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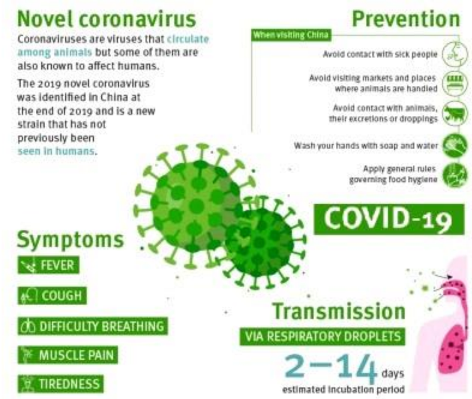
1.1 The Covid-19 Pandemic

Note: It will be highlighted from the outset that writing about the medical and socioeconomic implications of the Covid-19 pandemic from a perspective of ignorance at a time that most governments are battling to protect their national populations might be seen as irresponsible. However, given the fact that different governments around the world have taken different approaches to addressing the Covid-19 pandemic raises legitimate questions about these various strategies and the economic implications, both short and long term.



Based on the cautionary note above, this discussion will only attempt to provide some general background information surrounding the nature of the Covid-19 virus and its wider implications. While it makes no specific proposal for alternative action, it will attempt to raise questions and issues surrounding the handling of this pandemic and some of the wider potential implications. However, this discussion will only attempt to outline the complexity of problems surrounding this pandemic, such that external references will be provided to more authoritative information for the interested reader.

So, what is a virus and more specifically, the Covid-19 virus?

As a basic description, a *virus* is a microscopic infectious agent that replicates inside the living cells of an organism, which can infect all forms of life, e.g. animals, plants and micro-organisms. However, more specifically, the *Covid-19 virus* is described as an infectious disease that primarily affects the respiratory system, but where broader symptoms include fever, cough, and shortness of breath. The virus was first detected in the city of *Wuhan*, in the *Hubei province* of China, towards the end of 2019. In a historical context, the Covid-19 virus is the latest, and possibly worst, of a series of different *coronaviruses* assumed to have started in China that has now spread as a global pandemic.

Note: The statistics surrounding this global pandemic changes on a daily basis due to the exponential nature of the infection rate. Therefore, the website virusncov.com *should be referenced to determine the latest figures associated with each country. While these figures will be discussed in more detail below, it might immediately be highlighted that there is considerable variance in some of the national death rates that requires further understanding.*

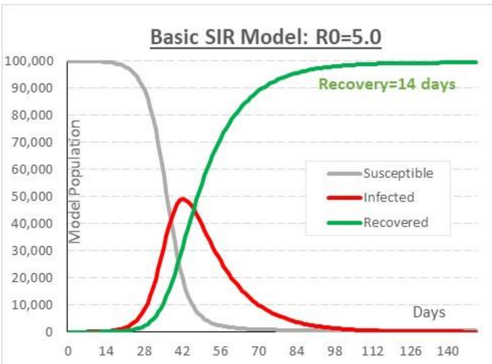
While this discussion will not pursue the issue of how the Covid-19 virus came to infect humans in any detail, there is a general assumption that it was the result of a *bat-borne virus*. However, at this time, there is no definitive evidence as to how, when and where the Covid-19 crossed from bats to humans, although there are a growing number of theories. While this discussion does not want to add to speculation, clearly it is important to tried to answer all the '*how, when and where'* questions surrounding this pandemic, as lessons as to how to best tackle future pandemics will need to be learnt.

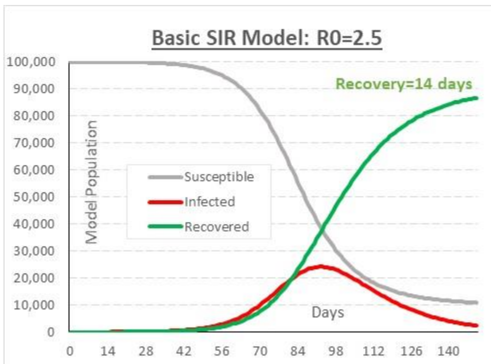
Note: Initially, it was assumed that the virus first infected humans in a wet market *in the city of Wutan given the obvious risk of the virus crossing into humans from both live and dead seafood, as well as other wildlife. However, it might also be highlighted that China's first biosafety level-4 virology laboratory is located in Wutan, less than 400 metres from the cited wet-market, which some have cited as the actual* Source of the Coronavirus *and* Origin of the CCP virus *– see videos for details.*

At the moment, the source of the virus is not necessarily the main priority facing most nations struggling to contain the spread of the virus within their own borders. However, there are many unanswered questions about the spread of the virus within a given population that require investigation. While the data presented on the *virusncov.com* website provides an alarming indication of the potential spread of the virus in terms of infections and deaths within given populations, these figures are open to different interpretation.

Note: Again, it is highlighted that this discussion does not wish to undermine the various strategies now being actively pursued by different governments to prevent unnecessary deaths. However, the analysis of the statistical data surrounding the modelling of this virus has raised questions that will need to be answered, if future pandemics are to be better addressed.

In advance of having detailed information about the spread of this specific virus in a given population, science has resorted to mathematical models in order to make any form of judgment about the preventative measures that might best be taken. One of the simplest models is called the *SIR model*, where the population is divided into 3 basic groups, i.e. susceptible [S], Infected [I] and Recovered [R]. However, some rename the recovered group as '*removed*' as it implicitly includes people who have died. Before outlining some of the details behind this model, we might simply present two typical graphical representations of the results as a function of time in days with different values of [R0], which represents the infection rate per person.





