Introduction

Panda (Pandemic ~ Data Analysis) is a multidisciplinary initiative seeking to inform policy choice in the face of COVID-19. All choices entail trade-offs, yet we see few signs of such trade-offs being evaluated coherently by policymakers and their advisors—globally. Our initial research project seeks to measure the benefits and harms of South Africa's lockdown policy.

Currently, we employ a "years of lost life" approach to comparing benefits and harms. This avoids the false dichotomy of "lives versus the economy". Viruses kill. But the economy sustains lives and poverty kills too.

Our latest estimate is that South Africa's lockdown will cause a loss of life at least 29x greater than the loss of life it stands to prevent.

It would be no exaggeration to say that each week of continuing lockdown will, in the long run, result in more loss of life than the virus itself. In the face of this, economically restrictive lockdown measures should be discontinued immediately.

Our analysis can be summarized as follows:

1. Lockdown aims to save lives by preventing overburdening of the healthcare system.
2. The impact of the virus is heavily skewed towards already ill elderly people and those with severe comorbidities. The impact of the virus on the vast majority of the population, particularly the economically active and school children, has been massively overstated.
3. Emerging data show that the years of lost life from potential overburdening of the healthcare system is a small fraction of what it was originally conceived to be when most lockdowns were introduced.
4. In contrast, the impact of extended lockdown on years of lost life of the population is staggering, overwhelming its benefits.

The work we present here expands mainly on the last of these assertions. We estimate years of life lost owing to economic contraction caused by lockdown to lie in the range of 14 to 34 million. In contrast, we estimate the years of life lost to avoidable overburdening of health resources to lie in the range of 26,800 to 473,500. (The latter should not be confused with the number of COVID-19 *deaths* expected, which is much lower.) We derive our 29x multiple above by taking the low point of the economic contraction effect and dividing by the high point of the overburdening effect. Under a less conservative view, this multiple would be substantially higher.

Our methods and assumptions will no doubt be challenged, but the gap any challenges need to overcome in order to reverse this conclusion is enormous.

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We also address the salient questions of HIV and TB—our sense is that neither will present as substantial comorbidities, so that our second assertion regarding deaths being skewed to the old and infirm is not threatened.

Implications

Decisions made by governments in relation to COVID-19 should take account of health system capacity, their commercial sector's health and the extent to which fiscal and monetary policy can realistically mitigate fallout from actions taken to protect health systems. They should balance the loss of life from COVID-19 overburdening their health systems with the loss of life expectancy flowing from the long-term economic impact of lower incomes that result from restrictive lockdown measures.

Middle-income nations need to tread particularly carefully, as a substantial portion of their populations are separated from poverty by the slimmest of margins. Their governments are also far more constrained fiscally and administratively to compensate for adverse economic situations. Consequently, even small changes in incomes can have a big impact on life expectancies.

Countries where the economic impact on life-years of a full lockdown would be much larger than that of the virus should devise different strategies:

- A smarter form of lockdown is advised, incorporating measures to protect the very old and very sick.
- Restrictions on economic activities should be limited to mild policies, such as bans on large gatherings.
- Children should stay at school.
- Measures with negligible economic cost should be considered—such as mask-wearing and non-coercive public appeals for personal distancing and handwashing.

Our team's approach

Panda's technical team brings to bear knowledge from the fields of actuarial mathematics, economics and medicine and is continually recruiting. Membership is on a volunteer basis and independent of any institutions or political parties.

We will continue to refine our work and welcome criticism. We have sought to make our models "as simple as possible, but no more so", rejecting refinements that do not affect the ultimate answer. We aim to disclose everything that a skilled reader might require to understand and reproduce our results.

Methodology

Before we confront the cold logic of actuarial mathematics, it is worth pointing out that *any* life lost is a tragedy for all involved. The purpose of this work is not to trivialise or diminish the value of any individual who dies. Net harm analyses are ethically fraught, but necessary to inform choices that must be made in order to reduce harm at a societal level. We must also sympathise with the policyholders whose lot it is to negotiate such choices.

Throughout, by “lockdown”, we mean the highly restrictive form of the phenomenon that is in place in South Africa, including its stage 4 and 3 forms.

The primary concept used in this analysis is called “years of life lost”. The years of life lost when someone dies from some impact corresponds to that person’s remaining life expectancy at the point when that impact occurs. We can sum this measure across a population to estimate the aggregate years of life lost (YLL) to an impact. We are interested in two impacts—the impact of COVID-19’s potential to overburden our healthcare system and the impact of economic contraction stemming from lockdown.

This class of measure is used extensively to assess the effects of health policy choices, for example when trying to allocate scarce healthcare resources to addressing the burden of communicable diseases. The basic formula for YLL, is:

$$YLL = N \times L$$

where:

- N = number of deaths
- L = remaining life expectancy at age of death in years

We estimate the YLL associated with each of the two impacts to assess the wisdom of continuing with the current state of lockdown.

Benefits of lockdown

Lockdown is premised on a strategy of “flattening the curve”. The idea is that it spreads the deaths expected from the virus over time, so that the hospital system is not overburdened.
It saves lives to the extent that avoidable deaths are prevented, but merely shifts the timing of the rest by some weeks.

Estimates of deaths avoided are a function of epidemiological forecasts—in particular of the number of serious cases that will emerge—and of the capacity of the healthcare system to deal with them. We propose a very conservative (i.e. high) measure of such deaths prevented by avoiding overburdening, deriving from it an estimation of the years of life lost to overburdening (YLLO).

Our current range of estimated YLLO, which represents the years of life saved by lockdown, is 26,800 to 473,500.

Harm from lockdown

Lockdown has caused a sharp contraction in production and exchange in the economic system, some of which will likely only recover over years rather than weeks or months. The temporary and permanent aspects of that contraction have an impact on the ability of millions to make a living.

Reduced income has long been known to cause a material decrease in life expectancy. We deploy methods from the insurance industry and poverty studies to estimate this decrease. This decrease in life expectancy is then used to calculate the YLL due to the economic impact of lockdown which we will call YLLE.

Our current estimate of YLLE, which represents South Africa's years of life lost to lockdown, is in the range of 14 million to 34 million.

Quantifying years of lost life

Calculating years of lost life from overburdening (YLLO)

There are two stages in calculating YLLO:

1. Calculating YLL for an average COVID-19 death, combining the proportion of deaths and average life expectancy per risk group.
2. Calculating YLLO, i.e. increased deaths without lockdown.

