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Life and Death During the First Six Months of the COVID-19 Pandemic: An analysis of cross-country differences in changes in quantity and quality of life

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Life and Death During the First Six Months of the COVID-19 Pandemic: An analysis of cross-country differences in changes in quantity and quality of life*

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Abstract

This study carries out a cross-country analysis of changes in quantity and quality of life during the first six months of the COVID-19 pandemic (11 March to 11 September 2020) for 124 countries. Changes in quantity of life are measured as life years lost to COVID-19, including excess deaths not officially reported as COVID-19 deaths. Changes in quality of life are proxied by the average change in daily mobility, compared to a pre-COVID baseline. We find a significant negative correlation between the two, meaning that the countries with the biggest reductions in mobility are also the countries with the biggest losses of life years.

We calculate that about 15 million life years were lost during the first six months of the pandemic, corresponding to 0.006% of all expected life years. For comparison, at least three times more life years are lost every six months due to children dying of diarrhea. About 28 million life years are created every day from babies being born, so the first six months of the pandemic set us back about 14 hours in terms of quantity of life.

The setbacks in terms of quality of life are several orders of magnitude larger. Some countries have suffered more than a 50% reduction in mobility sustained over half a year, with devastating effects on many aspects of quality of life. Globally, the equivalent of 400 million full-time jobs were lost. GDP is estimated to have been set back about three years, poverty about five years, and the tourism industry about 20 years. The already large inequalities in access to quality education have been further widened, leaving hundreds of millions of disadvantaged children farther behind.

Even countries that have managed the pandemic relatively well are suffering large economic contractions due to the negative spill-over effects from other countries. We still have a long way to go before this pandemic is over, and we urgently need to course-correct in order not to cause even more harm than has already been done. The paper provides a series of recommendations on what needs to be done to minimize total harm.

JEL Classification: H12, I14, I18, I38.
Keywords: COVID-19, pandemic, life years, mobility, quality of life.

Resumen

Este estudio realiza un análisis comparativo de los cambios en la cantidad y la calidad de vida durante los primeros seis meses de la pandemia COVID-19 (del 11 de marzo al 11 de septiembre de 2020) para 124 países. Los cambios en la cantidad de vida se miden como años de vida perdidos por COVID-19, incluido el exceso de muertes no reportadas oficialmente como muertes por COVID-19. Los cambios en la calidad de vida están representados por el cambio promedio en la movilidad diaria, en comparación con una línea de base anterior a COVID. Encontramos una correlación negativa significativa entre los dos, lo que significa que los países con mayores reducciones de movilidad son también los países con mayores pérdidas de años de vida.

Calculamos que se perdieron alrededor de 15 millones de años de vida durante los primeros seis meses de la pandemia, lo que corresponde al 0,006% de todos los años de vida esperados. A modo de comparación, se pierden al menos tres veces más años de vida cada seis meses debido a niños que mueren de diarrea. Alrededor de 28 millones de años de vida se crean todos los días a partir del nacimiento de los bebés, por lo que los primeros seis meses de la pandemia nos retrasaron unas 14 horas en términos de cantidad de vida.

Los contratiempos en términos de calidad de vida son de varias órdenes de magnitud mayores. Algunos países han sufrido una reducción de más del 50% en la movilidad sostenida durante más de medio año, con efectos devastadores en muchos aspectos de la calidad de vida. A nivel mundial, se perdió el equivalente a 400 millones de puestos de trabajo a tiempo completo. Se estima que el PIB retrocedió unos tres años, la pobreza unos cinco años y la industria del turismo unos 20 años. Las grandes desigualdades en el acceso a una educación de calidad se han ampliado aún más, dejando más atrás a cientos de millones de niños desfavorecidos.

Incluso, los países que han manejado la pandemia relativamente bien están sufriendo grandes contracciones económicas debido a los efectos indirectos negativos de otros países. Todavía tenemos un largo camino por recorrer antes de que termine esta pandemia, y necesitamos corregir el rumbo con urgencia para no causar aún más daño de lo que ya se ha hecho. El documento proporciona una serie de recomendaciones sobre lo que se debe hacer para minimizar el daño total.

Códigos JEL: H12, I14, I18, I38.
Palabras Clave: COVID-19, pandemia, años de vida, movilidad, calidad de vida.

"There are lies, damn lies, and COVID-19 statistics"

Johan Norberg

"The numbers have no way of speaking for themselves.

We speak for them, we imbue them with meaning."

Nate Silver

1. Introduction and motivation

The COVID-19 pandemic, caused by the SARS-CoV-2 virus, has confronted people and governments across the globe with tough life-and-death decisions: Should grandma be allowed to hug her grandchildren? Should children be allowed to go to school? Should colleagues be allowed to enjoy a beer together Friday afternoon? Should teenagers be allowed to go to the beach? Would it be OK to go for a run in the park Sunday morning?

Viruses outnumber people on the planet by approximately 143,000,000,000,000,000,000 to 1[1], so there is no way to avoid being exposed to viruses. In addition, the only way that viruses can replicate themselves is to enter the cells of another organism, and convince the reproductive apparatus of that cell to reproduce the virus's genetic structure instead of its own. Thus, viruses totally depend on their hosts to survive, and have no interest in killing them. Most viruses have a favorite host, and do not harm that host, because that would be self-defeating.

However, once in a while, mutations occur that allow the virus to jump to another species, which is not used to live with that virus. Given the vast number of viruses involved, and their rapid rates of multiplication, this happens quite frequently. To deal with that, humans, and all other living organisms, have had to develop defense mechanisms. This defense mechanism is our immune system, which, through millions of years of evolution, has developed several layers of defense against the constant onslaught of potential pathogens. The human innate immune system includes barrier tissues with antimicrobial chemicals, white blood cells trained to recognize potential pathogens, macrophages that ingest and kill viruses, natural killer cells that destroy infected cells, cytokines and chemokines that send signals to other innate immune cells about ongoing problems, and much more. If the innate immune system is not enough, we have a second layer of defense called the adaptive immune system, which deals with particularly tough threats. This adaptive immune system includes cytotoxic T cells trained to kill what looks like a pathogen,

[1] See Microbiology by numbers (2011).

B cells which produce antibodies that bind to pathogens in order to neutralize them, and memory B cells which remember how to deal with a specific threat if it should encounter it again in the future[2]. The adaptive immune system can be activated either by direct infection or by vaccination, which is designed to mimic infection, and prompt the immune system to produce antibodies.

Our bodies usually manage all this without us having to think about it consciously. However, once in a while, a particularly nasty virus mutation will appear, and if we don't identify it quickly and eradicate it early, it may cause a worldwide pandemic with high excess mortality rates.

Due to the huge numbers of viruses involved, these dangerous mutations happen regularly, with almost mathematical precision. However, due to increased global travel, increased population densities, and increased industrial animal production, the risk of a dangerous pandemic has increased steadily over the past century, and these trends will likely continue and intensify. There has been no shortage of warnings about these risks, both from scientists and science fiction, and the global community has been developing systems to deal with particularly nasty mutations.

While we have become increasingly susceptible to a dangerous virus mutation, we have also become much better at dealing with the threat, as the scientific understanding of viruses has increased tremendously. One hundred years ago, nobody understood even the basics of the Spanish Flu, while this year scientists managed to sequence the whole DNA of the novel virus within a few weeks of discovering it, and made it publicly available in the GenBank database (accession number MN908947) on 10 January 2020. This allowed other researchers to immediately start to develop test kits to detect cases in other countries (ECDC, 2020).

While some countries were prepared for a pandemic, and more or less followed previously devised plans and strategies to manage the new virus, many others were caught off guard and had to make important decisions in the heat of the moment, based on scarce evidence. It is still much too early to make final judgements, but in this paper we take stock of the results of the decisions taken during the first six months of the pandemic in 124 countries across the world, in order to guide decisions for the next several months.

There seem to be two main types of countries in the world:

A. Those who reacted swiftly and managed to test, trace and quarantine people in order to control the outbreak and thus avoid both significant excess mortality and major interruptions to the general functioning of the country (for example, Taiwan, Vietnam, New Zealand, South Korea, and Sri Lanka).

[2] For a general overview of the immune system, see for example Maggini, Pierre and Calder (2018).

B. Those who did not manage to suppress the outbreak, either because they did not even try to (e.g. Sweden, Japan and Brazil) or because they couldn't (most countries in the World).

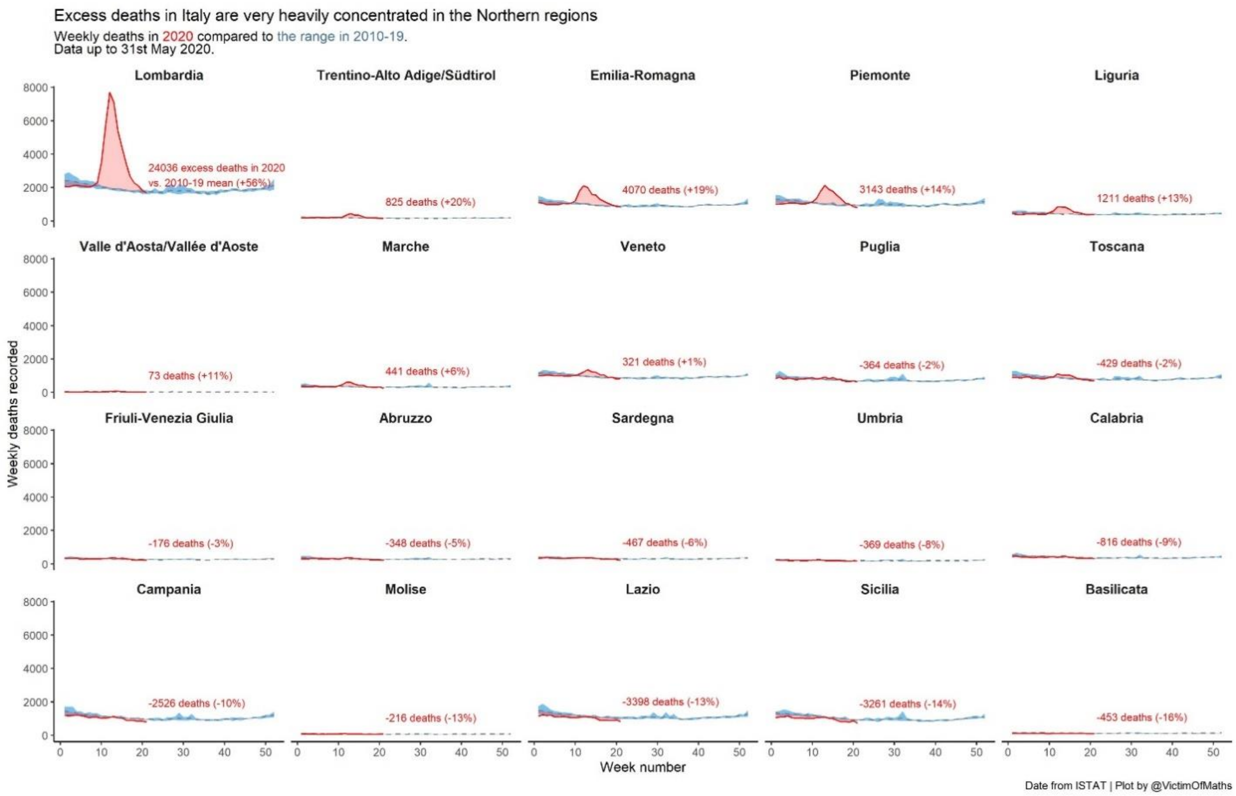
Type A countries are the envy of the World, but it is still too early for them to declare victory, as they are surrounded by type B countries where the virus is reproducing exponentially. Inhabitants of Type A countries have not had a chance to build up immunity, so they are still vulnerable to an undetected outbreak getting out of hand. Virus containment is a classic example of the chain being only as strong as its weakest link, and no country is safe as long as other countries are unable to control the virus.

