tr>
<tr>
<td>Arizona</td>
<td>362</td>
</tr>
<tr>
<td>Colombia</td>
<td>340</td>
</tr>
<tr>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Wisconsin</td>
<td>339</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>333</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>320</td>
</tr>
<tr>
<td>Mississippi</td>
<td>303</td>
</tr>
<tr>
<td>Alabama</td>
<td>290</td>
</tr>
<tr>
<td>Ukraine</td>
<td>288</td>
</tr>
<tr>
<td>South Carolina</td>
<td>275</td>
</tr>
</tbody>
</table>
Chart 18

COVID-19 - Infection Rate /Million (03-May-2020) — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

1—US New York
2—US New Jersey
3—US Massachusetts
4—US Rhode Island
5—US Connecticut
6—US District of Columbia
7—US Louisiana
8—Luxembourg
9—Qatar
10—US Delaware
11—Iceland
12—US Illinois
13—Spain
14—US Michigan
15—Ireland
16—Belgium
17—US Maryland
18—US Pennsylvania
19—Canada Quebec
20—US
21—Italy
22—Switzerland
23—Northern America
24—Singapore
25—US Indiana
26—US South Dakota
27—US Nebraska
28—US Iowa
29—US Colorado
30—United Kingdom
31—US Georgia
32—France
33—US Mississippi
34—Portugal
35—Netherlands
36—Sweden
37—US Virginia
38—Bahrain
39—Germany
40—US Washington
41—US Tennessee
42—Europe
43—Israel
44—US New Hampshire
45—US New Mexico
46—US Kansas
47—Belarus
48—US Nevada
49—Austria
50—US Ohio
51—Denmark
52—Ecuador
53—Panama
54—US Florida
55—US Alabama
56—Canada
57—US Utah
58—US North Dakota
59—Turkey
60—Norway
61—United Arab Emirates
62—US Vermont
63—US Missouri
64—Peru
65—US California
66—US Wisconsin
67—Canada Alberta
68—Estonia
69—US South Carolina
70—Canada Ontario

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000 11,000 12,000 13,000 14,000 15,000 16,000 17,000

© 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd
Chart 19
COVID-19 - Death Rate /Million (03-May-2020) Equivalent Age Mortality in [...] © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

1—US New York (38) 680.8
2—US New Jersey (34) 596.8
3—US Connecticut (31) 573.9
4—Belgium (31) 477.7
5—US Massachusetts (20) 433.1
6—Spain (18) 420.1
7—Italy (17) 403.5
8—US Louisiana (16) 381.5
9—United Kingdom (16) 348.3
10—US Michigan (16) 348.3
11—France (16) 296.0
12—US District of Columbia (15) 296.0
13—US Rhode Island (15) 265.3
14—Netherlands (15) 265.3
15—Sweden (14) 265.3
16—Ireland (14) 265.3
17—Canada Quebec (14) 265.3
18—US Pennsylvania (14) 265.3
19—US Maryland (14) 265.3
20—US Illinois (14) 265.3
21—US (14) 265.3
22—Switzerland (14) 265.3
23—Northern America (14) 265.3
24—Europe (14) 265.3
25—US Delaware (14) 265.3
26—US Indiana (13) 265.3
27—Luxembourg (13) 265.3
28—US Colorado (13) 265.3
29—US Georgia (12) 265.3
30—US Washington (12) 265.3
31—Portugal (12) 265.3
32—US Mississippi (12) 265.3
33—Canada (12) 265.3
34—Canada Ontario (11) 265.3
35—Ecuador (11) 265.3
36—US Ohio (11) 265.3
37—US Vermont (10) 265.3
38—Denmark (10) 265.3
39—US Nevada (10) 265.3
40—Germany (10) 265.3
41—US Virginia (9) 265.3
42—Iran (9) 265.3
43—US Minnesota (9) 265.3
44—US New Mexico (9) 265.3
45—Austria (9) 265.3
46—US New Hampshire (9) 265.3
47—US Florida (9) 265.3
48—US Missouri (9) 265.3
49—US Oklahoma (9) 265.3
50—US Alabama (9) 265.3
51—US Wisconsin (9) 265.3
52—US Iowa (9) 265.3
53—US Kentucky (9) 265.3
54—US California (9) 265.3
55—US South Carolina (9) 265.3
56—US Kansas (9) 265.3
57—US Arizona (9) 265.3
58—Slovenia (9) 265.3
59—Panama (9) 265.3
60—US Maine (9) 265.3
61—Finland (9) 265.3
62—Estonia (9) 265.3
63—Romania (9) 265.3
64—US North Carolina (9) 265.3
65—North Macedonia (9) 265.3
66—Turkey (9) 265.3
67—US Nebraska (9) 265.3
68—Peru (9) 265.3
69—Norway (9) 265.3
70—Virgin Islands (9) 265.3
8. SIGNS OF SLOWING DOWN OR ACCELERATING — INFECTION SPEED