Calculating YLL for an average COVID-19 death

Globally, it is apparent that two factors have a central influence on the impact of COVID-19 on a population—population age structure and comorbidity prevalence. The older the group and the worse their comorbidities, the worse their prognosis becomes. Conversely, younger age groups with no comorbidities experience a negligible impact. Their survival probability is essentially almost 100%.

Using actuarial models of life expectancy for different ages and those living with comorbidities in South Africa, we apply emerging death rates per age band to the age distribution in South Africa. This results in an estimate for the average expected years of life-lost per COVID-19 death in South Africa. Finally, this is multiplied by the total deaths in different scenarios, where the underlying distribution of deaths can be expected to remain the same, and result in the YLLO scenarios.

The data for COVID-19 deaths in a South African context remains sparse with just 131 deaths having occurred in the first 60 days of the epidemic. As more deaths and hospitalisations emerge we can place more emphasis on that data, but until then we need to draw inferences from global data.

New York State and New York City have done by far the most testing, and have the highest number of positive cases and deaths to date. Their data is accessible and as clean as we can hope for, so many of the conclusions are drawn from this dataset. Other death data from countries in more advanced stages, as well as detailed comorbidity data from Italy is used to support this data.

In order to apply the New York data to a South African context, it is important to understand the COVID-19 mortality rate between different age groups and then overlay these mortality rates to get a potential spread of deaths across the South African population by age, despite South Africa having a slightly higher prevalence of diabetes and hypertension.

This source data from New York City was used to derive the deaths per 100,000 in New York City. https://www1.nyc.gov/site/doh/covid/covid-19-data.page

At 30 April 2020, the death rate per 100,000 by age band showed an exponentially increasing risk with age. This can be seen in the graph below, which highlights the low risk of death for under-65s.

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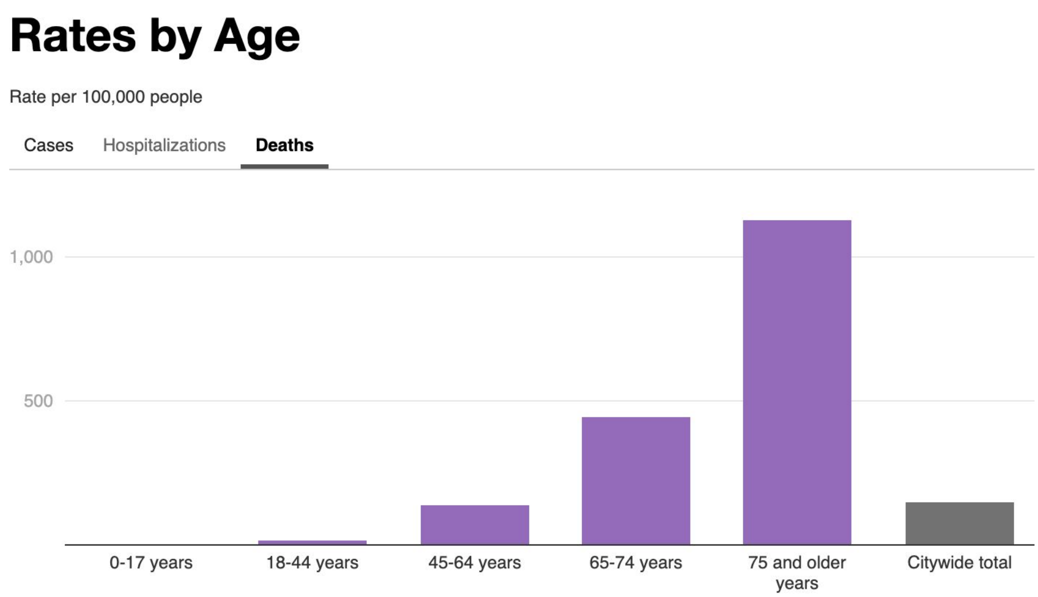
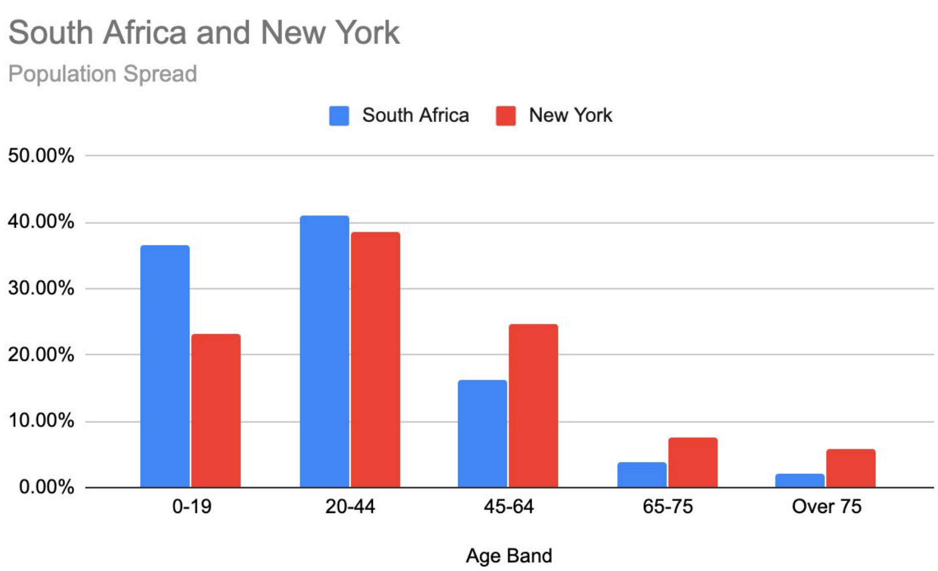


There will be more deaths in New York City and elsewhere in the coming days and weeks. For the purposes of this exercise, we are interested in the distribution of these deaths across age bands. We do not expect these further deaths to change this distribution that much.