Type A countries may be able to keep their populations safe through strict border controls and rigorous testing, tracing and quarantining until a vaccine has become available and widely deployed in order to reach population immunity. But it is simply still too early to tell if they can keep infections in check long enough. Several countries that did admirably well during the first wave, are now getting much harder hit by the second wave (e.g. Myanmar, Nepal, Czech Republic, Slovakia, Poland, Hungary, Greece, Israel, Tunisia, Morocco, Jordan, and others).

If we ignore Type A countries and concentrate only on Type B countries which have experienced significant spread of the virus, we still see very large differences in outcomes between countries. Some of these differences may be due to structural differences (such as differences in the age composition of the population, obesity rates, population density, quality of the health care system, etc.); some may be due to differences in behavior (such as working from home, wearing masks, using hand sanitizers, or maintaining physical distancing); and some may be due to differences in the timing of the pandemic, in the amount of testing, and in how cases and deaths are counted and reported.

Surprisingly, there can be very large differences in health outcomes even within the same country. For example, Figure 1 shows excess mortality in Italy by week and by region, comparing the first 5 months of 2020 to average all-cause deaths per week during the previous 10 years. Lombardy, a region in northern Italy which includes the metropolitan area of Milan, saw more than 24 thousand excess deaths between February and May, implying that at the peak of the outbreak the region saw 3 to 4 times the normal number of deaths. In contrast, the Lazio region, which includes Rome in the central part of Italy, saw 3,396 fewer deaths than normal during the first five months of 2020.

Figure 1. *Weekly deaths in Italy in 2020, compared to 2010-2019 average, by region*



Source: Colin Angus, University of Sheffield, UK (@VictimOfMaths twitter feed).

What can possibly explain such large sub-national differences in health outcomes? Is it just dumb luck? Or are there structural and/or behavioral differences that can explain the differences in health outcomes? Did some regions save lives, but at the cost of severe restrictions on the activities of the population? Is there a trade-off between lives and livelihoods? Or do regions that do well in terms of health also do well in terms of livelihoods?

These are the kinds of questions that we explore in this paper by analyzing the differences in outcomes for 124 countries in two main dimensions: Life and Death. Section 2 reviews the key literature that the paper is building upon. Section 3 describes the methodology and the data used. Section 4 shows the cross-country results. Section 5 explores a series of hypotheses about which structural and behavioral factors might explain the huge differences in outcomes between countries and regions. Section 6 attempts to put COVID-19 into perspective by calculating the magnitude of the setbacks in different dimensions of life and death. Finally, section 7 provides a summary as well as policy recommendations.

2. Key literature

Our paper builds on several other recent studies exploring how well different countries/regions have managed the pandemic so far. The paper is most directly related to the World Bank study by Decerf, Ferreira, Mahler and Sterck (2020) which estimates years of life lost (LY) and additional years spent in poverty (PY) due to the pandemic until early June 2020. The authors find that the ratio of PYs to LYs is very large, especially in poorer countries, implying that we certainly have to include the impacts on people's livelihoods as well as on their lives.

To estimate years of life lost, LY, the authors use age-specific mortality information, and assume that LY is equal to the residual life-expectancy at the age of death, as computed from the country's pre-pandemic age-specific mortality rates, which were obtained from the Global Burden of Disease Database (Dicker et al., 2018).

We will use a similar calculation of life years lost, but instead of using only reported COVID-19 deaths, we will include excess deaths that have not been reported as COVID-19. Excess mortality is a far more accurate measure of the health impacts of the pandemic, especially in countries where testing has been highly restricted, or where there have been a lot of collateral deaths due to overwhelmed hospital systems, lockdowns, or unemployment. The European Mortality Monitoring initiative, EUROMOMO[3], is a model for this kind of monitoring, and it has inspired several similar initiatives during this pandemic. For example, the New York Times now maintains a data base on excess mortality[4], and compares that to reported COVID-19 deaths. The database now includes several Latin American countries, including Bolivia. The Economist[5] and Financial Times[6] both have similar initiatives, and in Appendix A we unite all sources for our own data base on excess deaths during the first six months of the pandemic.

To estimate years spent in poverty (PY), Decerf, Ferreira, Mahler and Sterck (2020) use information about each country's income distribution, each country's poverty line[7], and the changes in economic growth estimates between January and June 2020, according to the World Bank's Global Economic Prospects (GEP) (World Bank, 2020a). Their method requires quite a lot of assumptions, including the conservative assumption that the additional poverty induced by COVID-19 will only last for one year. It is still far too early to know if these assumptions are reasonable, so in this paper we will offer an alternative way of

[3] See https://www.euromomo.eu/.
[4] See Wu, McCann, Katz, Peltier and Deep Singh (2020).
[5] See The Economist (2020a).
[6] FT Visual & Data Journalism Team (2020).
[7] The authors use the World Bank's income class poverty thresholds, as derived by Jolliffe and Prydz (2016), namely $1.90 per person per day in low-income countries (LICs); $3.20 a day in lower-middle-income countries (LMICs); $5.50 a day in upper-middle-income countries (UMICs); and $21.70 a day in high-income countries (HICs).

measuring the livelihoods dimension of the analysis.

While the increase in income poverty is clearly one of the most dramatic effects of this pandemic, the deprivations suffered go far beyond the lack of income. As suggested by the introductory paragraph of this paper, the pandemic has prevented grandparents from spending time with their grandchildren, has made it impossible for children to go to school, has made it illegal for colleagues to enjoy a beer Friday afternoon, and in many places people have not even been allowed to enjoy nature.

A potentially useful way to summarize all these diverse effects, is to measure how the pandemic has affected our interactions with other people. For that purpose, the Google Community Mobility Reports (Google, 2020), based on the movements of our cell-phones, are extremely useful. These reports show how the number of visits and the length of stay at different types of places (retail and recreation; grocery and pharmacy; parks; transit stations; workplaces; and residential) have changed during the pandemic compared to a pre-pandemic baseline (3 January to 6 February 2020). The data is calculated for most countries in the world, and for some countries even at sub-national levels. However, data is lacking for some big countries, like China and Ethiopia.

Several other studies have used the Google mobility data to analyze how countries have performed during the pandemic. The Sustainable Development Report 2020, prepared by Sachs et al. (2020), is probably one of the first world-wide studies that use Google Mobility Data to assess how well countries performed during the early months of the pandemic. They constructed a COVID Index of Epidemic Control (CIEC) which summarizes each country's performance over three dimensions:

- Cumulative COVID-19 mortality rate, per million inhabitants, as of 12 May 2020.
- The average Effective Reproduction Rate (ERR)[8] during 4 March to 12 May 2020.
- Epidemic Control Efficiency (ECE), which is calculated as the difference between the proportionate reduction in ERR and the proportionate reduction in mobility[9], during 4 March to 12 May 2020.

According to Sachs et al. (2020), reductions in mobility is a very costly and inefficient way of reducing the ERR and thus the mortality rate, which is why high reductions in mobility lowers the performance of the index. During their period of analysis, South Korea experienced a 10% reduction in mobility, while maintaining a low mortality rate of 5 COVID-19 deaths per million inhabitants, which is considered highly efficient. In contrast, Spain experienced a 60% reduction in mobility while reaching 575 COVID deaths per

[8] They use the daily values calculated by Arroyo Marioli et al. (2020), updated daily here: http://trackingr-env.eba-9muars8y.us-east-2.elasticbeanstalk.com/.

[9] Calculated as the average daily reduction in visits to retail outlets and recreation, visits to grocery stores and pharmacies, visits to transit stations, and visits to workplaces during March 4 to May 12, 2020, according to the Google (2020) Community Mobility Reports (https://www.google.com/covid19/mobility/).

million inhabitants by 12 May 2020, which is extremely inefficient.

Bargain and Ulugbek (2020) analyze the Google mobility data in more detail to assess how changes in work mobility depend on the level of poverty. They show that across 241 regions of 9 countries from Latin America and Africa, the decline in work mobility after lockdown is significantly lower in regions with higher poverty rates, since people simply cannot afford to shelter in place. They also estimate that poverty rates one standard-deviation above the mean regional poverty is associated with 11% more cases after a month and a half.

3. Methodology and data

The SARS-CoV-2 virus, despite having a relatively low infection fatality rate (Ioannidis, 2020), has had more dramatic impacts on all aspects of life, across the entire world, than any other virus during the last 100 years. Thus, when analyzing how well countries have managed the pandemic so far, we need to include more than just the number of COVID-19 infections and deaths, which every country on the planet seem to report daily.