In broad terms, these two graphs help to explain the approach now being taken by most governments around the world. On the left, we might interpret the value of [R0=5] as the infection rate without any preventive measures, such that the infections increase exponentially for about 28 days and will have infected 50% of the population after 42 days. On the right, the value of [R0=2.5] has been halved, such that only 25% of the population is now infected after an extended time of 90 days. Therefore, it has been argued that by reducing the infection rate, while maintaining a constant recovery time of 14 days, allows the number of infections to be minimised and hopefully constrained within the capacity of the health system. While this discussion will not go into the mathematical details of this model, the equations in [1] are provided by way of general reference of the spreadsheet model used, where the subscripts [t, t+1] represents the daily change in the [S, I, R] values.

[1]

$$S = susceptible; \quad I = Infected; \quad R = Recovered$$

$$S_{t+1} = S_t - \beta S_t I_t; \quad I_{t+1} = I_t + \beta S_t I_t - \gamma I_t; \quad R_{t+1} = R_t + \gamma I_t$$

$$\beta = infection\ rate; \quad \gamma = Recovery\ rate; \quad R0 = N\frac{\beta}{\gamma}; \quad where\ N = susceptibles$$

While the logic of this basic model appears to be a reasonable starting point, it is virtually impossible to make its results fit the daily update of statistics from any country. In part, this might first be outlined in terms of a variant model called *compartment SIR*, which might be scaled to the population of various cities and towns in a given country. For example, in the UK, the city of London has a population of over 8 million people in relatively close proximity, while the city of Birmingham is the only other city with a population over 1 million. The population of most other towns in the UK quickly falls from about 500,000 to about 100,000, such that each might be better described by a compartment SIR model. In this type of model, we might account for the geographical spread of these towns, where the initial spread of the virus could have been subject to significant variance in terms of the numbers and start date, which might then be lost in the aggregation of national statistics. However, what is more problematic with these models is the percentage of the *'susceptible'* population that needs to be infected for the virus to be effectively eliminated.

Note: It is highlighted that the accuracy of the figures in the virusncov.com *website have to be questioned on a number of levels. As of 04-April-2020, over 2 million infections had been reported worldwide, which only translates to about 0.03% of the global population. Any examination of the top-10 infected countries also shows a comparatively small infection rate, when calculated as a percentage of the national population. At face value, this might suggest that the size of the 'susceptible' population is hardly affected, such that it might continue to remain susceptible to secondary phases of the pandemic.*

So, how might we start to correlate actual data with the models?

The first Covid-19 case in China has been tentatively traced back as early as 17-Nov-2019. However, at this point, the discussion will cite the UK as a general example of the preventative strategies adopted to reduce the infection rates shown in the previous graphs. Prior to any preventative measures, the first UK Covid-19 case was reported on 31-Jan-2020, although the first death did not occur until 6-Mar-2020. By 16-Mar-2020, this figure had risen to 50, although limited analysis suggests that all deaths were in the higher risk categories, i.e. age 60 and over with pre-existing health conditions. However, while the UK Prime Minster urged people to stop non-essential contact and unnecessary travel on 16-Mar-2020, the actual enforced '*lockdown*' was not announced until 23-Mar-2020. This equates to 52 days after the first case being reported and 17 days after the first death. This delay is not a direct criticism as any *'lockdown'* of any developed economy is a very serious political decision, which cannot be taken lightly, but leads to a fairly obvious question of interest to any SIR model.

How many of the UK population might have been already infected by 23-Mar-2020?

As of 07-Mar-2020, the UK was only reporting 164 infected cases, which would equate to just 0.0002% of its 67 million population, where 2 deaths correspond to 1.22% of the reported 164 infections. While we might initially assume that the deaths were accurately recorded, we might seriously question the reality of only 164 infections by this date. However, successive statistics also question the %-death rates, relative to recorded infections, being attributed to the Covid-19 virus.

Date	**Country**	**Population**	**% Infected**	**% Death**	**% Active**	**% Recovery**
07/03/2020	UK	67,772,000	0.000%	1.220%	87.805%	10.976%
16/03/2020	UK	67,772,000	0.002%	2.516%	96.046%	1.438%
20/03/2020	UK	67,772,000	0.005%	4.405%	93.607%	1.988%
04/04/2020	UK	67,772,000	0.056%	9.445%	90.201%	0.354%
07/03/2020	Italy	60,461,826	0.008%	4.249%	84.469%	11.281%
16/03/2020	Italy	60,500,000	0.041%	7.310%	83.255%	9.435%
20/03/2020	Italy	60,500,000	0.068%	8.298%	80.882%	10.820%
04/04/2020	Italy	60,500,000	0.198%	12.252%	71.259%	16.489%
07/03/2020	Germany	82,800,000	0.001%	0.000%	97.368%	2.632%
16/03/2020	Germany	82,800,000	0.007%	0.224%	98.985%	0.791%
20/03/2020	Germany	82,800,000	0.019%	0.287%	98.962%	0.751%
04/04/2020	Germany	82,800,000	0.110%	1.399%	71.643%	26.958%
07/03/2020	Global	7,700,000,000	0.001%	3.449%	39.691%	56.861%
16/03/2020	Global	7,700,000,000	0.002%	3.837%	50.419%	45.744%
20/03/2020	Global	7,700,000,000	0.003%	4.096%	60.220%	35.684%
04/04/2020	Global	7,700,000,000	0.029%	5.340%	73.998%	20.662%

In the table above, we see a general trend to increasingly higher %-death rates in all countries by date. While some of the variance in the %-death rate figures might be attributed to differences in age demographics and the possibility that some of the national healthcare services in some countries may have been overwhelmed by the numbers requiring treatment, it is unclear that these two factors alone can be telling the whole story.