South Africa's age demographics are markedly different from New York City's, and the relative proportions are shown below:

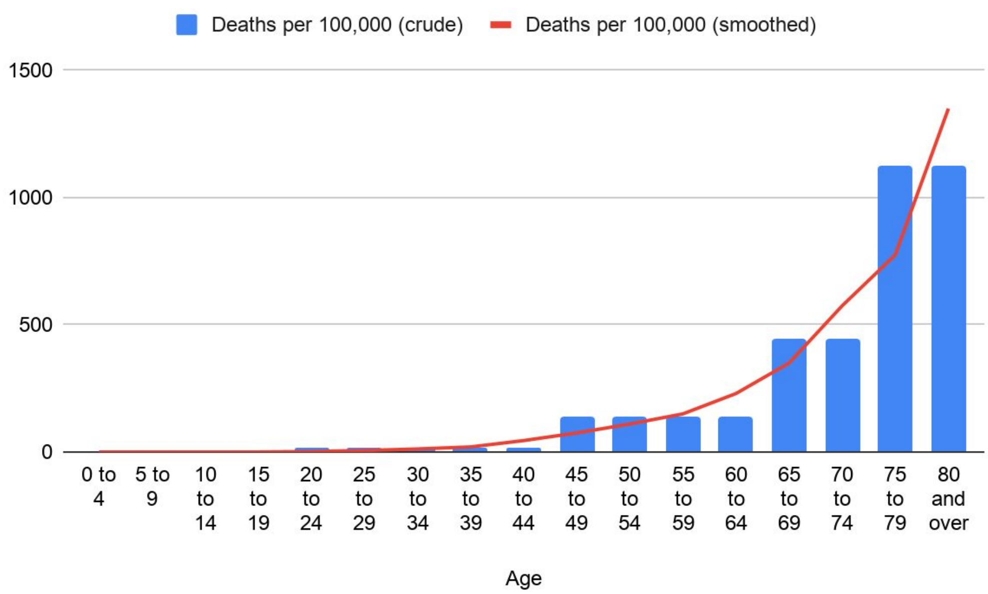


Sources [NYC]() and [StatsSA]()

Proportion of deaths per age group in South Africa

To avoid misinterpretation, we note that the above death data are reported per 100,000 of population and not per 100,000 cases or infections.

The data available from New York City shows the deaths per 100,000 population in fairly wide age ranges. In order to estimate the potential proportional spread of deaths in South Africa with our own age distribution, we calculated the smoothed deaths per 100,000 population in more granular five-year age bands. The graph below demonstrates this curve, which resulted in the same number of estimated total deaths in New York City and is a good approximation of the potential deaths per 100,000 population by five-year age band.



Applying this to the South African population suggests that the death experience in South Africa will be spread across age groups as follows:

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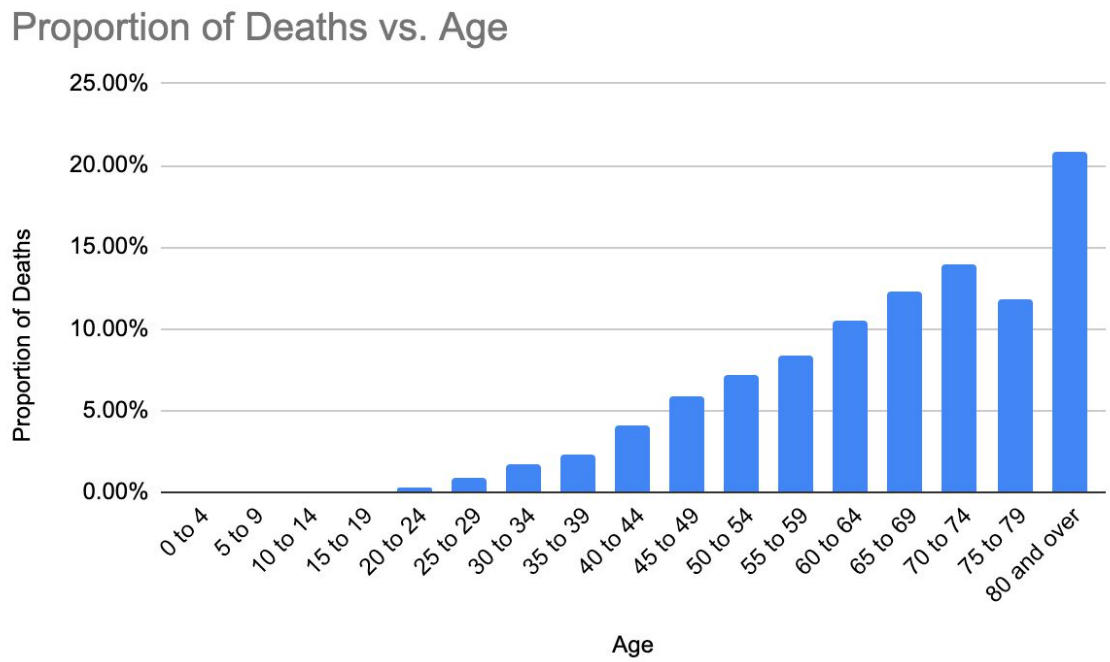


Observed experience in South Africa fits this, with approximately 40% of deaths being below the age of 65 in our model and in reality.

Calculating the years of life lost per COVID-19 death

Prevailing data suggests that years of life lost when a person dies from COVID-19 depends primarily on that person's age, gender and number of serious comorbidities. We draw our assumptions for this from observed experience in other countries.

It is clear that COVID-19 patients with severe comorbidities have worse clinical outcomes than those with no known comorbidities. Data from 14 April 2020, showed that in New York City, 97.4% of deaths occurred in patients with at least one comorbidity, including diabetes, lung disease, cancer, immunodeficiency, heart disease, hypertension, asthma, kidney disease and GI/liver disease.
(https://www1.nyc.gov/assets/doh/downloads/pdf/imm/covid-19-daily-data-summary-deaths-04152020-1.pdf)
(https://www.worldometers.info/coronavirus/coronavirus-age-sex-demographics/)

Italian data present a very similar story, with 96.4% of deaths occuring with one serious comorbidity present and 60.9% with three or more. (https://www.epicentro.iss.it/en/coronavirus/bollettino/Report-COVID-2019_23_april_2020.pdf)

The Italian data give us a good idea of the proportion of people who have underlying comorbidities. As of 28 April 2020, the proportion of comorbidities by sex for fatal cases is as follows:

Comorbidities	Male	Female
0	4.54%	2.36%
1	14.87%	13.61%
2	21.30%	21.73%
3+	59.29%	62.30%

Using this information we can estimate the excess mortality (EM) of those dying with Covid-19.

Life insurers typically place EM loadings on insurance applicants based on comorbidities. The loading depends on the age of the applicant, with the younger the applicant, the lower the EM loading. With increasing age, these conditions become more difficult to control with medication, and complications often develop, which explains the increasing EM with age.