Assessing all impacts simultaneously for all countries is obviously empirically challenging. In this paper we will assess two major groups of effects: i) Effects on death and ii) effects on life. That leaves out some major effects on governments and public finances, but obtaining data to assess that will require more time.

3.1 Measuring the death dimension

The most commonly used way of gauging the deadly impacts of COVID-19 is accumulated deaths per million inhabitants. This metric is updated daily by several sites, such as Worldometer[10] and Our World in Data[11]. The results so far show astonishing differences between countries, ranging from less than 5 per million (e.g. Taiwan, Tanzania, Myanmar, Vietnam, Thailand, Uganda, Mozambique) to more than 500 per million (e.g. Peru, Belgium, Spain, Chile, Bolivia, Brazil, Ecuador, UK, US).

This data, however, suffers from serious problems of under-reporting in many countries where COVID-19 testing was severely limited during most of the early phases of the pandemic, or where reporting guidelines implied that only COVID-19 deaths in hospitals were counted. In other countries, the lack of testing may have led to over-reporting, since any death with COVID-like symptoms or in persons who had previously tested positive for COVID-19 were included.

This problem of under- and over-reporting has been widely acknowledged, and, as mentioned above, several

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[10] See https://www.worldometers.info/coronavirus/.
[11] See https://ourworldindata.org/coronavirus.

institutions have implemented major efforts to monitor excess mortality. In this paper we combine information from Our World in Data[12], EUROMOMO[13], The Human Mortality Database[14], The New York Times[15], The Economist[16] and Financial Times[17] to estimate the number of excess deaths in each country during the first six months of the pandemic (11 March to 11 September 2020). **Appendix A** provides details.

One additional consideration, that has to be taken into account, is the age of the people who died prematurely. A person dying at 23 years of age will lose many more expected life years than a person dying at 93. It is well-known that care homes, nursing homes and other assisted living facilities have been particularly hard hit by COVID-19 in many countries. But care homes tend to be places where people are spending their last few months or years of life, because they have become so old and frail that they are no longer able to take care of themselves.

In order to take into account differences in the age structure of COVID-19 associated deaths, we will apply the methodology of Decerf, Ferreira, Mahler and Sterck (2020). Combining information on the age pyramid in each country, the residual life expectancy by age in each country, and inferred COVID-19 deaths by age in each country, they estimate how many life years is lost, on average, for each COVID-19 death in each country. The authors have kindly shared their calculations with us, and we simply use their estimates of life years lost per COVID-19 death, which range from a minimum of 8.1 years in Latvia to a maximum of 20.0 years in Iraq.

We express the total number of life years lost as a percentage of total remaining life years of the population pre - COVID-19 and call this variable *ΔDeath*. Given that even in the worst hit countries less than 0.2% of the population has died due to COVID-19, and given that most of those who died were already quite old, the percentage of lost life years is so far below 0.1% for all countries.

3.2 Measuring the life dimension

To measure changes in the life dimension, we use daily mobility data from the Google (2020) Community Mobility Reports, which aggregate anonymized data from the location history of mobile phones in most countries of the world. These reports were specifically created to provide information to help monitor and manage the pandemic. They record percent changes, compared to a baseline, in the number of visits or length of stay at six different types of location:

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[12] See Giattino, Ritchie, Roser, Ortiz-Ospina and Hasell (2020).
[13] See https://www.euromomo.eu/
[14] See Shkolnikov, Barbieri, and Wilmoth, (2020).
[15] See Wu, McCann, Katz, Peltier and Deep Singh (2020).
[16] See The Economist (2020a).
[17] See FT Visual & Data Journalism Team (2020).

1. **Retail and Recreation**: Restaurants, cafes, shopping centers, theme parks, museums, libraries, and movie theaters.
2. **Grocery and Pharmacy**: Grocery markets, food warehouses, farmers' markets, specialty food shops, drug stores, and pharmacies.
3. **Parks**: Local parks, national parks, public beaches, marinas, dog parks, plazas, and public gardens.
4. **Transit Stations**: Public transport hubs such as subway, bus, and train stations.
5. **Workplaces**: Places of work.
6. **Residential**: Places of residence.

The baseline is calculated during the five-week period from 3 January to 6 February 2020, as the median value for the corresponding day of the week.

For the first five categories of location, the reports show the percentage change in the number of visits, whereas for the residential category, they show the change in length of stay.

In order to create a summary measure of how the pandemic has impacted the quality of our lives, we calculate a *ΔLife* index which is the simple average of the daily changes in visits to the first five categories of locations over the period of analysis, compared to the baseline.

We have given the same weights to each of the five categories of locations, although in reality people probably did not visit each of these areas with the same frequency in the baseline period. However, to protect privacy, Google (2020) does not report absolute values, only percent change, so we don't have the necessary information to establish differentiated weights.

3.3 Period of analysis

The period of analysis is the first six months of the pandemic. That is, from 11 March 2020, the day the World Health Organization declared COVID-19 a pandemic, and at which time the virus had been detected in at least 78 countries in the World[18], to 11 September 2020.

During this period most countries experienced their first wave of infections, and the vast majority of countries failed to suppress the outbreak, which means that significant spread occurred, especially in densely populated areas. Seroprevalence studies indicate that in New York city, 22.7% had been infected by March (Rosenberg et al., 2020); in Oise, France 25.9% had been infected by late March (Fontanet et al., 2020); in the Guilan province of northern Iran about 33% of the population showed antibodies by April (Shakiba et al., 2020); in Rio de Janeiro 3-4% of the population showed antibodies by late April (Amorim

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[18] According to Our World in Data, 78 countries had reported COVID-19 cases by 11 March 2020 (Roser, Ritchie, Ortiz-Ospina and Hasell, 2020).

Filho et al., 2020); in Kenya the share was about 5% by late May (Uyoga et al., 2020); in Manaus, Brazil it reached 52% by June (Buss et al., 2020); in urban Pakistan it reached 17.5% by early July (Javed et al., 2020); in Qatar it reached 30.4% in early July (Abu Raddad et al., 2020); in Mumbai slums it reached about 58% by early July (Malani et al., 2020); and it was close to 50% in Tokyo by late August (Hibino et al., 2020).

3.4 Countries included

Our analysis requires enormous amounts of data, so only countries that collaborate and contribute to the various global efforts of generating reliable and comparable data are included. Specifically, we only include countries that simultaneously are included in the Google Mobility data initiative, and provide sufficient data to be included in the Sustainable Development Report 2020.

We have grouped the 124 countries with complete data in 4 main groups defined by location, and they are listed in Table 1.

These countries include the majority of the World's population (approximately 5.6 billion people), but they also exclude some really big countries. For example, China and Ethiopia were not taken into account because they are not included in the Google Mobility data set.

Table 1. The 124 countries included in the analysis

Africa	Americas	Asia-Pacific	Europe
Angola	Argentina	Afghanistan	Austria
Bahrain	Barbados	Australia	Belarus
Benin	Belize	Bangladesh	Belgium
Botswana	Bolivia	Cambodia	Bosnia and Herzegovina
Burkina Faso	Brazil	Fiji	Bulgaria
Cabo Verde	Canada	India	Croatia
Cameroon	Chile	Indonesia	Czech Republic
Côte d'Ivoire	Colombia	Japan	Denmark
Egypt	Costa Rica	Kazakhstan	Estonia
Gabon	Dominican Republic	Kyrgyzstan	Finland
Ghana	Ecuador	Lao PDR	Franca
Iraq	El Salvador	Malaysia	Georgia
Israel	Guatemala	Mongolia	Germany
Jordan	Haiti	Nepal	Greece
Kenya	Honduras	New Zealand	Hungary
Kuwait	Jamaica	Pakistan	Ireland
Lebanon	Mexico	Papua New Guinea	Italy
Mali	Nicaragua	Philippines	Latvia
Mauritius	Panama	Singapore	Lithuania
Morocco	Paraguay	South Korea	Luxembourg
Mozambique	Peru	Sri Lanka	Malta
Namibia	Trinidad and Tobago	Tajikistan	Moldova
Niger	United States of America	Thailand	Netherlands
Nigeria	Uruguay	Vietnam	North Macedonia
Oman			Norway
Qatar			Poland
Rwanda			Portugal
Saudi Arabia			Romania
Senegal			Russian Federation
South Africa			Serbia
Tanzania			Slovakia
Togo			Slovenia
Uganda			Spain
United Arab Emirates			Sweden
Yemen			Switzerland
Zambia			Turkey
Zimbabwe			Ukraine
			United Kingdom

Note: For convenience, we use commonly known short country names rather than the official names of each country. Thus, we use "Bolivia" instead of "The Plurinational State of Bolivia", "Greece" instead of "The Hellenic Republic", "Sri Lanka" instead of "The Democratic Socialist Republic of Sri Lanka", etc.
Source: Authors' elaboration.

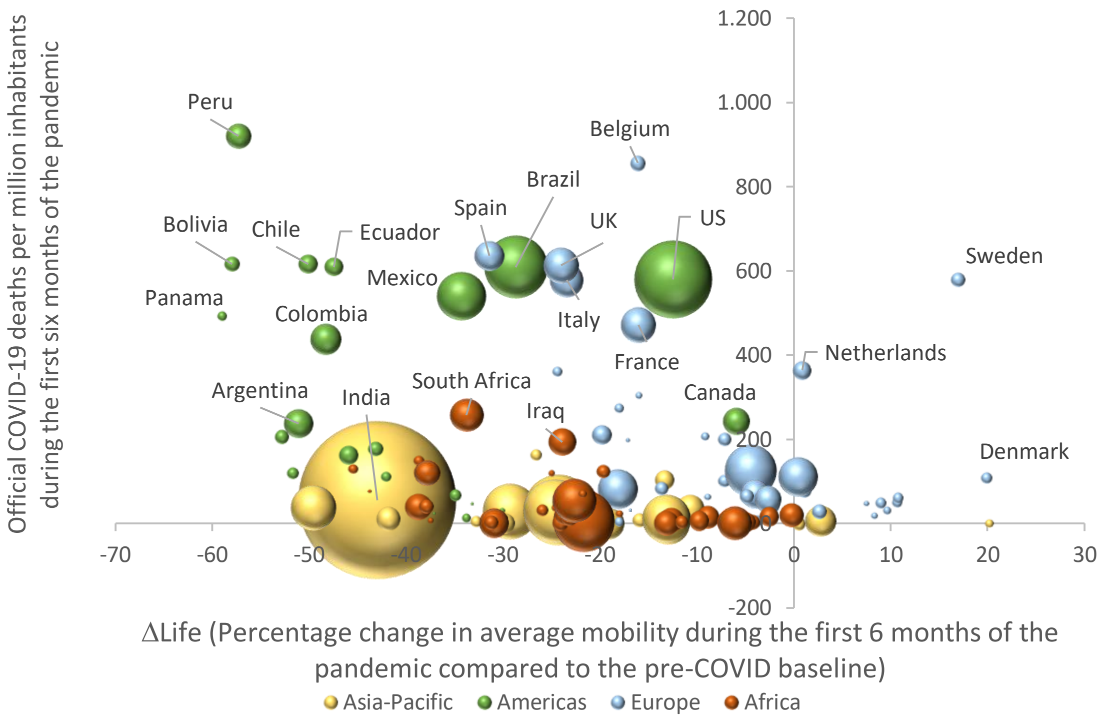
4. Cross-country results

This section presents the main cross country results in a series of Life and Death diagrams. The horizontal axis of each graph represents changes in the quality of life, *ΔLife*, as measured by changes in mobility, and the vertical axis represents changes in the quantity of life, measured in different ways. The time period is always the first six months of the pandemic, i.e. from 11 March to 11 September 2020.