Note: Based on the variance in the previous table, we might question the accuracy of the reported infections, which in all cases only represents a minimal % of the population. However, there is also some reasonable grounds to suggest that the %-death rates are being inflated because the cause of death is being attributed to the Covid-19 virus, simply because it was present at the time of death, without necessarily any testing to prove this was the actual cause of death – see video Corona crisis: Open letter to the Chancellor from Prof. Sucharit Bhakdi *for some further details.*

While not wishing to minimise the tragedy of people dying as a result of the Covid-19 virus, some statistical perspective is possibly required at this point. Again, we shall use the UK as a general example, where in 2018 over 600,000 people died. The following two tables, first shows the approximate breakdown of the cause of the 2018 UK deaths, where 78%, i.e. 468,000, were related to medical conditions, which would translate into an average 1282 deaths per day. The second table shows the assumed death rates specific to the Covid-19 virus, as a percentage by age group. While there is no direct correlation between these tables, there is an inference that Covid-19 deaths may only be a smaller percentage of overall deaths.

Non-Covid Death Rates	% Rate	Deaths
Cardiovascular	28.62%	171,702
Cancers	25.61%	153,630
Respiratory	12.18%	73,074
Digestive diseases	4.65%	27,876
Mental disorders	3.61%	21,630
Nervous system	3.35%	20,076
All Other causes	22.00%	132,000
All causes, all ages	100.00%	599,988

Age	% Death	Overall %
10-19	0.20%	0.20%
20-29	0.20%	0.40%
30-39	0.20%	0.60%
40-49	0.40%	1.00%
50-59	1.30%	2.30%
60-69	3.60%	5.90%
70-79	8.00%	13.90%
80+	14.80%	28.70%

Addressing the first table left, as of today, 05-Apr-2020, some 29 days have passed since the first Covid-19 death was reported in the UK, which might be compared to the 37,183 deaths related to the health issues listed above. Over the same period, the number of UK recorded Covid-19 deaths was 4,313. i.e. 11.6% of 37,183, although it is far from clear that all 4,313 Covid-19 deaths can all be directly attributed to the virus and not any of the pre-existing health issues listed above. The second table right relates to the estimated Covid-19 death rates by age groups shown and while the two tables are not directly related, we might speculate that the increasing probability of death by age might have something to do with the fact that people tend to accumulate the health problems listed, as we age.

Note: At this stage, for the reasons outlined, we probably do not have accurate figures for the number of people infected in any population as a whole nor do we really know whether all the deaths being attributed to the Covid-19 virus are an accurate assessment of the actual cause of death. If so, the data accumulated from the virusncov.com *website is probably an inaccurate database on which to base any statistical SIR model.*

As the analysis above carries no authoritative weight, we possibly need to make further reference to more informed analysis, which it has been reported to have influenced the UK government's Covid-19 strategy – see *Imperial College COVID-19 Report* for details. While the report should be read in full, the following paraphrased quote is taken from the initial summary.

Two fundamental strategies are possible: (a) mitigation, which focuses on slowing but not necessarily stopping epidemic spread, but reducing peak healthcare demand while protecting those most at risk of severe disease from infection, and (b) suppression, which aims to reverse epidemic growth, reducing case numbers to low levels and maintaining that situation indefinitely. Each policy has major challenges. We find that that optimal mitigation policies (combining home isolation of suspect cases, home quarantine of those living in the same household as suspect cases, and social distancing of the elderly and others at most risk of severe disease) might reduce peak healthcare demand by 2/3 and deaths by half. We conclude that the effectiveness of any one intervention in isolation is likely to be limited, requiring multiple interventions to be combined to have a substantial impact on transmission.

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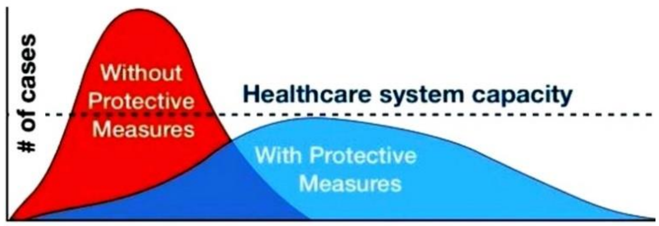
While this discussion is not in a position to comment on the details of the simulation model used by the Cambridge team, it is assumed that it is based on SIR-like models, although presumably far more sophisticated than the simple spreadsheet model used to produce the previous SIR graphs. However, despite the simplicity of the earlier model, this report appears to broadly propose that the [R0], i.e. the *basic reproduction number*, needs to be minimised in order to supress the number of infected people with serious complications from overwhelming the health service. Based on the previous quote, the report forwards two approaches, summarised below, where the second option is the preferred policy option.

- Mitigation focusing on slowing but not necessarily stopping epidemic spread.
- Suppression to reduce case numbers to low levels and maintaining that situation indefinitely.

Again, without going into all the details, the suppression option infers what most populations now generally understand as *'lockdown'*, '*self-isolation'* and '*social distancing'*. Broadly, it is hoped that these policies will first reduce [R0] to a point where the infected case load remains within the capacity of the health service. We might simply attempt to characterise the hopeful outcome in the chart below.



More broadly, the longer-term hope appears to be that suppression of the virus might eventually lead to a figure of [R0<1], where new infections are outnumbered by the number of recoveries and, in so doing, buy the necessary time, e.g. 18 months, for the development of a vaccine. This said, the Cambridge report highlights that if these policies are relaxed, presumably before the general availability of the vaccine, then '*transmission could quickly rebound'*.