8.1. Introduction

The COVID-19 pandemic may remain with us for sometime. However, three major breakthroughs may happen.

1. The first one is the creation of a vaccine that will help immunize the population.

2. The second one is the flattening of the curve, or essentially achieving a stable position with no significant movement of the rates of infection and/or the rates of death. We can observe these changes in some countries but not in others. The series of graphs in this section illustrate these characteristics.

3. The third one is an effective cure for those affected. This could be a regime of drugs, lung exercises, or other combinations.

The x-axis represents the average number of new infections or deaths. The y-axis represents the total number of infections or deaths. At the beginning of a pandemic, the number of new infections (x-axis) increases rapidly as the total number of infections (y-axis) keeps increasing. This means the curve will go from the bottom left of the graph towards the top right side of the graph.

A smoothing mechanism has also been used to make the graph more useable by combining the data over a number of days, from day one to day five. This approach is an educated guess based on the final results. We have found that, in general, using a three-day average works best. To illustrate this, we compare four countries in the Americas. The US is so large that it distorts the comparison, so we have excluded it for this purpose.
These charts show the infections and deaths using single day observations:

Here are the infections and deaths using 5-day average observations:

In Charts 20 and 21, we see some clear evidence of a zigzagging effect. Obviously, people get infected or die at a continuous speed. Since the data gathering is daily, it follows that there will be more fluctuations from day to day.

Detailed charts on the various continents and specific countries are included later in this report. Next in this section, we highlight the Infection Speed of some key countries.
8.2. Some Key Countries

In this comparison of four key countries we are able to illustrate well the differences:

We can immediately distinguish the great differences between the US and the other three countries. China has completely turned the situation around. Their one-party system has helped to lock down the country and force social distancing, which reinforces the point that controlling a pandemic is doable in some cases. The data show that the US still has a way to go before they reverse their position.
Let us examine all the major countries in the world in terms of number of infections and deaths.
9. THE AMERICAS


[B] COVID-19 - CRUDE DEATH RATE /1,000,000 (03-May-2020 - Day 123) - Americas — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd
[J1] Correlation Analysis between Case Infection Rate and Case Fatality Rate for (03-May-2020 - Day 123) - Americas — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

\[ y = 0.0061x + 0.0361 \]
\[ R^2 = 0.0555 \]

[J2] Correlation Analysis between Case Infection Rate and Testing Rate for (03-May-2020 - Day 123) - Americas — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

\[ y = 6.1625x + 0.2781 \]
\[ R^2 = 0.7095 \]
9.1. Infection Speed in the Americas

Here is a sample for some countries in the Americas. The US is included in the first chart. However, it clearly eliminates any details of the other three countries, Canada, Mexico and Brazil. We added Peru in the second chart.

While Brazil seems to be continue to increase, the other countries have slowed in their increase.
9.2. Emphasis on the US States

Let us focus on the differences in US States,

![Graph showing infection rates in US States](image)

The rate of infections in New York State is 1.63%. This is by far the highest in the world when compared to other countries. Luxembourg is at 0.61% and Spain at 0.465%. Even New Jersey is at 1.42%. And Massachusetts is at 0.98%.