Figure 2 shows official COVID-19 deaths per million inhabitants against average changes in daily mobility. Due to the widespread quarantines and precautionary actions of the populations, few countries have seen positive changes in mobility compared to the baseline, but there are a couple of exceptions worth mentioning, notably Sweden and Denmark. These positive changes are mainly due to the baseline period being mid-winter for the northern hemisphere, so it is natural to see a big increase in visits to parks compared to January. In Denmark and Sweden, we do indeed observe big increases in visits to parks (about 150% more than during the baseline), while in both countries there are significant reductions of around 30% to transit stations and work places. It is worth noting, though, that the UK has the same climate as Denmark, and in the UK the increase in visits to parks was only 30% compared to baseline, far from the 150% increase seen in Denmark and Sweden.

The correlation between the two indicators in Figure 2 is -0.29, implying that the countries that have seen the biggest reductions in mobility have also seen the highest COVID-19 deaths rates. This suggests that there is not a trade-off between health and the economy or between lives and livelihoods. Peru, Bolivia, Panama, Chile, and Ecuador all suffered extremely high reductions in mobility during the first six months of the pandemic, but that didn’t prevent them from having very high COVID-19 death rates.

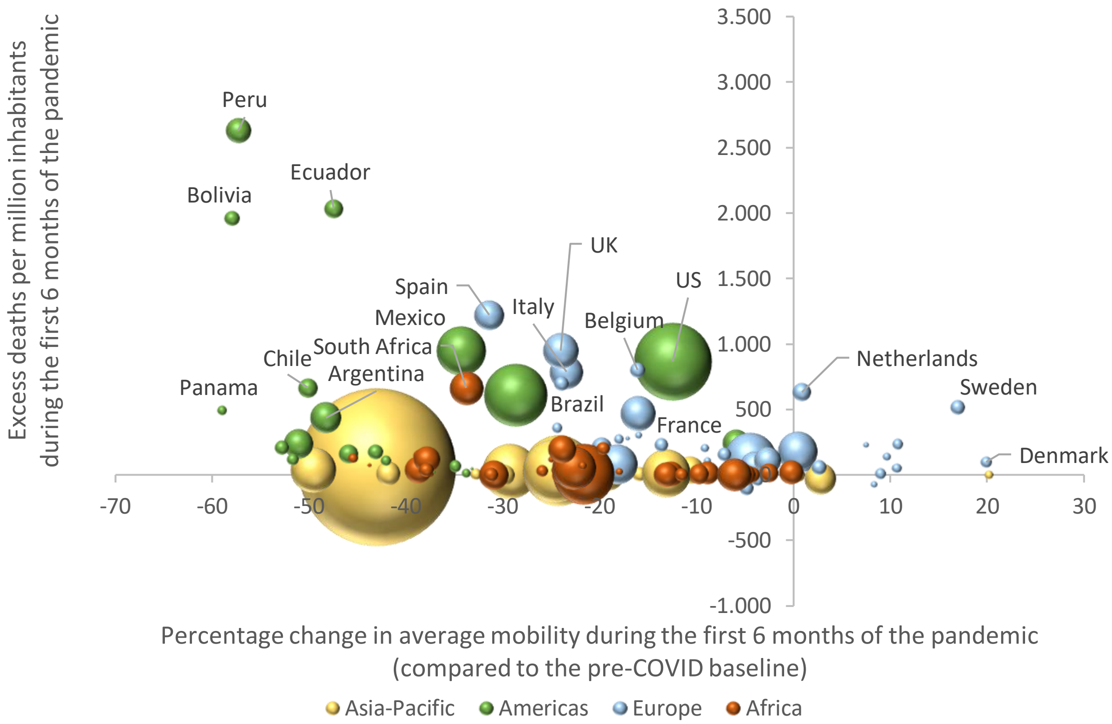
Figure 2. *Official COVID-19 deaths per million inhabitants versus average change in mobility, during the first six months of the pandemic (11 March 2020 to 11 September 2020)*



Source: Authors' elaboration based on data from Roser et al. (2020) and Google (2020).

However, Figure 2 only includes officially reported COVID-19 deaths, and the countries with very high death rates also had very limited testing capacity, so not all COVID-19 deaths got reported. A more accurate impression is provided by the number of excess deaths registered during the period of analysis. Figure 3 shows excess deaths per million inhabitants versus average change in mobility. Taking into account excess deaths changes the scale of the vertical axis, but otherwise does not change the main picture. When taking into account excess deaths rather than officially reported COVID-19 deaths, the death rate per million for Peru increases from 920 to 2630, which means that more than a quarter of 1% of the entire population died within just six months. And this despite having observed one of the strictest lock down in the world throughout the whole period, as evidenced by a reduction in average daily mobility of almost 60%.

Figure 3. *Excess deaths per million inhabitants versus average change in mobility, during the first six months of the pandemic (11 March 2020 to 11 September 2020)*



Source: Authors' elaboration based on data from Roser et al. (2020), The New York Times, The Financial Times, and Google (2020). For details, see **Appendix A**.

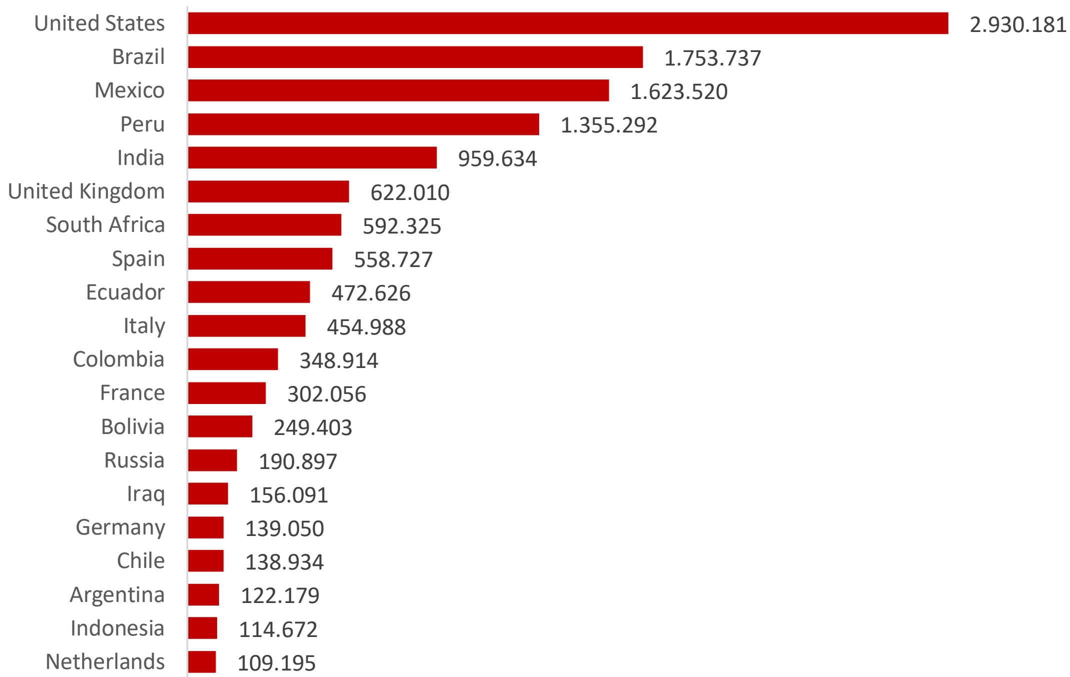
The correlation between the two indicators in Figure 3 is -0.33, confirming that the countries that have seen the biggest reductions in mobility have also seen the highest excess mortality rates. Four European countries have actually experienced fewer deaths than normal during the first six months of the pandemic (Hungary, Slovakia, Bulgaria, and Latvia), despite hardly any reductions in mobility. The same is true for South Korea.

Since the death of a young person implies many more lost life years than the death of an older person, we can further refine the analysis by calculating the total number of life years lost due to COVID-19, and compare this to the expected remaining life years of the population in each country.

In total, the world lost approximately 15 million life years to COVID-19 during the first six months of the pandemic. Figure 4 shows the 20 countries that lost most life years. United States heads the list. With an estimated 286,866 excess death causing an average loss of 10.2 years of life per death, the total loss during the first six months of the pandemic is about 2.9 million life years. The 20 countries included in Figure 4 account for about 90% of all excess deaths in our 124 countries during the first six months of the pandemic[19].