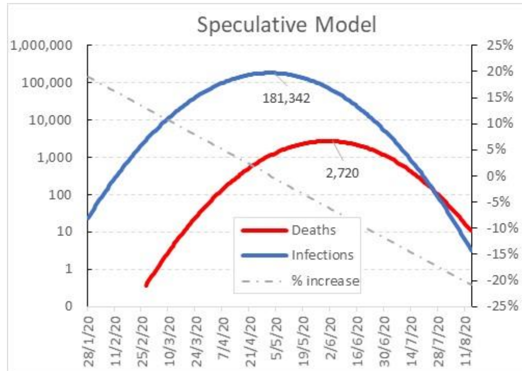
> *Note: As stated, this discussion will make no direct criticism of any attempts to both understand or minimise the impact of the pandemic. However, this does not mean that alternative perspectives have to be suppressed provided that the source carries a sufficient weight of authority.*

As outlined, all the SIR charts presented appear to suggest that only through the process of infections and recovery will a significant percentage of the population cease to be susceptible to the virus. However, to-date, all statistics about the spread of the virus appears to have infected less than 1% of any national population, although it is suspected that actual infections may have been grossly under-estimated. In this context, an Oxford epidemiologist, *Sunetra Gupta*, has questioned some of the assumptions underpinning the Cambridge model. While no link to the report produced by the team of researchers at Oxford University can be found, it apparently suggests that a much larger percentage of the UK population may have been infected prior to the first death on 06-Mar-2020.

> *Note: Given any problems with the statistics, i.e. infections and deaths, it might be assumed that both Cambridge and Oxford research teams have to be projecting the impact of the pandemic based on variations of SIR-type models. While we might assume that these models are much more sophisticated than the spreadsheet model suggested in this discussion, the results of any model can be highly dependent on the assumptions underpinning its input parameters.*

So, let us proceed on the not unreasonable assumption that the percentage of the UK population infected with the virus was possibly much higher than the statistics suggest. If so, we would then need to explain why the number of deaths in the UK did not reflect this higher level of infection. While any explanation has to be speculative, we might still attempt to anchor this speculation to what are assumed to be known facts. As outlined earlier, the first UK Covid-19 case was reported on 31-Jan-2020 with the first death reported on 6-Mar-2020. However, it is also known that the suppression policies forward by the Cambridge report were not enforced until 23-Mar-2020, which was some 52 days or 7.5 weeks after the first UK infection case was reported. Given the minimal level of testing for the presence of the virus in the UK during this period, any estimate of the actual number of people infected would appear to be speculation, irrespective of the source.

So, what might have happened in this first 52 days?



While it is not possible to give a definitive answer to this question, the chart right might simply be seen as a visual, and speculative, model of both the infections and deaths as a function of time. However, this chart is based on a mathematical formulation that differs from the SIR model previously outlined, as it follows a compound growth rate subject to a linear decay. The start-date of 28-Jan-2020 is broadly aligned to the first reported case of the virus in the UK and adopts an initial growth rate of 19%, which was generally supported by the statistical data at that time, but is then subject to a linear decay of 0.2% per day, where both infections and deaths are shown on the left, but now on a logarithmic scale. The peak of the infection is reach when the %-growth rate, shown left, reaches zero around the beginning of May-2020. However, the red curve representative of deaths is now offset from the start of the infections by 30 days.

How might this 30-day lag between infections and the first death be explained?

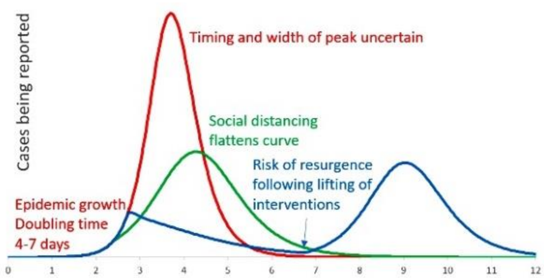
Let us assume that the chart above reflects a large city like London with a population of 8 million. Let us also assume that the initial infections were introduced by people returning from other regions, e.g. China and Italy. While speculative, it might not be unreasonable to assume that these people were younger and possibly had fewer underlying health conditions than the general population. As such, statistics suggests that they would be less susceptible to the effects of the virus, even though they might have still been carriers. Again, statistically, it has been estimated that 80% of those infected may only have mild symptoms, while another 15% will have more severe symptoms possibly requiring some medical treatment with the final 5% experiencing life threatening symptoms. However, given that the worst effects of the virus are biased towards increasing age, especially when linked to pre-existing health conditions, this initial group of virus carriers may have had very few symptoms of concern. Equally, at this time, most people were not necessarily that aware of the growing pandemic, such that most symptoms might have been simply attributed to seasonal flu-like infections, which typically occur in the winter months in the UK. Of course, on return from abroad via London's international airports, any initial carriers could have started to expose a much broader cross-section of the population, although possibly concentrated within the UK's larger urban cities.

> *Note: While increasingly speculative, we might question whether those at greatest risk, i.e. by age and health conditions, would have had much contact with those initially infected, i.e. younger and healthy. Equally, as previously highlighted, the UK health service was possibly dealing, on average, with 1282 deaths per day during the normal winter flu months before the implications of the pandemic were really understood. If so, the many deaths now being attributed to the Covid-19 virus might have simply been attributed to the normal range of health conditions. If so, it might partly explain why there was a 30-day lag between the start of the infections and the first reported Covid-19 death.*