Let use examine the speed of infection.
Measurement on the speeding of slowing down of DEATHS Analysis — (UNITED STATES 1) — (from 01-Jan-2020 to 03-May-2020 - Day 123) — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

Measurement on the speeding of slowing down of DEATHS Analysis — (UNITED STATES 2) — (from 01-Jan-2020 to 03-May-2020 - Day 123) — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd
The State of New York eclipses all other states. Nonetheless, the next 12 states show some slowing down at times, but it is not yet very definite.
In this last chart, the state of Ohio and Indiana seem to be running in various directions.

9.3. States Comparison

The following chart clearly shows the high disparity across the states.

New York State and New Jersey, a neighbouring state, have a combined 38% of all infections in the United States.
9.4. Emphasis on the Canadian Provinces

The Canadian Provinces also show some different trends.

The province of Québec is definitely showing a much greater rate of infection than the other provinces, three times that of Ontario. Alberta and Nova Scotia are also very high. Of course, these rates pale in comparison to those in Europe, except for Québec.

Québec and Ontario seem to slow down a little. Canada as a whole seems to hesitate and keeps increasing, partly due to Alberta and Nova Scotia as the next charts show.
[L] Measurement on the speeding of slowing down of INFECTIONS Analysis — (CANADA 1) — (from 01-Jan-2020 to 03-May-2020 - Day 123) — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

Average Number of Total INFECTIONS per Day (over 3 Days)

Average Number of New INFECTIONS per Day (over 3 Days)

[Canada_Ontario] [Canada_Quebec] [Canada_Alberta] [Canada] [Canada_British Columbia] [Canada_Alberta] [Canada_Manitoba] [Canada_Saskatchewan]
With respect to the maritime Provinces, Nova Scotia seems to be the one pushing out further.
9.5. Provinces Comparison

The following chart clearly shows the high disparity across the provinces.

[D] COVID-19 - No. INFECTION RATE (03-May-2020 - Day 123) - Caribbean — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd
[H] COVID-19 - Ratio of DEATH RATES to Latin America and the Caribbean (03-May-2020 - Day 123) - Caribbean — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

[I] COVID-19 - Ratio of CASE FATALITY RATES to Latin America and the Caribbean (03-May-2020 - Day 123) - Caribbean — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd
[J1] Correlation Analysis between Case Infection Rate and Case Fatality Rate for (03-May-2020 - Day 123) - Caribbean — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

\[ y = -0.0129x + 0.0602 \]
\[ R^2 = 0.0061 \]

[0.00% 2.00% 4.00% 6.00% 8.00% 10.00% 12.00% 14.00%]

[0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00]

[INFECTION RATE /1,000]

CASE FATALITY RATE

INFECTION RATE /1,000

[0.00 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80]

[0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00]

TESTING RATE /1,000

[J2] Correlation Analysis between Case Infection Rate and Testing Rate for (03-May-2020 - Day 123) - Caribbean — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

\[ y = 0.1584x + 0.0382 \]
\[ R^2 = 0.0164 \]

INFECTION RATE /1,000
[M] Population of Selected Countries for Caribbean — © 2020 ECKLER LTD and QED
Actuaries & Consultants (Pty) Ltd

[AA] No. of Days since No. Infections ≥ 10 - Caribbean (03-May-2020 - Day 123) — © 2020 ECKLER LTD and QED
Actuaries & Consultants (Pty) Ltd
10.1. Emphasis on the Caribbean

There may not be enough data yet to have a reliable profile of the Caribbean. Nonetheless, here is a sample.