[19] Deaths outside the 124 countries included in our analysis account for less than 5% of total confirmed global Covid-19 deaths

Figure 4. *The 20 countries with the largest total number of life years lost due to COVID-19 during the first six months of the pandemic (11 March 2020 to 11 September 2020)*



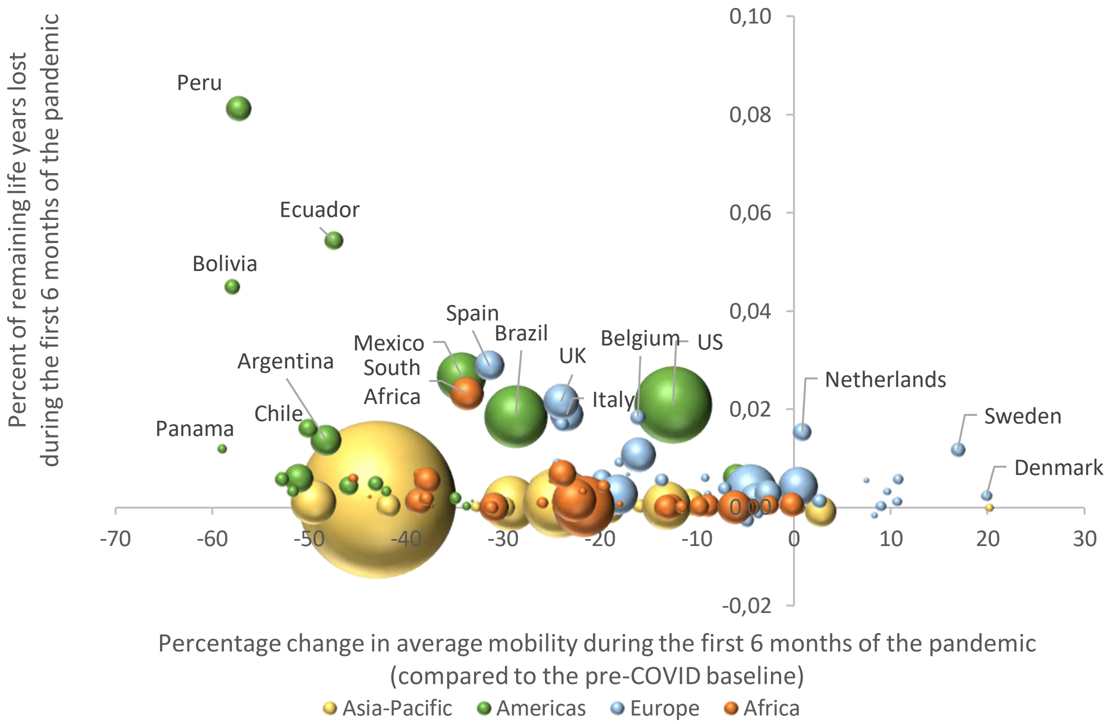
Source: Authors' elaboration based on data from Roser et al. (2020), The New York Times, and The Financial Times. For details, see **Appendix A**.

The remaining life years for the entire pre-COVID population of United States was about 14 billion, though, so in percentage terms, only 0.021% of total life years were lost due to COVID-19 during the first six months of the pandemic. Figure 5 plots the percentage loss of life years for each country against the percentage loss in mobility.

Peru is still the most extreme example, having lost 0.081% of total life years due to COVID-19 during the first six months of the pandemic, while during the same time period average daily mobility was reduced by almost 60%.

during the first six months of the pandemic, but we have added 4.5% to reach the global total of 15 million lost life years due to COVID-19 during the first six months of the pandemic.

Figure 5. *Percent of remaining life years lost versus average change in mobility, during the first six months of the pandemic (11 March 2020 to 11 September 2020)*



Source: Authors' elaboration based on data from Roser et al. (2020), The New York Times, The Financial Times, Google (2020) and Decerf et al. (2020).

The correlation between the two indicators in Figure 4 is -0.35, again suggesting that there is no trade-off between protecting economic/human activity and protecting lives.

5. What explains the enormous differences in outcomes?

In general, the Asia-Pacific region has done very well maintaining low death rates, but with varying impacts on mobility, from -49.6% in the Philippines to positive changes in Mongolia, South Korea and Fiji. The African continent has also done quite well in terms of low death rates, except South Africa and Iraq, at opposite extremes of the continent, but again with widely varying impacts on mobility. Kuwait experienced a 45.5% average reduction in daily mobility during the first six months of the pandemic, while Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Mali, Niger, Tanzania, Zambia and Yemen all saw reductions in mobility of less than 10%.

Europe is very heterogeneous, spanning from Spain with the strictest lock downs and the highest death rates to Denmark with the highest level of mobility and hardly any excess mortality during the first six months of the pandemic. In general, southern Europe was harder hit than northern Europe and western Europe harder hit than eastern Europe. However, there were notable exceptions. For example, Greece has been doing very well in the South, while UK did badly in the north.

By far the hardest hit region is the Americas, with very bad outcomes for Peru, Bolivia, Ecuador, United States, Brazil, Mexico and Chile. But mixed between these hard hit countries are exceptions like Uruguay, Paraguay and Costa Rica, with low death rates so far.

A cross-country econometric model including structural factors as explanatory variables is unlikely to be able to explain these differences in outcomes. Distance to the original outbreak, for example, doesn't work, as all China's neighbors have done very well. Health care expenditure, education levels and access to water and sanitation, also will not work, since most African countries have done well despite large deficiencies in these areas.

We calculated simple correlations between our main *ΔDeath* variable (Percentage of Life Years Lost to COVID-19 during the first 6 months of the pandemic) with all 83 variables available for most countries in the Sustainable Development Report 2020 (Sachs et al., 2020). Not a single one of these 83 variables had a stronger correlation with *ΔDeath* than our *ΔLife* variable (Percentage change in average daily mobility during the first 6 months of the pandemic compared to pre-COVID baseline). The one variable that does have a stronger correlation (-0.50) with *ΔDeath* is the Average change in visits to work places during the first six months of the pandemic, compared to pre-COVID baseline. A reduction in visits to workplaces is strongly correlated with an increase in the percentage of life years lost.

Table 2 shows that no other variable comes even close to that level of correlation, and there are clearly quite a lot of spurious correlations. For example, starving children is associated with lower COVID-19 deaths, while protected marine sites, women in parliament, access to water, and happiness are associated with higher death rates.

Some variables, such as obesity rates, show the expected sign of correlation, but the important take-away from this exercise is that no variable show a stronger cross-country correlation with *ΔDeath* than restrictions in mobility, and especially restrictions on going to work.

Table 2. Simple cross-country correlations between ΔDeath and various sustainable development indicators from the Sustainable Development Report 2020 (only includes indicators with a statistically significant correlation above |0.2|)

Indicator	Correlation with ΔDeath
Average change in visits to work places during first six months of the pandemic (compared to pre-COVID baseline)	-0.4961
ΔLife (Average change in daily mobility during first six months of the pandemic compared to pre-COVID baseline)	-0.3534
Mean area that is protected in marine sites important to biodiversity (%)	0.3158
Prevalence of wasting in children under 5 years of age (%)	-0.3074
Seats held by women in national parliament (%)	0.3038
Universal health coverage (UHC) index of service coverage (worst 0-100 best)	0.3012
Age-standardized death rate due to cardiovascular disease, cancer, diabetes	-0.2794
Age-standardized death rate attributable to air pollution	-0.2741
Access to improved water source, piped (% of urban population)	0.2569
Victims of modern slavery (per 1,000 population)	-0.2521
Lower secondary completion rate (%)	0.2480
2020 SDG Index Score	0.2454
Subjective well-being (average ladder score, worst 0-10 best)	0.2382
Prevalence of obesity, BMI ≥ 30 (% of adult population)	0.2356
Life expectancy at birth (years)	0.2321
Births attended by skilled health personnel (%)	0.2161
Population with access to electricity (%)	0.2146
Population using at least basic sanitation services (%)	0.2146
Literacy rate (% of population aged 15 to 24)	0.2138
Mortality rate, under-5 (per 1,000 live births)	-0.2055
Neonatal mortality rate (per 1,000 live births)	-0.2050
Anthropogenic wastewater that receives treatment (%)	0.2040

Source: Authors' calculations.

Since these are simply cross-country correlations, we cannot infer anything about causality. While the cross-country differences suggest that strict and prolonged lockdowns during the first six months of the pandemic have not been helpful, it is possible that without the lockdowns death rates would have been even higher.

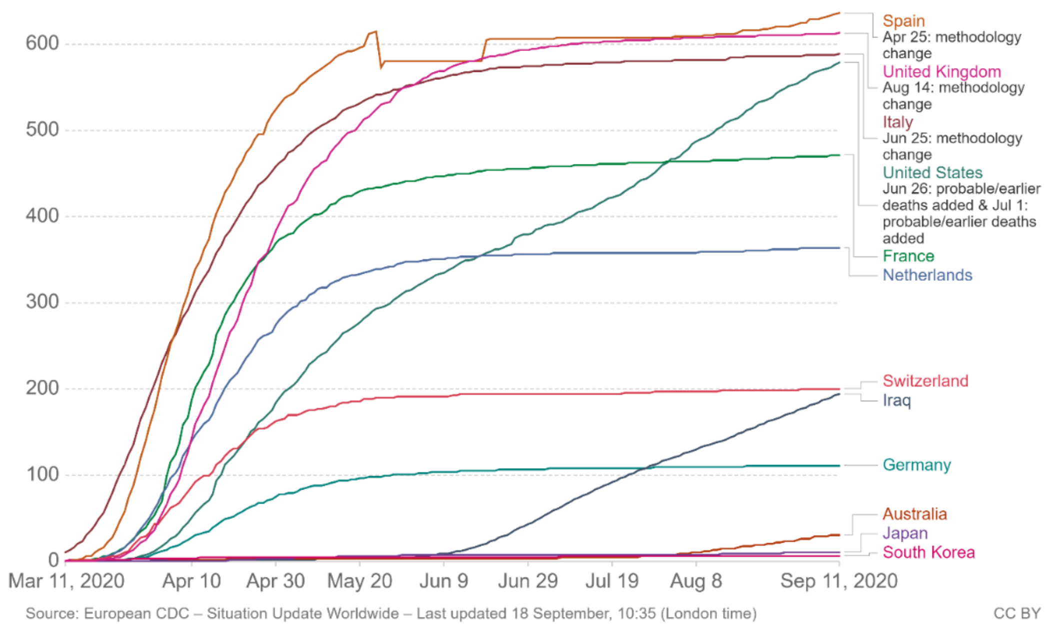
In the rest of this section we will explore a series of alternative hypotheses. It is obvious that there is no simple explanation. There are many different ways things can go wrong, just as there are several different ways of preventing extremely bad outcomes.