It is highlighted that while the previous example may appear to give some credence to the Oxford model, the peak number of infected in the London model in early May-2020 would be 181,342, i.e. 2.27% of the 8 million population of London with a corresponding %-death rate of 1.5%, basically in-line with Germany and original estimates. Therefore, these figures are far more conservative than the Oxford model, which was projecting infections to be as high as 40-50% of a similar population. To-date, 07-Apr-2020, the model for London suggests that infections would be in the order of 100,000 with some 140 deaths. In contrast, the corresponding reported figures for the same date for the whole of the UK are 51,608 infections with 5,373 deaths suggesting a 10.4% death rate. As argued, it is possible that the UK reported infections may have been under-estimated, especially in large urban cities and towns, while a %-death rate of 10.4% may be being inflated simply because the virus was presence at death, but not necessarily being the primary cause of death, especially for those in the upper age groups with underlying health conditions. Again, this speculative model is not attempting to undermine the suppression policy forwarded by the Cambridge model, which is now broadly accepted as UK public policy. However, what all these different models might tell us is that they are what the name implies, i.e. '*models*' of a pandemic, which may not accurately reflect the reality of the situation. So, while everybody should support the suppression policy in terms of lockdown, self-isolation and social distancing, especially in this first phase, there are potentially wider considerations that may need to be taken into account, if the spread of the virus is subject to secondary phases.

But, might the Covid-19 virus simply burn itself out and life return to normal?

It might be realised that this is not really a single question, as even on a superficial level we might separate the issue of the ending of the pandemic as a medical emergency and everyday life simply returning to normal without further consideration of potentially lasting economic and social impacts. At this point in time, it is probably not too much of an exaggeration to say that if you ask any two experts in the field of pandemics when it will end, you will probably get two different answers. However, in part, the reasons for these different opinions, even by those who have an understanding of the problems, has already been broadly outlined. While it has been repeatedly highlighted that this discussion does not have the authority to draw any conclusions, based on the information available in terms of statistics and models, the worry is that only a minimal percentage [1%] of any national population may have been infected, which implies that the majority [99%] must still be susceptible. If so, we might consider a potential projection of the pandemic in terms of the chart below.



As shown, the red curve is the number of infections, which if subject to the suppression policy discussed might flatten to a reduced number of infections, as shown by the green curve. However, as highlighted by the Cambridge report, if and when these policies are relaxed, before the general availability of the vaccine, then '*transmission could quickly rebound'* as suggested by the blue curve, especially if 99% of the population is still susceptible. Of course, the hope is that the initial phase of the suppression policy will not only reduce the immediate number of deaths by preventing the health service from being overwhelmed, but also buy time to better prepare for any potential secondary phases.

> *Note: Secondary phase preparations would include new tests for detecting the presence of the infection, even before symptoms are obvious, plus tests for detecting recovery from the virus. Even these measures would greatly improve the accuracy of the statistics, such that any secondary outbreak might be more quickly detected and suppressed. In addition, South Korea has shown that a 'test and trace' ability for those exposed to the Covid-19 virus has help reduced their death rate to 0.7%. Equally, the time between the first and any secondary phase would allow time for a significant increase in the production and distributions of masks and respirators.*

So, if we simply assume that the risk of secondary outbreaks cannot necessarily be avoided given the size of the susceptible population, especially if the virus might re-enter a population in any number of ways, we might still be hopeful that the medical emergency surrounding the pandemic might be minimised after the end of the first phase.

But what risks and implications might remain after phase-1?

The first part of this discussion has tried to provide a broad outline of the impact of the Covid-19 pandemic within the context of a medical emergency. Clearly, within this emergency, many people have been infected and died as a result of the Covid-19 virus, where each case is a personal tragedy to those directly affected. However, in terms of a statistical assessment of this pandemic, this is not necessarily the best way to quantify the impact of the virus or to judge how governments should best respond. We might also recognise that mainstream media has been broadcasting about the dangers of the Covid-19 virus on a 24/7 basis, where much coverage has been focused on individual tragedies in the form of '*human-interest*' stories. Of course, this sort of coverage not only influences what the '*public thinks*', but what '*politicians do*' in order to maintain the support of the public, at least, in most democracies. We might also recognise that we live in a world increasingly defined by a somewhat abstracted and idealised concept of '*political correctness*', which can destroy the career of not only a single politician, but potentially an entire government, even authoritarian ones. So, in this context, we might wish to consider the implications of the following statement apparently made by the Governor of New York, Andrew Cuomo.

> *I want to be able to say to the people of New York, I did everything we could do.*
> *And if everything we do saves just one life, I'll be happy.*

While we might all perceive the moral or political reasoning behind these words, we still need to question their wisdom as the basis of public policy. Of course, recognising that anybody questioning this morality might risk never being elected to public office, the truth is that our ability to save every life is subject to practical limits.

> *Note: While statistics can be perceived as cold and impersonal, they possibly highlight the wider reality of a problem. For example, statistically, it is estimated that 1-billion people go to bed hungry with 25,000 dying, every day, as a result of malnutrition and hunger-related diseases. Possibly more tragic in human terms is that 18,000 of this number is estimated to be children under 5 years old.*

While we know that many of these unfortunate people might have been saved, there are often practical limits to what can be realistically achieved. So, while we might readily understand why the governor of New York might sincerely believe in his statement, others will have to assess the implications on other lives in other sectors of the US population. However, it is recognised that this outline will make many feel uncomfortable with the direction of this discussion, but it will be argued that this perspective cannot simply be ignored.