The following table shows the EM loading per comorbidity. Naturally the EM differs per actual comorbidity in practice (with less severe pre-existing conditions getting lower or no EM loadings and vice versa) however the figures used below are appropriate averages to use based on the types of comorbidities linked most commonly with COVID-19 deaths.

Age Band	Excess Mortality per Condition
20-30	50%
30-40	100%
40-50	150%
50-60	200%
60-70	300%
Over 70	350%

In addition, when more than one comorbidity is present in a single applicant, the effect is not additive. In order to take this into account, the sum of EM loadings is increased by a factor of 10% where there are 2 comorbidities and 20% where there are 3 comorbidities.

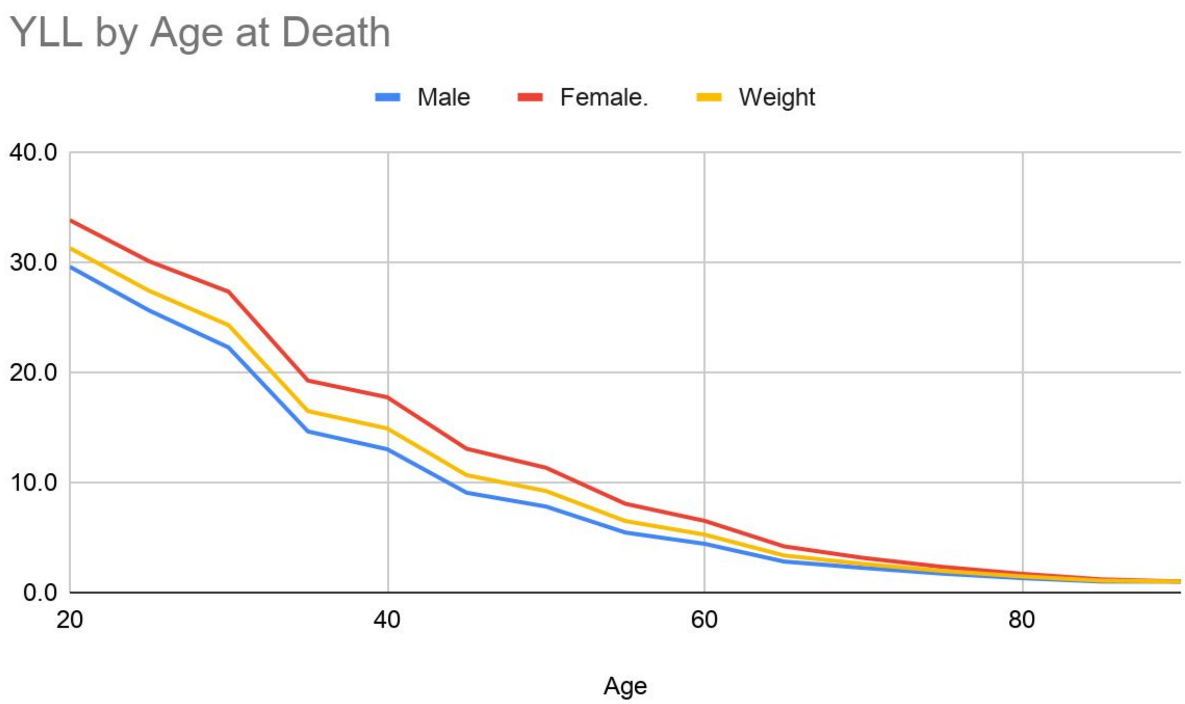
Combining all this information together means that we can get a weighted average comorbidity, by both age band and gender, for COVID-19 deaths.

Key Assumption: in the absence of data, we are assuming the mixture of additional comorbidities is consistent across age bands.

Age Band	Weighted EM Males	Weighted EM Females
20-30	138%	143%
30-40	275%	286%
40-50	413%	429%
50-60	550%	571%
60-70	700%	700%
Over 70	700%	700%

Note: These EM loadings are typically used in a life insurance context for comparison with a peer group with zero heavy comorbidities. As the general population ages, it becomes increasingly common to find comorbidities in the general peer group, so at older ages the additional EM wouldn't be as severe as suggested by life industry loadings. In order to compensate for that, we both capped the total EM at 700% at the older ages (despite the method suggesting higher) and set the life expectancy at a minimum of 1 year in cases when the model projected a sub year life expectancy at the older ages.

Based on these excess mortalities applied to an underlying population life table (ASSA 2016), we can determine the expected life years per person in each age band and sex. We weight the numbers 60% towards the male figures to get a weighted average, based on the observation that more COVID-19 deaths are attributable to males.



The vertical axis represents the life expectancy in years, with age at death on the horizontal axis. For example, a COVID-19 death at age 40 would have a life expectancy of 13.0 years for males and 17.7 years for females.

As explained before, based on the NYC distribution of deaths by age, and taking into account the age demographic of the South African population, we estimated the distribution of COVID-19 deaths for South Africa.

We can then build a weighted average of YLL per COVID-19 death by applying this distribution to the YLL calculated per age above.

This gives us an estimate of **5.4 years of lost life per COVID-19 death.**

Total years of life lost from COVID-19

We use the following three estimates combining with the average YLL to get total YLL:

1. Internal estimate: **20,000** COVID-19 deaths (still a work in progress)
2. Current New York deaths translated directly to SA and applying NYC population fatalities to South African demographics: **40,000 deaths**
3. “Low Road Scenario” of COVID-19 deaths from the Actuarial Society of South Africa: **88,000 deaths**

Based on the potential total of COVID-19 deaths we might experience in South Africa, the sum total of COVID-19 deaths could amount to the following.

Potential Total Deaths	Deaths	Total YLL
Scenario 1 - Internal estimate	20,000	104,808
Scenario 2 - New York Deaths	40,000	209,615
Scenario 3 - ASSA Low Road	88,000	461,154

A few observations regarding these numbers are in order. We find the ASSA Low Road scenario to be highly implausible. It entails deaths of 1,500 per million of population. Many European countries are clearly well past their epidemic peaks and not experiencing any resurgence of deaths as they relax their lockdowns. Spain, for example, has a similar population size to South Africa. Its death toll stands at around 25,000 and its current rate of daily deaths is less than 300 per million, despite its lockdown having been substantially eased. When all is said and done it would be surprising if its cumulative death rate exceeded 600 per million, which would be one of the worst in the world.