5.1 The role of timing

Some countries were infected by the SARS-CoV-2 virus very early on in the pandemic, and thus may have become overwhelmed due to lack of sufficient warning. Apart from China, 12 countries already had registered two or more COVID-19 deaths by the time the World Health Organization (WHO) declared

COVID-19 a pandemic (11 March 2020). Figure 6 shows how each of those 12 countries have fared during the first six months of the pandemic in terms of officially confirmed deaths per million inhabitants. Clearly, they span a wide variety of outcomes, from sustained low levels of death during the whole period (South Korea and Japan), to rapidly reaching very high levels of death (Spain, United Kingdom and Italy), and everything in between.

Figure 6. *Cumulative confirmed COVID-19 deaths per million people, for the 12 countries that had registered more than 2 COVID deaths by 11 March 2020*



Source: Our World in Data by Roser et al. (2020).

At least one of the countries that was seeded late (Bolivia) has passed all of the early seeded countries in terms of accumulated deaths per million by now. Thus, early seeding of the virus does not seem to be an important determining factor of cumulative death rates.

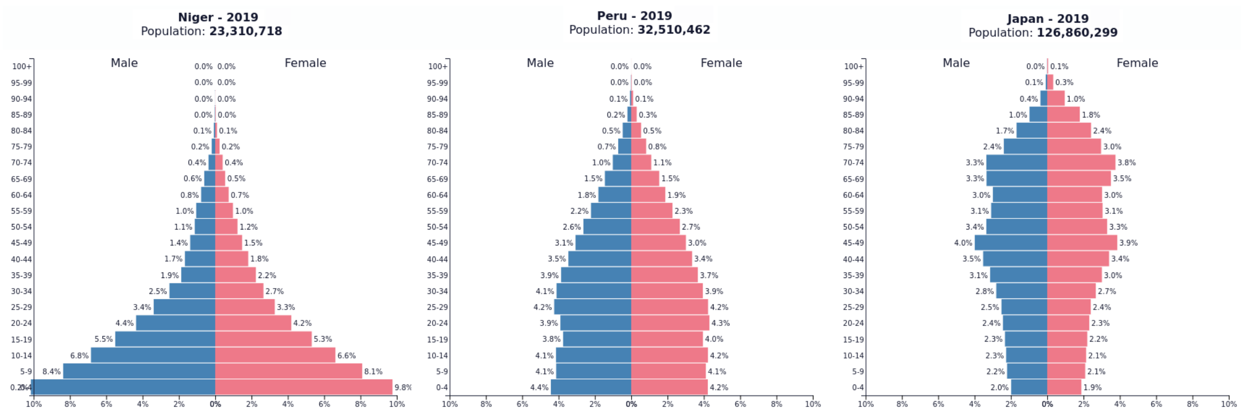
5.2 The age structure of the population

The risk of dying from COVID-19 is known to increase exponentially with age[20], so countries with relatively old populations would be expected to end up with higher overall deaths rates than countries with relatively young populations. That would certainly help explain the low death rates in most African countries.

[20] The risk of dying increases by about 12.8% for each additional year of age, which implies that the risk of contracting and dying from Covid-19 is more than a thousand times higher for a 78-year-old compared to an 18-year-old person (Spiegelhalter, 2020).

Figure 7 shows just how much the age structure of populations vary between countries. Niger has one of the youngest populations in the World, with only 4.0% of the population older than 60 years. In contrast, Japan has the oldest population in the World, with 34.1% of the population older than 60 years. Peru is an intermediate case with 12.0% of the population older than 60 years.

Figure 7. *Population pyramids for Niger, Peru and Japan, 2019*



Source: PopulationPyramid.Net (2019).

However, Japan, with the world's oldest population and the world's most populous city, has extremely low COVID-19 mortality rates[21], despite early seeding of the virus and despite relatively modest constraints on human interaction. Japan experienced an average reduction in mobility of only 13.1% during the first six months of the pandemic, and that was mainly driven by a reduction in visits to transit stations. And the low death rates are not due to the country having eradicated the virus early on. A seroprevalence study involving employees of a large Japanese company, working at 11 different locations across Tokyo, indicate that COVID-19 infection may have spread widely across the general population of Tokyo. The results of the study showed that seroprevalence increased from 5.8% to 46.8% over the course of the summer, with the most dramatic increase observed in late June and early July, paralleling the rise in daily confirmed cases within Tokyo, which peaked on 4 August 2020 (Hibino et al., 2020).

In contrast, Peru, Bolivia and Ecuador, with some of the highest death rates during the first six months of the pandemic, do not have particularly old populations. In a study on the importance of the age structure in COVID-19 mortality, Medford and Trias-Llimós (2020) found that while Italy has the oldest population in Europe, the relative proportion of deaths at ages above 90 years was lower in Italy than in the other countries studied (France, Italy, the Netherlands, Germany, Sweden, Spain, and China).

[21] Both official Covid-19 reports and analyses of excess deaths (Kurita et al., 2020) agree on the surprisingly low levels of deaths in Japan.

Thus, while age is the most important risk factor at the individual level, and a youthful population may provide some protection at the country level, the cross country correlation is very weak, due to a lot of confounding factors. In our data set of 124 countries the correlation between excess mortality per million inhabitants and the share of the population aged 65 or older is only 0.11, which is not statistically different from 0.

5.3 The role of co-morbidities and the basic health of the population

It has been clearly shown that certain underlying medical conditions increase the risk of severe illness, and higher mortality rates, from COVID-19. The ones with the strongest evidence are: hypertension, cardiovascular diseases, chronic obstructive pulmonary disease (COPD), diabetes, and obesity (CDC, 2020).

One meta-study collected information from 6,560 patients from around 30 different studies that assess hypertension and outcome in COVID-19. The study concluded that hypertension was associated with increased composite poor outcome, including mortality, severe COVID-19, acute respiratory distress syndrome, need for intensive care unit and disease progression in patients with COVID-19 (Pranata et al., 2020).

Matsushita et al. (2020) performed a systematic review of studies that explored pre-existing cardiovascular diseases (CVD) and their effects on severe COVID-19 (defined as death, acute respiratory distress syndrome, mechanical ventilation, or intensive care unit admission). The study included 51,845 COVID-19 patients including 9,066 severe cases. Using random-effects models, they pooled relative risk estimates and conducted meta-regression analyses concluding that CVD were associated in univariate analyses with severe COVID-19.

Likewise, a meta-analysis aimed to explore the risk of severe COVID-19 in patients with pre - existing chronic obstructive pulmonary disease (COPD). This meta - analysis, which includes studies on SARS-CoV-2 virus infection from December 2019 to 22 March 2020, published in either English or Chinese language, concluded that this underlying condition is associated with a fourfold increased risk of developing severe COVID-19 (Zhao et al., 2020).

Several studies have found that diabetes is a major comorbidity of COVID-19. Zhu et al. (2020), for example, analyzed 7,337 cases of COVID-19 in Hubei Province, China, among which there was a group having pre-existing Type 2 diabetes. They found that the group with this pre-existing condition required more medical interventions, they had multiple organ injury, and had a significantly higher mortality, 7.8% versus 2.7%, than the non-diabetic individuals. Likewise, they found that good levels of blood glucose (glycemic variability within 3.9 to 10.0 mmol/L) was associated with lower mortality compared with individuals with poorly controlled blood glucose (upper limit of glycemic variability exceeding 10.0 mmol/L).

A retrospective analysis developed in Bronx, New York, included a cohort of 200 patients admitted to a tertiary medical center with COVID-19. In this cohort of hospitalized patients, severe obesity was independently associated with higher mortality and in general worse in-hospital outcomes (Palaiodimos et al., 2020).

The studies mentioned above are just some of many analyses that found associations between co-morbidities and worse outcomes in COVID-19 patients. However, these co-morbidities interact with other confounding factors, such as age, sex and other unknown factors that might influence in the outcomes of patients with SARS-CoV-2 virus.

To investigate whether co-morbidities might explain at least some of the differences in the outcomes between countries, we analyzed the relationship between the general "health status" of a country and its COVID-19 mortality rates. For this we used the "Healthiest Countries Index, 2019" (HCI)[22] and the excess deaths per million inhabitants during the first six months of the pandemic. Although we did not find any correlation[23] among these two variables, there are interesting examples that might be useful to analyze, in order to determine the factors that might influence in the outcome of the pandemic.

Table 3 lists the Top 20 Healthiest Countries, together with their excess deaths per million inhabitants during the first six months of the pandemic. Spain is supposedly the healthiest country on the planet, but that did not prevent it from experiencing extremely high COVID-related excess mortality. The UK, Italy, and Netherlands are also among the Top 20 Healthiest Countries, but experienced high excess death rates. In contrast, most countries in Africa scored low on the HCI, but fared well during the first six months of the pandemic. Thus, differences in underlying health cannot explain cross-country differences in COVID-mortality outcomes.

Only the prevalence of obesity (BMI$\geq$ 30) in the adult population had a significantly positive correlation with excess mortality rates ($\rho = 0.24$), as shown in Table 2 above.

[22] This Bloomberg index has crunched numbers from the UN, World Bank and World Health Organization, scoring 169 nations on a range of factors from life expectancy to obesity, tobacco use, air quality and access to clean water. (Miller and Lu, 2019).
[23] The correlation coefficient is 0.095, which is not statistically significant from 0.

Table 3. The Top 20 Healthiest Countries and their excess deaths per million during the first six months of the pandemic

Country	Healthiest Countries Index (HCI)	Rank HCI	Excess COVID-19 deaths per million inhabitants
Spain	92.75	1	1,222
Italy	91.59	2	785
Japan	91.38	4	11
Switzerland	90.93	5	158
Sweden	90.24	6	515
Australia	89.75	7	31
Singapore	89.29	8	5
Norway	89.09	9	11
Israel	88.15	10	202
Luxembourg	87.39	11	280
France	86.94	12	469
Austria	86.30	13	230
Finland	85.89	14	236
Netherlands	85.86	15	632
Canada	85.70	16	243
South Korea	85.41	17	-29
New Zealand	85.06	18	5
United Kingdom	84.28	19	948
Ireland	84.06	20	361

Source: Authors' elaboration based on data from Bloomberg and calculations in **Appendix A**.