This shows a rapid slowing down of infections. This is probably as a result of social distancing implemented early. The numbers are of course small, but they do show a definite trend.
[H] COVID-19 - Ratio of DEATH RATES to Europe (03-May-2020 - Day 123) - Europe — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

**Correlation Analysis between Case Infection Rate and Case Fatality Rate for 03-May-2020 - Day 123 - Europe**

- **Equation:** $y = 0.0092x + 0.0558$
- **$R^2$:** 0.0916

**Correlation Analysis between Case Infection Rate and Testing Rate for 03-May-2020 - Day 123 - Europe**

- **Equation:** $y = 6.5743x + 10.3$
- **$R^2$:** 0.4425
[M] Population of Selected Countries for Europe — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

[AA] No. of Days since No. Infections ≥ 10 - Europe (03-May-2020 - Day 123) — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd
11.1. **Emphasis on the Europe — 1**

Here is a comparison of four major European countries among the highest ones affected, using a 3-day average.

While France, Italy and Spain are three of the most affected countries in the world, a definite trend is emerging in the reduction of new infections and deaths. In the United Kingdom, where actions such as social distancing and lockdown were implemented much later, we observe that although the trend has slowed down, it has not yet reversed itself.
11.2. **Emphasis on the Europe — 2**

This comparison looks at four other major European countries:

Germany has reversed the trend with respect to infections, even though the number of infections is quite large. Portugal, the Netherlands and Switzerland have also started a reverse trend.
Finally, the following comparison looks at four Nordic countries:

The trend is very clearly a deceleration for Norway, Denmark, and Finland. For Sweden which is resisting lockdown or at least more social distancing measures, there is a marked indication that their approach may not be working so well.
12. ASIA


[B] COVID-19 - CRUDE DEATH RATE /1,000,000 (03-May-2020 - Day 123) - Asia — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd
[J1] Correlation Analysis between Case Infection Rate and Case Fatality Rate for (03-May-2020 - Day 123) - Asia — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

\[ y = -0.0071x + 0.0312 \]

\[ R^2 = 0.1789 \]

[J2] Correlation Analysis between Case Infection Rate and Testing Rate for (03-May-2020 - Day 123) - Asia — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

\[ y = 9.8342x + 4.7275 \]

\[ R^2 = 0.3937 \]
Although the curves are flattening in virtually all countries in South-East Asia, Singapore is accelerating.
12.1. Emphasis on Asia

We need to exclude China for these charts as their scale causes some distortions.

Thailand seems to have started a reversal trend. However, the Philippines have not yet established a clear one. With a population of 110 million, the tally could increase quickly. And now, Singapore is running a fast acceleration as well.
13. AFRICA


[B] COVID-19 - CRUDE DEATH RATE /1,000,000 (03-May-2020 - Day 123) - Africa — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

[D] COVID-19 - No. INFECTION RATE (03-May-2020 - Day 123) - Africa — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

[H] COVID-19 - Ratio of DEATH RATES to Africa (03-May-2020 - Day 123) - Africa — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

[I] COVID-19 - Ratio of CASE FATALITY RATES to Africa (03-May-2020 - Day 123) - Africa — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd
**J1** Correlation Analysis between Case Infection Rate and Case Fatality Rate for (03-May-2020 - Day 123) - Africa — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

\[ y = -0.0454x + 0.0417 \]

\[ R^2 = 0.0069 \]

**J2** Correlation Analysis between Case Infection Rate and Testing Rate for (03-May-2020 - Day 123) - Africa — © 2020 ECKLER LTD and QED Actuaries & Consultants (Pty) Ltd

\[ y = 3.7151x + 0.4114 \]

\[ R^2 = 0.0374 \]
13.1. Emphasis on the Africa

Africa is still developing the COVID-19 trends. However, already it shows sign of control, especially in South Africa for infections.