Applying our age-based fatality and population estimates from above, South Africa should expect to end up at about one third of Spain's level of death, or 200 per million. This would imply around 12,000 deaths, and this works off one of the worst country experiences in the world. Performing the same calculation on "no-lockdown-Sweden", also past its peak, we would estimate fewer than 8,000 deaths for South Africa. Using past-peak Iran as a proxy we arrive at 5,000. This adds further weight to our suspicion that projected deaths are still being wildly overestimated. Combined with an observation that no country's epidemic has ever manifested as exponential, we tentatively surmise that the attack rates employed in these models are way too high and that the entire model class being applied is inappropriate. If we are correct, then our analysis of lockdown's ratio of harms to benefits will move from overwhelming to infinite.

So far, South Africa's age distribution of deaths is very close to what our simple age-based approach implies, leading us to believe that models estimating more than 20,000 deaths for our country may be well overblown. In relation to this, it is worth remembering that our lockdown was introduced when estimates of total deaths were in the order of 350,000.

Implicit in this perspective are the following observations:

- TB is not showing up as a risk factor. It is noteworthy that Indonesia, which has a more advanced epidemic and high TB prevalence is not exhibiting high TB-related fatalities either.
- HIV, managed or unmanaged, is not showing up as a risk factor. In relation to our population of people who are old and very sick (numbering in the hundreds of thousands), our unmanaged population of HIV cases is in the range of 1.5 to 3.0m. If these represented highly at risk people, they would be representing a majority of deaths

by now, which they aren't. Indeed, it appears that the rate of prevalence of HIV among South Africa's deaths is below the population prevalence rate, thought it needs to be noted that we are dealing with very small samples.
- Socio-economic factors seem to be inversely correlated with aggregate fatality rates, *after adjusting for age distributions.* This may be a story of epidemic progress being slower in poor countries, but as time passes this explanation begins to look weak.

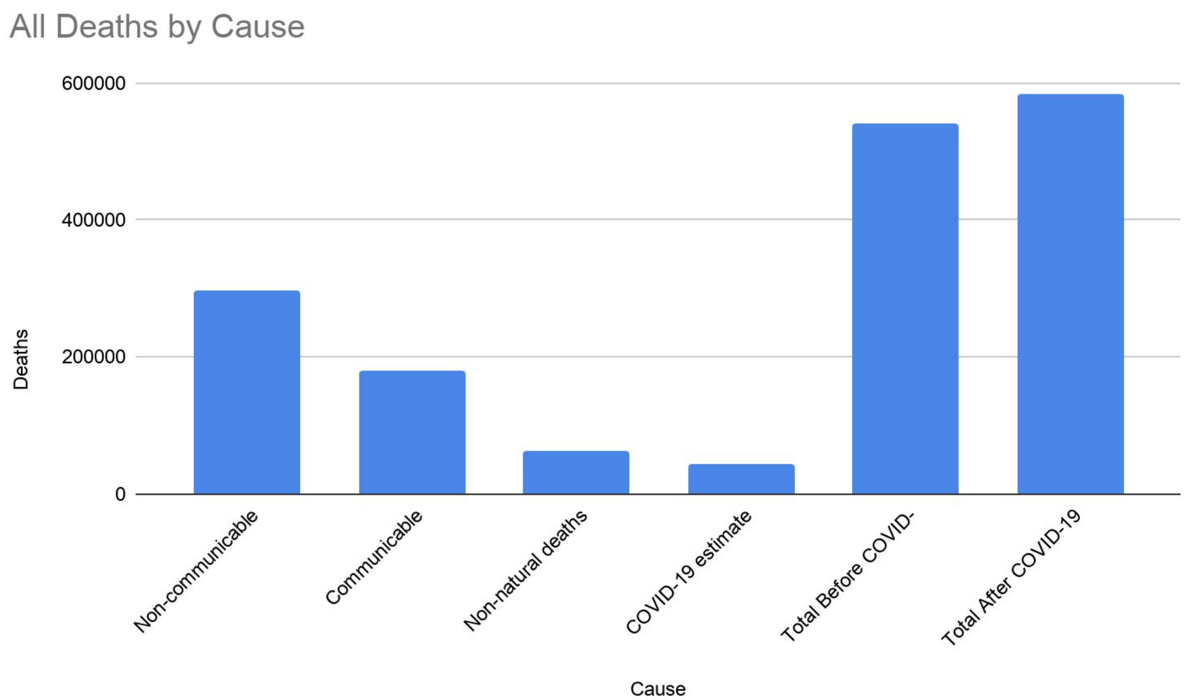
Please note that our headline ratios do not use this number, but the Scenario 3 value. We are developing a model using an entirely different approach from the conventional epidemiological models that have led the world to implement such strict lockdowns, but are not ready to publish details. For the time being, we are putting up our 20,000 estimate as a marker, with a sense that we might bring it down or decide that it is the top of our range..

Contextualising the death counts

South Africa's current rate of mortality is approximately 9.2 deaths per 1,000 population per year. With a population of 58.7 million, this implies annual deaths of approximately 540,000.

According to StatsSA, 55% of total deaths (297,000) result from noncommunicable diseases, 33% (180,000) from communicable diseases and the remaining 12% (63,000) from non-natural causes. 45,000 COVID-19 deaths would represent 25% of the deaths from other communicable diseases.

The Thembisa model estimates that 89,000 South Africans died of AIDS-related causes in 2017, down from a peak of around 270,000 in 2005.



Calculating YLLO

It is important to note that the total YLL figures above calculate the impact of the virus, not of the benefits of lockdown. The point of lockdown is to "flatten the curve", meaning that these modelled deaths are expected to occur, with some marginal mitigation, with or without lockdown. We find it implausible that a vaccine or cure will be discovered this year, manufactured in massive quantities and distributed before the majority of modelled infections and deaths have occured.

Whether coercive lockdowns do indeed "flatten the curve" relative to natural popular adaptation and, if so, by how much, are open questions, and ones that will only be answered in the fullness of time. It's a deeply difficult problem-set to analyse as there are many variables moving at the same time—severity of measures taken, testing rates and strategies, prevalence of susceptibility determinants, density effects and knowledge of the shape of the epidemic's natural progression curve. Sweden and non-lockdown states in the US will provide useful data points.

Estimating the number of deaths that will be attributable to relative overburdening of the South African healthcare system is very challenging. In many cities the system is overburdened all the time, with patients lying in corridors and quite aggressive triage systems in place. We nonetheless take a generous interpretation, supposing that:

- lockdowns do indeed flatten the curve, bringing peak death rates down by, say, 50%;

- elimination of peak deaths avoids a doubling of case fatalities above this 50% level during the month around the would-be peak.