5.4 The critical role of the immune system

The majority of people infected with the SARS-CoV-2 virus eliminate it quite easily suffering only mild symptoms (like cough, fever, fatigue, headache and shortness of breath), or no symptoms at all. Some, however, develop severe, life-threatening disease, which may lead to either long-lasting damage or even death.

The main difference between no symptoms and death, seems to be the effectiveness of our immune system. In those who show no symptoms, the innate immune system seems to have been able to immediately mount a protective T-cell response, defeating the virus without the infected person even developing anti-bodies (e.g. Liu et al., 2017; Unterman et al., 2020). This seems to be the case in at least 50% of infections (King, 2020a; Nelde et al., 2020, Soresina et al., 2020). Interestingly, a study of COVID-19 patients admitted to Yale New Haven Hospital showed that male patients produced fewer T-cells than female patients, and unlike female patients, their T-cell response dropped with age (Takahashi et al., 2020). This sex-based difference in T-cell response may help explain why men are more likely than women to suffer complications and death when contracting the SARS-CoV-2 virus.

In those persons whose innate immune system does not manage to eliminate the virus quickly, the adaptive immune system becomes activated, and B cells start producing antibodies that bind to and neutralize the virus. This process may take several weeks, during which the infected person may experience fever, fatigue and other side effects of the body's fight against the virus.

In a sub-set of cases, however, the immune system seems to overreact, causing a dangerous and uncontrolled local and systemic inflammatory reaction sometimes referred to as the cytokine storm. Cytokines are chemical signaling molecules that guide the immune response, but in a cytokine storm, levels of certain cytokines soar far beyond what's needed, and immune cells start to attack healthy tissues. As a result, blood vessels leak, blood pressure drops, clots form, and catastrophic organ failure can ensue (Wadman, Couzin-Frankel, Kaiser and Matacic, 2020). The inflammation usually starts in the lungs, causing damage to the alveoli, leading to pulmonary edema and potentially progressing to life-threating Acute Respiratory Distress Syndrome (ARDS) (Gonzales, Lucas and Verin, 2015). Deaths caused by COVID-19 is typically due to massive alveolar damage and irreversible respiratory failure, but other complications can also develop, such as acute cardiac injury, acute kidney injury, coagulopathy and shock (Rodriguez-Morales et al., 2020).

Thus, the immune system is not only responsible for eliminating the virus, but is also the main culprit when things go seriously wrong.

5.4.1 Vitamin D and the immune system

The immune system is incredibly complex, and it depends on many different vitamins and minerals to function correctly[24]. However, vitamin D has received particular attention during the COVID-19 pandemic because of its critical role in the immune system[25], and because of the fact that many people, especially in rich countries, are vitamin D deficient.

Vitamin D3 is a fat-soluble vitamin produced mainly in the skin by the action of UVB sunlight, but it can also be obtained from a limited number of food sources, such as fatty fish. Vitamin D3 is converted in the liver to 25 hydroxyvitamin D, or 25(OH)D, also called calcidiol, which is the form that circulates in the blood and can be measured in order to determine serum vitamin D status. The kidneys carry out a further transformation of calcidiol to produce calcitriol, or active vitamin D (King, 2020b).

[24] Various micronutrients are essential for immunocompetence, particularly vitamins A, C, D, E, B2, B6, and B12, folic acid, iron, selenium, and zinc (Maggini, Pierre and Calder, 2018).
[25] For a detailed explanation of how Vitamin D affects the immune system, see Mora, Iwata and von Andrian (2008).

The calcitriol form of vitamin D functions as a hormone in every cell of the body, all of which have vitamin D receptors, that epigenetically control the expression of up to 2,000 different genes, including almost 300 genes just in white blood cells involved in the immune response (Hossein-Nezhad, Spira, and Holick, 2013). Vitamin D increases the phagocytic killing ability of innate immune cells such as natural killer cells, macrophages and neutrophils and reinforces the physical barriers of epithelial cells by maintaining tight junctions (Sassi, Tamone and D'Amelio, 2018). Vitamin D has also been proven to be essential to facilitate the maturation of naïve T cells to become dedicated, specific T cells that can kill a specific virus (Von Essen et al., 2010). In addition, vitamin D has been shown to play an important role in modulating the immune response, and avoiding a potentially fatal cytokine storm (Razdan, Singh and Singh, 2020). Finally, a number of studies have demonstrated the anticoagulant effects of vitamin D, and linked the lack of vitamin D to increased blood clotting and deep vein thrombosis (e.g. Lindqvist, Epstein and Olsson, 2009; Banerjee and Khemka, 2017).

The impressive protective mechanisms of our immune system evolved mainly while humans were running around more or less naked outdoors in Africa, and thus received plenty of sunlight every day. This is very different from the modern situation where most of us are clothed and work indoors most of the day. In addition, many people live at high latitudes with too little sun during the winter months to generate any vitamin D at all. This means that, in the absence of supplements, most people will be vitamin D deficient, and therefore their immune systems will not be functioning optimally.

Optimal 25(OH)D levels are considered to be between 40 and 60 ng/ml, while less than 20 ng/ml is considered dangerously deficient. In the US, only 13% of the population has optimal levels, and this is reduced to 6% for blacks, as darker skin is less efficient in producing vitamin D than lighter skin. More than 50% of the black population in the US are dangerously deficient in vitamin D. Similarly, more than 50% of the population in the UK, Northern Ireland, Belgium, Italy, Greece, Canada, India, and the Middle East have vitamin D levels below 20 ng/ml (King, 2020b).

By now, several studies have shown that lower vitamin D levels are associated with higher COVID-19 infection rates (Israel, et al., 2020; Kaufman et al., 2020) and higher COVID-19 mortality (Daneshkhah et al., 2020; Castillo et al., 2020; King, 2020b; Maghbooli et al., 2020), and that vitamin D supplementation could reduce risk of severe disease and death (Grant et al., 2020). Vitamin D levels have been shown to be systematically lower in men than in women (Sanghera et al., 2017), which may explain why their immune systems are less able to deal with COVID-19. Similarly, vitamin D levels are negatively correlated with Body Mass Index (Sanghera et al., 2017), which may be part of the explanation why obese people are at higher risk of complications from COVID-19.

The half-life of Vitamin D in the body is 2 to 3 weeks for supplements, but 4 to 6 weeks for vitamin D produced in the skin (King, 2020b). This means that people at high latitudes will quickly deplete their vitamin D levels during winter, and the same holds for people in strict quarantine without access to sun.

Figure 5 above shows that the countries with the strictest quarantines also had some of the highest excess mortality rates. Sun deprivation and lack of vitamin D may well play a role in that. In Bolivia, for example, nobody was allowed outside their house on weekends for the first six months of the pandemic. During the week, people were only allowed out for a few hours per week to get supplies, on a rotating schedule depending on their ID number. This was gradually increased to a few days per week, but children below the age of 18 were not allowed out at all during the first six months of the pandemic. This situation may not have been a problem for rich people with private gardens, good internet, and a guaranteed source of income, or for poor, self-sufficient people living in rural areas. But for vulnerable and middle-class people living in small apartments in the cities, it has been catastrophic.

5.4.2 Stress and its effect on the immune system

It has long been known that stress is bad for our health (e.g. Selye, 1907; Macciochi, 2020), and that it weakens our immune systems (Caiabrese, Kling and Gold, 1987; Segerstrom and Miller, 2004). Stress reduces the production of T cells, which are crucial for fighting off viruses (Kiecolt-Glaser et al., 1984). Chronic stress, lasting from days to years, is associated with higher levels of pro-inflammatory cytokines, which increases the risk of chronic diseases and has been shown to cause the activation of latent viruses (Morey et al., 2015). Stress may also have an indirect effect on the immune system, through unhealthy coping strategies, such as drinking and smoking (McLeod, 2010). Tan et al. (2020) showed that higher stress, as measured by increased levels of the stress hormone cortisol, are associated with more severe COVID-19 outcomes.

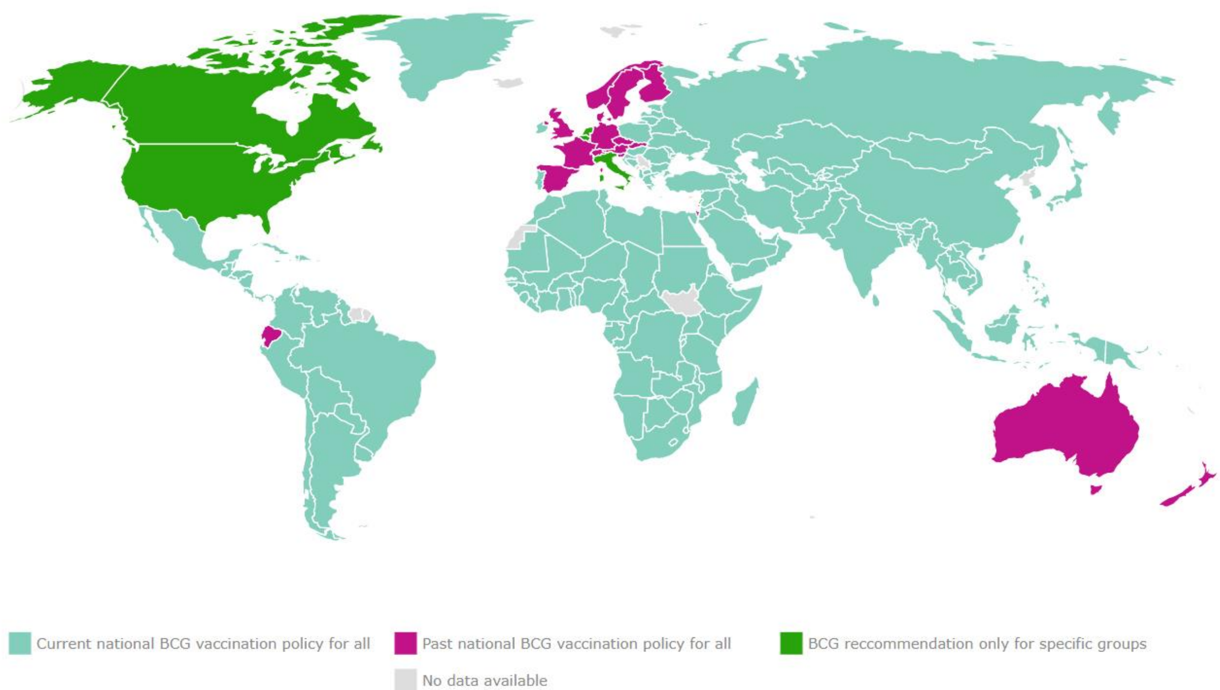
In normal times, most families in the world maintain a rather precarious equilibrium between incomes and expenses. Many of the people who are lucky enough to actually have a job, just barely make it to their next paycheck, whereas self-employed people, or day-laborers, depend on the income they generate every day to actually eat that day. The pandemic has upended this precarious equilibrium for hundreds of millions of families. The International Labour Organization estimated that during the second quarter of 2020, working hours worldwide were 14% lower than the previous year, equivalent to 400 million full-time jobs lost (ILO, 2020).