The trend in new infections is somewhat clear. In particular, after some improvements, the situation in South Africa seems to have deteriorated seriously.
14. MAJOR “HIGHEST” AND “LOWEST” RATES OF INFECTION

Each of the previous graphs usually show major countries within their continent. The y-axis is automatically adjusted to fit the higher limits. So, by design, there is always a country that will reach the upper end of the graph. This is not misleading for what it is intended. However, it hides the fact that one country at the upper end of one continent could actually be at the bottom end of another continent. We continue to look at ways to depict these disparities across all countries. For now, we provide the following graph:

The above graph shows the relative size of the rates of infection across countries. For instance, although the US has a rate of infection compared to, say, Canada, at more than two to one, it almost pales in comparison to most countries in Europe. Moreover, from this graph we can discern that Europe is dealing with a major situation, followed by the US individually, and then the Middle East and Canada. As far as S-E Asia, Latin America, the Caribbean and Africa are concerned, their levels of infections and deaths are still relatively low.
The data on age-specific experience is not entirely available and what is provided at this stage must be used with caution until we have more reliable data. Nonetheless, it shows interesting differences between ages. The data is also partly inconsistent by country, so what we are reporting here should be treated carefully.

[Charts showing distribution of infections by age group and gender for Belgium, Germany, Italy, the Netherlands, Spain, Portugal, Austria, Sweden, and Switzerland.

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Belgium, Germany, Italy, Netherlands, Spain — Distribution of Infections (584,853) by Age Group and Gender

Portugal, Austria, Sweden, Switzerland — Distribution of Infections (43,410) by Age Group and Gender

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Page 79 — COVID-19 Statistics and Analysis
The pattern of cases varies by country. This of course may depend on many factors, including the actual age distribution. It usually increases by age and then eventually decreases as the total number must decrease since the exposure is much lower at the older ages. However, Asia shows a strange pattern of increase cases at the 20-30 age bracket.
The rates of infection is clearly a function of age, with older ages experiencing significantly higher rates.
The rates of death are not dissimilar.
By now, it should be obvious that the very old age individuals experience by far the highest rates of infections as well as the highest rates of death. That should of course not come as a surprise, since older people will have other health issues which will affect their rates of survival. Although every life is important of course, it would be interesting to examine the statistics by excluding the ages 80 and over, or another age bracket. It may be discovered that for a large majority of people, the COVID-19 would not qualify as a pandemic, but just another flu-like illness, while it would be qualified as a pandemic for the older population.
The CFRs are also showing some clear trends when it comes to comparing the differences by age.
Norway Estonia Greece Ireland — Case Fatality Rate by Age Group and Gender

MALE □ FEMALE □ UNKNOWN

Canada USA Mexico — Case Fatality Rate by Age Group and Gender

MALE □ FEMALE □ UNKNOWN
By this time, it should be obvious that the rates of infections are more severe for women than men, at least in Europe and Asia, and that the rates of death are more severe for men than women. The following charts show this relationship quite clearly.

![Belgium, Germany, Italy, Netherlands, Spain — Distribution of Infections (584,853) by Gender](image)

- **Male**: 46.0%
- **Female**: 54.0%

![Portugal, Austria, Sweden, Switzerland — Distribution of Infections (43,410) by Gender](image)

- **Male**: 44.5%
- **Female**: 55.5%
China South Korea — Distribution of Infections (10,752) by Gender

- Male: 40.4%
- Female: 59.6%

Canada USA Mexico — Distribution of Infections (15,529) by Gender

- Male: 57.8%
- Female: 42.2%
20. GENDER-SPECIFIC EXPERIENCE — DEATHS

Belgium Germany Italy Spain — Distribution of Deaths (58,862) by Gender

- MALE, 59.5%
- FEMALE, 40.5%

France Portugal Switzerland — Distribution of Deaths (14,869) by Gender

- MALE, 59.5%
- FEMALE, 40.5%
Based on the above samples, more women seem affected by the COVID-19, but more men die as a result rather than women (by more than 50%).
21. OTHER INTERESTING SOURCES

21.1. i.e. Muhanna & co, Actuaries & Consultants

Our colleagues at i.e. Muhanna & co in Lebanon have developed an interactive website on the evolution of the COVID-19 pandemic. The site is updated daily based on UN / JHU data.

You can visit the site at: http://muhanna.com/en/research/

For more information, please contact Michael Muhanna at: Michael@muhanna.com

Here are some screenshots from the site, reproduced with permission.
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