Gauging from time-distributions of deaths in countries that have passed their peak daily deaths, we think it is not plausible that extra deaths from overburdening will exceed 20% of total epidemic deaths, noting that these would include deaths from causes other than COVID-19. We conservatively apply country-average remaining life expectancy of 26.9 years to these deaths to derive a measure of years of life lost. For the “Low Road” Scenario 3 this translates into YLLO of 473,500, approximately equal to that worst case YLL estimate for the epidemic as a whole. We note that a substantial portion of COVID-19 deaths, particularly among the very old and frail, who constitute the majority of cases, occur outside of a hospital setting or before they make it to high care or ICU. These would not be as affected by hospital overburdening, making our 20% loading even more conservative. We also ignore the potential effect of triage practices that have anecdotally been undertaken in New York and Italy, in terms of which younger cases, for whom hopes of recovery were higher, were given preferential access to high care and ICU facilities. The effect of this would be to reduce the years of remaining life expectancy we apply by a large amount. Furthermore, the fatality rates deployed in the underlying epidemic model already encompass a significant element of the overburdening effect. Our overall sense is that our worst case YLLO estimate will decline significantly as we learn more and apply our minds.

For Scenario 1, our least severe epidemic forecast, it seems likely that local overburdening will still take place—possibly at a quarter as many places. We thus load the total epidemic deaths by 5%. Applying the same remaining life expectancy for these deaths we arrive at YLLO of 26,800. Similar observations regarding out-of-hospital deaths and triage practices apply.

Given the number of variables at play, this wide range for YLLO of 26,800 to 473,500 is not surprising. We hope to refine this measure further as we do more work.

In particular, we expect to pay attention to the time variation of case fatalities in other countries where hospitals are overburdened. We note that ICU outcomes have been particularly bad, with survival rates as low as 20% being seen, and that hospitalization death rates have also been quite high.

Calculating YLL from the economic impact of continued lockdown

Economic impact of lockdown

The economic impact in South Africa from the lockdown is severe and will have effects that last well beyond 2020. National Treasury has estimated that the number of jobs lost could range from 3 to 7 million depending on the length and severity of lockdowns. Our work shows that a 10-15% decline in GDP in 2020 is plausible based on the current lockdown strategy being adopted by the government. This estimate is echoed by National Treasury’s own scenarios. We estimate this would be associated with an initial decline in employment of around 2.5 to 3.3 million. Extending lockdowns into the second half of 2020 would start to see National Treasury's more pessimistic employment scenario come into play.

The challenge resulting from major economic crises is that their effects tend to last for many years. From the 2008/09 recession, it took South Africa's economy two years to return to its pre-crisis levels, and overall employment took five years to recover all losses. In the same period, the United States took four years to surpass pre-crisis GDP levels, and six years to match previous employment levels. In the Euro Area, this took seven years and six years respectively.

Recoveries can take a very long time due to policy responses and knock-on effects of the downturn into banking and financial risks which impact the real economy negatively and require further policy choices that may again hamper recovery.

Depending on economic policies adopted during and after the particular crisis, some employment and business opportunities may take as long as 5 to 10 years to remerge and some may never return depending on the nature of a specific crisis or the policies adopted.

The empirical record shows that in the 2008/09 financial crisis and recession in South Africa, the bottom half of skill and pay grade occupations accounted for nearly 80% of the initial job losses and also were slowest to recover, accounting for less than 30% of all employment gains from 2008 to 2020. Several of these occupations did not recover back to their 2008 peaks for 5 to 10 years after the recession.

People with fewer marketable skills and access to capital, networks or experience struggle hardest to re-enter the job market in the wake of a crisis.

Conservatively, we estimate that, of the jobs lost due to a continuation of lockdown, around 500,000 to 750,000 will be unlikely to return quickly. These jobs indirectly support approximately two to three million people. The long term job losses are expected to occur disproportionately among the lower half of the income scale. This will force mainly people in the lowest socioeconomic levels into even harder living conditions, and a proportion of people living just above the poverty threshold will fall into poverty.

In addition, even at the higher socioeconomic classes, there will be a meaningful number of South Africans who experience a fall in socioeconomic status, though they may not fall into absolute poverty.

From economic impact to YLLL: Method 1

In South Africa, socioeconomic class is a strong predictor of mortality (and therefore life expectancy). Between the very lowest and very highest socioeconomic class, the mortality rate has a range of 500%. It's noteworthy that this range of excess mortality refers to an insured population, which in South Africa is a large subset of the general population. In reality the difference in mortality rate between the highest socioeconomic class and lowest in the general population would far exceed 500%. We have chosen to use 500% to err on the conservative side of the estimations.

In other words, the lowest socioeconomic class experiences a chance of death each year that is five times heavier than the best class.

Life insurers have traditionally used either four or five socioeconomic classes to determine underlying mortality for pricing life insurance, with the difference between each class commonly being an additional 100% extra mortality.

We believe that it is conservative to assume that at least 10% of the South African population will experience an increase of at least 100% in relative mortality. In other words, 10% of the population may experience a drop in one level of socioeconomic class.

It is also conservative to assume that this impact will not be permanent. We model that this impact is in place for only ten years, after which the pre-crisis mortality experience is experienced.

Therefore, in order to determine the YLL for the South African population, we can estimate the change in life expectancy for the population before and after adding this incremental extra mortality.

Age Band	YLL per person	YLL Total
0 to 4	0.06	334,939
5 to 9	0.05	271,941
10 to 14	0.07	380,134
15 to 19	0.13	631,331
20 to 24	0.22	1,101,000
25 to 29	0.31	1,687,789
30 to 34	0.34	1,889,314
35 to 39	0.34	1,559,123
40 to 44	0.33	1,188,492
45 to 49	0.33	999,832
50 to 54	0.35	864,295
55 to 59	0.37	808,145
60 to 64	0.39	710,638
65 to 69	0.42	584,682
70 to 74	0.43	429,718
75 to 79	0.43	255,523
80 and over	0.41	248,517
	Total	**13,945,412**

This calculation shows that for the average South African, life expectancy may reduce by between 0.43 years and 0.05 years. Applying this to the South African population results in a total YLL of approximately 14 million.

A more aggressive assumption—that the average South African experiences increased mortality of 25% for a period of ten years—YLL exceeds 34 million years.