> *Note: As previously highlighted, 616,000 people lost their lives in the UK in 2018 and undoubtedly each was a personal tragedy to those involved. Morally, it might be argued that if even one life could have been saved, then there should be no financial limits imposed on the UK health service. However, while this may be a moral conclusion, it is unclear that it is a realistic one.*

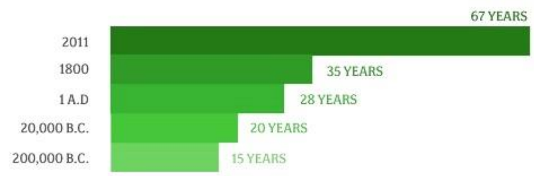
So, widening the scope of this statistical perspective, it is estimated that there have been, at least, 15 million US cases of '*the flu*' in the 2019-2020 season, which would translate to 4.6% of the US population. So far, this flu season has resulted in 140,000 (0.93%) hospitalizations and 8,200 (0.05%) deaths relative to the 15 million cases, not the population as a whole. By way of a comparative measure, it is estimated that 2.5 million people die every year, or 0.76% of the US population, which as an average would translate to 6,849 deaths per day. Again, it is recognised that this is a cold and impersonal assessment, but one that allows the risk of death to be put into some perspective.

So, what is the comparative risk of the Covid-19 virus to the US population?

As of 09-Apr-2020, the US has, by far, the largest number of reported Covid-19 infections anywhere in the world. Why this is the case might be debated in terms of suppression policies adopted and its demographics, which this discussion will not address. In statistical terms in this time frame, the US has reported 435,160 Covid-19 infections, which translates to 0.13% of its 329 million population, with 14,796 deaths or 3.4% of those infected. However, New York state with an estimated population of 20 million, i.e. 6% of the US population, has reported 149,316 infections, which is 34.31% of the US total and 6,261 deaths or 42.32% of US total. While these numbers associated with the Covid-19 virus are more worrying than normal cases of the flu, statistics suggest that the total deaths represent about 0.6% of the estimated 2.5 million deaths in the US every year. Again, while statistics do not reflect the personal tragedies taking place in all these cases, they can possibly put our fears into some better perspective. For life has always come with risks, although this does not mean that, as individuals and society, we should not seek ways to further minimise this risk.

What might history tell us about risk?

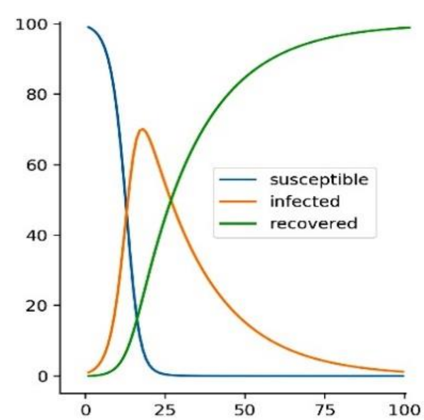
Again, we might seek some perspective in statistical numbers, where it is estimated that possibly 90% of all whose have ever lived were born before 1850, such that we might estimate a number in the region of 100 billion. Today, the global population is approaching 7.8 billion or 7.8% of those people who have ever lived. Looking back in time, we might understand that this 90% lived before the development of modern medicines and sanitation, where most would have had to survive on minimal calories and poor-quality food, even assuming they were lucky enough to survive the appallingly high child mortality rates. Against this historical backdrop, we might also highlight the increase risk of death from diseases like malaria, tuberculosis, plague, cholera, influenza and smallpox, which may have accounted for the deaths of billions over human history. So, while modernity presents us with its own set of problems in the form of industrialization and urbanization along with diseases like heart attacks, cancers and strokes, we might still reflect on the diminishing risk of death in terms of an increasing average life expectancy, as shown in the chart right. Within this historic timeline of diseases, we might now return to the immediate risks associated with pandemics.



Note: The cause of most modern pandemics are viruses that have been passed from animals to people. For example, the HIV virus *is believed to have originated in chimpanzees, while the class of* coronaviruses*, e.g. SARS, MERS and COVID-19, are all believed to have originated from bats, which then mutated through secondary animals into humans.*

While the *Spanish flu* pandemic of 1918 was a type of influenza virus, *subtype H1N1*, it is estimated that it may have infected upwards of 500 million people or 25% of the world's population at that time and caused 50 million deaths. While the accuracy of these statistics might be questioned, it was probably one of the deadliest pandemics in human history, just behind the *Black Death*. However, given that this pandemic also existed before a vaccine had been developed and before the suppression policies now being adopted to address the current Covid-19 pandemic were understood, we might possibly want to pursue some general questions about the nature of pandemics.

How do pandemics start and end?



While most people will be more interested in how pandemics end rather than start, the initial spread of a virus often depends on its *pathology*. While this discussion cannot address the nature of this complexity, the initial spread of a virus depends on how infectious it is and how quickly it is transmitted. In terms of the basic SIR model used, illustrated right, the rate of transfer between susceptible [S-blue], infected [I-orange] and recovered [R-green] is defined by the following equation.

[2] $$\frac{dI}{dt} = \beta SI - \gamma I; \quad where\ \beta = infection\ rate; \quad \gamma = recovery\ rate$$

However, within the simplicity of this model, both [β] and [Υ] are assumed to be constants, such that the value of the *basic reproduction number [R0]* might vary as a function of the remaining susceptible population [N_S], as shown in [3].

[3] $$R0 \Leftarrow N_S \frac{\beta}{\gamma}$$

So, as the initial value of [R0] effectively changes as the SIR model progresses, its value may eventually fall below unity, such that the number of infections reduces as each remaining infected person can only pass on the disease to fewer people. If so, the virus cannot sustain its own spread and the pandemic will '*burn*' itself out. However, what is not clear from the current statistics is that the percentage reduction of the number of people susceptible to the Covid-19 virus appears minimal [<1%] in all national populations. As such, the value of [S] in [2] must remain large relative to both the number of infected [I] and recovered [R], such that any change in the value of [R0] is simply being affected by the isolation policies and not as described by the SIR model itself, such that the population might remain susceptible to a secondary phase of the pandemic should the infection be reintroduced by any means.