It is worth noting that lives lost through the impacts of poverty are going to be harder to measure and are typically not in the public eye. In addition, the impact on mortality through falling socioeconomic class, while very real, will not be immediate since there is a lag between falling incomes and socioeconomic class and actual deaths. Therefore, while there may be a delay in the deaths from the restricted economy, our estimate of the total YLL remains unchanged.

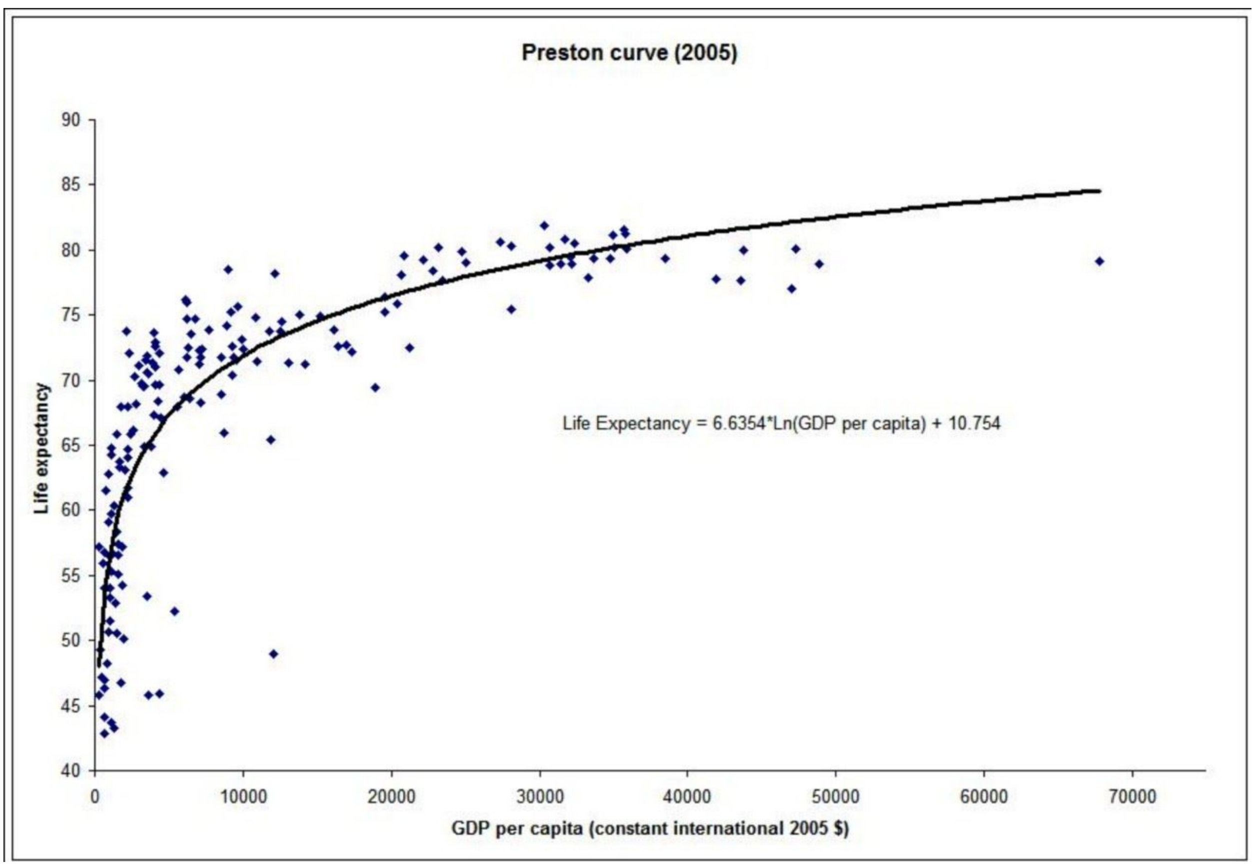
From economic impact to YLLL: Method 2

In order to challenge the results of Method 1, we approached the same problem using a different method.

The Preston curve is an empirical cross-sectional relationship between life expectancy and real per capita income. It is named after Samuel H Preston who first described it in 1975. Preston studied the relationship for the 1900s, 1930s and the 1960s and found it held for each of the three decades. More recent work has updated this research.

The Preston curve can be expressed using the following formula.

Life expectancy = 6.6354 * Ln (GDP per capita) + 10.754



South Africa's 2018 GDP per capita was $6,374. According to the Preston curve, this would imply a life expectancy of 68.9 years. South Africa's actual life expectancy is a few years lower than this due to the continuing impact of HIV.

However, the Preston curve might give us an idea of a potential change in life expectancy with a change in GDP per capita. Estimates of the GDP impact of a continuing lockdown on the economy range from 5% to 10%, which gives a projected life expectancy of 68.5 and 68.2 respectively.

This translates to a loss of life expectancy range of between 0.70 and 0.34 years.

Applying these to the South African population of 58.7 million indicates that the YLL could fall between 20 and 41 million YLL.

While this method is somewhat crude, it does lend credibility to the results from Method 1, which conservatively estimate YLL of 14 to 34 million.

From economic impact to YLLL: Method 3

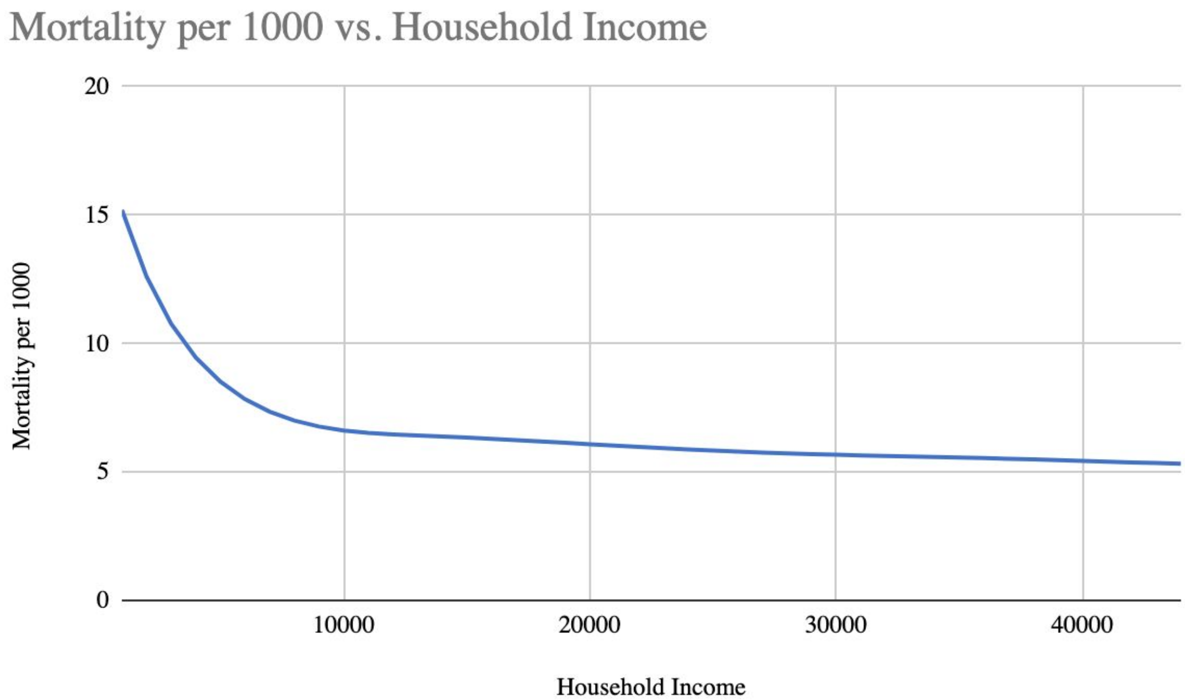
We considered this question from one further angle. Based on economic data from the 2008 crisis where jobs were shed, both the burden of the job losses and the subsequent recovery of those job losses were felt hardest in the lowest five employment deciles (the bottom 50%).

While the projections of job losses are in the range of 3 million, there will be a subset of those jobs which may be lost on a semi-permanent basis. We estimate that the number of jobs lost on this basis will range from 500,000 to 750,000 jobs. Assuming that each of these jobs support 3 additional people, the net number of people directly impacted would amount to between 2 million and 3 million people.

Based on the 2008/09 recession experience, roughly 80% of these long term job losses are likely to be experienced by the bottom 5 earning deciles. This means that between 1.6 million and 2.4 million of the lowest income earners stand to lose their jobs and their incomes on a semi-permanent basis.

For insurance purposes, income is not the only contributor factor in determining socioeconomic class, yet it is a primary driver of mortality predictability. Industry pricing data suggest that the relative impact on mortality by monthly household income looks as follows.

DRAFT VERSION



The average mortality for the South African population is 9.2 deaths per 1000. Taking only income into account and combining it with income data from a number of StatsSA surveys, we can estimate that the death rate per thousand could have the following profile shown in the graph above.

As can be seen, the impact on increased relative mortality is steepest at the lower end of the household income spectrum. Again, this curve is representative of an insured subset of the general population, and therefore underestimates the total impact.

The highest income earners may experience a mortality rate of 5.3 deaths per 1,000 while the lowest income individuals may have a mortality rate as high as 15.2 deaths per 1,000. As discussed under method 1 above, this curve is likely still a conservative estimate since it reflects the shape of an insured population. The difference between the highest income and lowest income earns is likely to exceed the 10 deaths per 1000 shown here.

This is a crude approximation but we believe that the shape may actually be more extreme for the following reasons:

- This assumes that smoking prevalence is stable across income groups, yet there is a high incidence of smoking as income decreases.
- This assumes that average levels of education is stable across income groups, and education is another strong proxy for socioeconomic class

- Working in the other direction, higher income groups would be older on average

The median income in the lowest 50% decile is approximately R6000 per month (Stats SA surveys). Assuming that one individual moves from this level of income to an income in the region of the government social grant, they would experience an increase in mortality of 7.4 deaths per 1,000 using this conservative approximation.

Summing this across 1.6 million people means that on average, the number of deaths in a given year would increase by approximately 11,800. In the worse scenario, with 2.4 million people falling from an average income of R6,000 would result in approximately 17,700 additional deaths per year.

In the same way we calculated the YLL for an individual COVID-19 death, we can estimate the average YLL for any South African death taking into account the mortality rate, age and gender demographics in South Africa.

This number comes to 26.8 YLL per death in South Africa.

We assume that these jobs are lost on a semi-permanent basis, and many of them may never come back. We might assume that the recovery of these jobs would happen over time, but given that these are approximate calculations, and we are ignoring the millions of job losses that would occur on a more temporary basis, for simplicity we have assumed that these jobs are lost for a period of ten years, and no more.

Using this simplification, we can crudely estimate that an additional 118,000 to 177,000 lives will be lost over a period of ten years as a result of semi-permanent job losses experienced by the most vulnerable workers in our society.

Applying the YLL per death gets us to a total YLL of between 3.1 million and 4.7 million. As expected this number would be lower than the 14 million calculated earlier since here we are only measuring a subset of the impacted individuals, and the assumptions used to do the calculation are crude and conservative. In addition, we are ignoring the other factors which contribute to an even higher increased mortality with worsening socioeconomic classes.

It's worth pointing out that we do not predict the timing at which these extra deaths will occur. There will be a lagged effect of loss of income to deaths as poorer nutrition, living conditions and healthcare take their toll on the new poor.

Negative mortality impacts of lockdown not included

Many sources highlight issues such as curtailed cancer screening and immunization programmes, deaths arising from reluctance to visit hospitals (especially following heart attack and pancreatitis problems) and the like as factors that count against lockdown, with some claiming that their impact alone could negate the benefits of lockdown. Given that the effect size of our primary economic calculations dominates these, we have not taken account of them. We also note that it is difficult to assess how many of these would occur anyway, with the storm cloud of the epidemic creating enough fear even absent a lockdown.

Conclusion

Bringing this all together:

- COVID-19 is expected to cost up to 476,000 years of lost life.
- Lockdown benefits may prevent an incremental 26,800 to 473,500 years of lost life.
- Lockdown is estimated to cost at least 14 million years of lost life.

Comparing the highest, yet least likely, end of the potential YLL from COVID-19 deaths of 476,000 years to a conservative estimate of YLL as a result of economic collapse of 14,000,000 years suggests that the economic impact on lives will be in excess of 27 times greater than impact of the virus itself.

Even if you disagree with our methods or our parameter choices, what our work surely highlights is the need for policymakers to assess trade-offs amid the current crisis. Advisors to government are ethically bound to include estimation of harms from the economic contraction. Our work proposes proceeding by taking a “years of life lost” approach. We estimate that continuation of lockdown in its current form entails harms that outweigh benefits by a factor of at least 29x. In light of this, continuing with such a restrictive and economically damaging lockdown would be a moral outrage.

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