> *Note: The reason for returning to the possible risk of secondary phases of the pandemic is that we may now have a better assessment of the relative statistical risk, such that public policy might be put into better perspective and rationalised. As previously highlighted, if governments use the initial phase of the pandemic to better prepare to minimise the scope of any localised secondary outbreaks, the risk to the population at large may also be minimised, such that we might now discuss some wider implications.*

Let us generally assume that secondary outbreaks cannot be avoided, even if the impact can be minimised. However, there is a suggestion that the suppression policies, i.e. *'lockdown'*, '*self-isolation'* and '*social distancing',* imposed during phase-1 may have to be extended for as long is necessary, e.g. the availability of a vaccine. For practical reasons, let us assume that a vaccine will not be available to the 99% susceptibles in any given population for, at least, 2 years.

If so, might the suppression policies of phase-1 have to be revised?

Let us first be brutally honest about the limitation of phase-1 policies to try to save every life irrespective of the costs, as this was never the goal. Rather the more realistic hope was by minimising the number of infections, the numbers requiring hospitalisation would also be minimised, therefore preventing the health services from being overwhelmed. In this context, the goal was only to minimise the number of preventable deaths.

But are preventable deaths the only issue to society?

Clearly, this might be seen as a very contentious issue, especially in terms of morality, which many in public life will not want to discuss. For reasons already outlined, many politicians may be *'happier'* to be associated with the idea that society must simply do '*everything to save just one life'*. For while the idea that financial costs is a factor in this discussion may appear unpalatable to many, the truth is that no government can afford to incur the cost of the collapse of its economy.

> *Note: While this discussion will not expand on the issues surrounding such* moral or ethical dilemmas*, it might be highlighted that the dilemma represents a choice that has to be made between two or more unpalatable options. In this case, the national economy requires as many people to return to productive work as soon as possible, even though this may increase the risk of secondary phases of the pandemic.*

It might be readily understood that the Covid-19 pandemic has already severely affected most major economies in terms of both supply and demand. As a broad generalisation, the phase-1 suppression policy of lockdown has effectively reduced the workforce, which then leads to a reduction in output or supply capacity. Likewise, this policy has also required people to stay at home, which has adversely affected both consumption and demand. This overall downturn in so many markets is having a very serious effect on many businesses, both large and small, as profits fall and cash-flow becomes increasingly problematic. Again, the scope of these problems can only be outlined, but it might still be highlighted that '*saving just one life'* in terms of the current medical emergency is not the only problem requiring consideration.

Note: As businesses increasingly struggle to maintain their balance sheets, it may inevitably lead to increase unemployment and therefore social welfare costs at a time when government tax revenues are falling. In such times, fiscal and monetary policy may be limited to simply printing money leading to an increase in national debt and interest payments, especially when viewed as a ratio of potential falling national GDP. In such a scenario, governments may have to choose which industries and businesses can be saved from potential bankruptcy in order to be in a position to recover as, and when, the pandemic finally subsides. However, we may also have to face up to the fact that many of the national 'rescue packages' being announced in the current phase of the pandemic may not be sustainable should secondary phases of the pandemic extend over years, rather than months.

While this outline is only trying to characterise some of the wider implications of the pandemic, it might be realised that many of the worst effects related to the economy will often fall on younger generations. As a generalisation, these younger generations often have minimal job security and financial savings, but many financial costs in terms of mortgages, rent and children that do not simply disappear in this crisis, even if their government is in a position to offer some short-term protection. However, there is a certain irony associated with the Covid-19 pandemic in that those most-likely to be financially affected are statistically the least-likely to be affected by the virus.

Note: By citing a statistical probability to a given age-group does not mean that everybody in this age-group will be immune from its health risks. However, it may suggest a possible revised suppression strategy after the phase-1 outbreak appears to be under control. It might also be highlighted that while [R0] might help define the peak of infection, deaths will lag this point, while the falling curve of infections may also account for as many as the rising curve.

Of course, as highlighted, given a remaining susceptible population being in excess of [99%], the probability of localised secondary outbreaks would appear high. If so, then some trade-off between health risks and economic necessity might have to be considered. Simply by way of a conceptual and statistical model, whereby younger generations with lower-risk to the virus are allowed to return to work and given more licence to continue a normal social life, which is generally more important to younger generations, while older generations with higher risk remain subject to phase-1 suppression policies. The following table is reflective of the age demographics being associated with the younger generations with lower-risk to the virus within a UK population of 67 million, but where a secondary phase outbreak only infects 100,000 people in some localised region.

Age	**%**	**Pop**	**% Death**	**Deaths**	**%-Age**
0-9	11.80%	7,906,000	0.00%	0	0.0000%
10-19	12.10%	8,107,000	0.20%	200	0.0025%
20-29	13.60%	9,112,000	0.20%	200	0.0022%
30-39	13.10%	8,777,000	0.20%	200	0.0023%
40-49	14.60%	9,782,000	0.40%	400	0.0041%
Low-Risk	53.40%	35,778,000	1.00%	1,000	0.0028%

As shown, the %-death figure reflects the assumed probability of death within each age group, such that deaths are based on the number of infections, e.g. 100,000, not the age-group population. However, the %-age number reflects the percentage of deaths relative to the age demographic population. In this statistical model it has to be recognised that individual tragedies will occur, which reflects the moral dilemma being discussed, but the 1% put at risk allows 53% of the UK population to return to some kind of normality and help maintain the economy on which younger generations are so dependent.

Note: While 0-20 age groups are not necessarily integral to the economy, they generally reflect the age groups that have to return to education, inclusive of childcare, in order that many parents within the 20-49 age groups can return to work.

While it has not been specifically highlighted, people within these younger age groups with known pre-existing health conditions, which effectively puts them in a higher-risk category, would not be required to return to work. However, the issues surrounding these and other exceptions to the general model will be discussed after presenting the next table.

Age	%	Pop	% Death	Deaths	%-Age
50-59	12.20%	8,174,000	1.30%	1,300	0.0159%
60-69	10.80%	7,236,000	3.60%	3,600	0.0498%
70-79	12.10%	8,107,000	8.00%	8,000	0.0987%
80+	11.80%	7,906,000	14.80%	14,800	0.1872%
High-Risk	46.90%	31,423,000	27.70%	27,700	0.0882%

Again, this table presents the equivalent figures for the age groups assumed to be at higher risk to the virus, such that most might still be subject to the phase-1 suppression policies. Collectively, these age groups with a smaller overall demographic population, i.e. 31.4 million compare to 35.7 million, have a 27-fold increase in risk compared to the younger age groups. However, as before, individuals in the older age groups may be exempt, if they have no underlying health problems or the number of infections in their region is minimal, such that any cases might be handle by the local health services. Again, these exemptions may also help to restore or maintain essential components of the national economy on which everybody ultimately depends.

> *Note: As a generalisation, it is possible that second phase policies may have to shift much of the responsibility of minimising risk on to individuals. If somebody knows that a person is at greater risk due to age or health conditions, then it is clearly in the interests of these individuals to maintain their social distancing and potentially remain in self-isolation for as long as possible. However, the responsibility of 'policing' of these individuals would possibly have to shift towards social services or the individuals themselves.*

Based on the general review of the SIR models presented, a reduction in the number of infections and deaths appears to require some significant percentage reduction in the susceptible population. To-date, this reduction does not appear to have taken place as statistics suggest that less than 1% of any national population has been infected. If so, then it is unclear how secondary phases of the Covid-19 pandemic can be completely avoided, although there are reasons to hope that these outbreaks might be locally contained. Likewise, an understanding of the actual risks, rather than *'media-driven hysteria'* centred on individual *'human-interest'* stories might help everybody to put the risks into a more realistic perspective. In this way, people might return to work in order to maintain their own incomes and hopefully help to stabilise the national economy, even if initial priority has to be given to essential services, hopefully in the knowledge that the government has the ability to detect secondary outbreaks and the strategy to contain them should they occur.

What other preventive measures might be considered?

Again, while recognising that this is not an authoritative discussion, some potential preventive measures might still be highlighted by way of general commentary. These additional preventive measures should also be seen as over and above the existing prevention measures already being proposed, e.g. avoid potential sources of infection and washing your hands as often as possible. However, as supported by statistics, it appears that the Covid-19 virus is more dangerous to older age groups, especially those with pre-existing health conditions. However, while age in isolation may still be a factor, as it is known that our immune system generally weakens as we age, many in their '*retirement years'* may still be healthier than many of younger years. To be clear, the statistical risks assigned to the different age groups does not imply that younger healthy people are immune from the more serious effects of the Covid-19 virus, simply that the number of deaths in these younger age groups will be statistically lower. As such, good diet, exercise and reduced stress may be a preventative factor that may help protect all age groups – see *Prevention versus Cure* for more details.

Note: There are growing statistics suggesting that obese people have an increase risk to the Covid-19 virus, especially in terms of surviving intensive care treatment when breathing problems require mechanical ventilation. Of course, it might also be recognised that being overweight is possibly reflective of other underlying health problems.

It might also be highlighted that many are now researching the issue of vitamin-D deficiency, where its production in the human body is dependent on an exposure to sunlight. From an evolutionary perspective, it is assumed that lighter skin colour may have developed as people migrated further north, such as to make the most of what little sunshine was available. Of course, in the modern world, many avoid direct exposure, such the vitamin-D deficiency may affect the majority of those now living in northern latitudes. However, new research is now indicating that Vitamin-D may be essential to the health of our immune system – see video *Vitamin D and Human Health* for more details.

Note: Clearly, there may be grounds to assume that anybody taking steps to improve their general health may also gain some increased protection from the Covid-19 virus. Again, this may only be realised in terms of statistical probability, as any individual may be unknowingly at increased risk for any number of reasons, e.g. genetic susceptibility.

However, while some important steps may be taken to improve our own general health, reducing the susceptibility of an entire population to the Covid-19 virus will probably require a *vaccine* that will not be generally available to the wider population for, at least, 2 years and possibly much longer. If so, it might be realised that this future vaccine may not provide any solution for the current pandemic, such that other interim solutions that only mitigate symptoms might have to be pursued in the shorter term. As such, these mitigation solutions may not necessarily help prevent infection, but may help increase survival rates, especially for those most severely affected. One line of research that is being prioritised is the potential to *'repurpose'* existing antiviral drugs in the hope that they may also provide an effective treatment for the Covid-19 – see video *Repurposing Existing Drugs* for a general overview of possibilities currently being researched. Another line of research being pursued is the use of *natural* and *synthetic* antibodies to the Covid-19 virus that might provide almost instant immunity to the virus, although it might only work for a limited time.

Note: The role of antibodies *within the* immune system *is very complex, which research is only beginning to understand. However, medical literature published during the Spanish flu pandemic of 1918 includes case reports describing how transfusions of blood products, obtained from survivors, may have contributed to a 50% reduction in death among severely ill patients. However, natural antibodies obtained from blood plasma of survivors is time-consuming in terms of the volumes required and may only have limited shelf-life, which is why some researchers are now focused on the production of synthetic antibodies that may provide some protection up to 60 days.*

Despite all these possibilities, most will not be available to the general public within the expected phase-1 timeframe of the current pandemic. In this context, the best advice appears to be to try to avoid the risk of infection, when and wherever possible.