The hundreds of millions of families affected by these job losses saw their incomes decimated, and for each additional month of quarantine they were left worrying if they would be able to stay in their home, if they could maintain electricity, water and other essential services, if their children would be able to remain in school, and if they could even afford to eat. The level of stress on families worldwide has probably not been higher in at least 100 years, and it seems plausible that the populations suffering the most stress are likely to experience higher COVID-19 mortality rates.

5.4.3 The BCG vaccine and its effect on the immune system

Several studies have demonstrated a protective action of the Bacillus Calmette-Guerin (BCG) vaccination against unrelated respiratory infections both in children and adults (Escobar et al., 2020). The protective effect is believed to be mediated by lymphocyte activation and the initiation of innate immune memory, and this effect may be applicable to SARS-CoV-2 as well (Mohapatra, Mishra and Behera, 2020). Some studies have found that countries without universal policies of BCG vaccination (Italy, Belgium, the Netherlands and USA) have been more severely affected compared to countries with universal and long-standing BCG policies (Miller et al., 2020). However, this finding was presented early on in the pandemic, before Latin America got hard hit despite almost universal coverage of the BCG vaccine, so the argument is not quite as convincing anymore (see Figure 8).

Figure 8. *BCG vaccination policies, by country*



Source: Zwerling, Behr, Verma, Brewer, Menzies and Pai (2017).

However, proper clinical trials are now underway to test if the BCG vaccine really has a beneficial effect on vaccinated individuals in terms of COVID-19 severity. For example, the University Health Network in Toronto has recently begun a BCG trial involving more than 3,600 front-line workers in the area, including medical staff, paramedics, police officers and firefighters, and at least a dozen similar trials are currently under way in other countries, including Australia, Europe and Mexico (Favaro, Philip and Cousins, 2020). Although the vaccine is known to be safe, since we have been using it for 99 years, it will still take a while to determine if it has any beneficial effect on COVID-19. Until clinical trial evidence appears, the WHO does not recommend using BCG vaccines to fight COVID-19. One of the reasons is that supply of the vaccine is limited, and they do not want routine vaccination of children in areas with endemic tuberculosis to be adversely affected (Mohapatra, Mishra and Behera, 2020).

6. *Putting COVID-19 into perspective*

In this section we will put the effects of the COVID-19 pandemic in perspective, both in terms of life years lost and setbacks in the quality of life.

As shown in Section 4, just 20 countries accounted for close to 90% of life years lost due to COVID-19 during the first six months of the pandemic, and only 17 countries lost more than 0.01% of their remaining life years. This means that the vast majority of countries have seen limited loss of life so far. The global loss of life years during the first six months amounted to approximately 15 million years, which is a relatively small number. Every six months, at least three times as many life years are lost due to children dying of diarrhea[26], although typically not in the same countries as people are dying of COVID-19. During the first six months of the pandemic, COVID-19 related excess deaths accounted for 2-3% of all lost life years[27].

Another way of putting COVID-19 deaths into perspective is to compare the 15 million life years lost to COVID-19 to the number of life years added simply through babies being born. During the first six months of the pandemic, about 70 million children were born across the world, with an average life expectancy of about 72.6 years[28], meaning that about 5 billion life years were added to the global stock. Thus, for every life year lost to COVID-19, we gained about 340 life years from babies being born. On an average day, we gain about 28 million life years just by babies being born. This means that the 15 million life years lost to COVID-19 during the first six months of the pandemic have set us back about 14 hours.

[26] According to Our World in Data, 1.57 million people (mostly young children) died of diarrheal diseases in 2017 (https://ourworldindata.org/causes-of-death). Conservatively assuming that each of these deaths imply on average 64 life years lost, this sums to about 100 million life years lost to diarrhea every year, or 50 million every six months.

[27] Assigning conservative estimates of lost life years to each cause of the approximately 27 million deaths that take place every six months (e.g. 40 years lost for each traffic fatality, 15 years lost for a death due to cancer, liver disease, or diabetes, 10 years for dementia, etc.), we calculated a total loss of life years of at least 700 million life years during a normal six-month period.

[28] According to the World Bank's World Development Indicators for 2018. (https://data.worldbank.org/indicator/SP.DYN.LE00.IN).

It is more difficult to put the *ΔLife* dimension of the pandemic into perspective, as we have not experienced anything even remotely similar during our lifetimes. The initial draconian lockdown of the 11 million people in Wuhan was unprecedented in public health history and shocked the world (Reuters, 2020). But the sacrifice made sense, since the initial data from Wuhan suggested that this new virus would kill many more millions if it were allowed to spread. The lockdowns of Wuhan, and other cities in the Hubei province of China, lasted about 10 weeks and were quite effective at squashing the virus there. Unfortunately, the virus had already escaped, and while Wuhan was working hard to eliminate the virus, it spread quickly to almost every country and territory in the world on the approximately hundred thousand flights that occurred daily before the pandemic. Once the world saw hospitals of the rich northern region of Italy collapse with COVID-19 patients, many governments panicked, closed borders, and placed more than 2 billion people in lockdown.

The costs of these lockdowns have been astronomical and multidimensional, with simultaneous shocks on both the supply side and the demand side of the world economy. ILO (2020) calculated that the equivalent of 400 million full-time jobs were lost worldwide during the second quarter of 2020, compared to the same quarter the year before. Few governments have been able to compensate workers and business owners for their lost income during the pandemic, so hundreds of millions of families have seen incomes drop dramatically. Lakner et al. (2020) estimate that the COVID-19 pandemic is likely to push between 88 and 115 million people into extreme poverty in 2020. Decerf et al. (2020) estimate that 235 million additional poverty years have been generated by our responses to the pandemic, thus reversing decades of steady progress in poverty reduction. The World Bank (2020b) estimates that the ongoing crisis will erase almost all the progress made during the last five years in terms of poverty reduction.

The OECD forecasts that global GDP will fall by 4.5% in 2020, compared to 2019. In Italy, India, Mexico, UK, and France the contraction is forecast to be more than double that (Armstrong, 2020). Since global GDP normally increases by a bit more than 2% per year, this means a three-year setback in global GDP due to our reactions to the pandemic.

According to the United Nations, "the COVID-19 pandemic has created the largest disruption of education systems in history, affecting nearly 1.6 billion learners in more than 190 countries and all continents." They argue that "the crisis is exacerbating pre-existing education disparities by reducing the opportunities for many of the most vulnerable children, youth, and adults", and that "closures of educational institutions hamper the provision of essential services to children and communities, including access to nutritious food, affect the ability of many parents to work, and increase risks of violence against women and girls" (United Nations, 2020).

While children can potentially catch up on missed learning in the future, the gaps that are opening up between privileged and disadvantaged students will be very difficult to close. Privileged students with good Internet access, private teachers, appropriate spaces to study, and strong self-motivation will likely continue to do fine despite closed schools and quarantine. However, disadvantaged children without Internet, without food, and without personal space, will find it almost impossible to advance with their study program. In any future admissions tests, interviews or competitions, the latter will have little chance of competing with the former, so the disadvantaged children (the majority) will suffer permanent setbacks from these school closures. Hopefully, the pandemic will at least provide a natural experiment which will allow future researchers to test the impact of public education systems on inequality, both in poor countries and richer countries.

There have also been huge setbacks in terms of public health, as regular public health interventions have been interrupted. The World Health Organization highlights that "preliminary data for the first four months of 2020 points to a substantial drop in the number of children completing three doses of the vaccine against diphtheria, tetanus and pertussis (DTP3). This is the first time in 28 years that the world could see a reduction in DTP3 coverage – the marker for immunization coverage within and across countries." They warn that "the avoidable suffering and death caused by children missing out on routine immunizations could be far greater than COVID-19 itself" (World Health Organization, 2020a).

Mental health is a critical part of overall health and well-being, and, according to a recent global survey by the WHO, mental health services have suffered major disruptions at a time when they are much needed (World Health Organization, 2020b). Isolation, separation from loved-ones, bereavement, loss of income, uncertainty, and fear can all trigger or exacerbate adverse mental health conditions. This can lead to increased levels of alcohol and drug use, insomnia, anxiety, or even suicide. The Economist recently carried out a survey of early signs of increases in suicide due to COVID-19 and found the signs to be ominous. For example, a CDC survey carried out this summer showed that one in four young adults had considered taking their own life. Some suicide hotlines in the US have seen an eightfold-increase in calls. Japan and Nepal have already reported increases in suicides of 15% and 20%, respectively, while Thailand fears an increase of more than 30% this year. Since it takes time for lives to unravel completely, suicide experts expect the tolls to be much worse in 2021 (The Economist, 2020b).

Even the countries that have managed the pandemic relatively well, with few deaths and minimal lockdowns, are suffering the economic consequences of the mismanagement of the pandemic in other parts of the world. Japan, for example, has seen extremely low COVID-19 mortality, despite early seeding of the virus, despite relatively modest constraints on human interaction, and despite having the world's oldest population and the world's most populous city. But, since Japan is the world's third biggest exporter, the recession in the rest of the World has had a dramatic effect on exports, and Japan is currently suffering the biggest slump on record (BBC News, 2020a). New Zealand briefly managed to eliminate the virus, but at a huge cost, as they have had to seal off the island country (BBC News, 2020b). They are now battling the deepest recession since at least 1987, when the current system of measurement began (BBC News, 2020c). and borders are still closed to all but the most critical travel.

Probably the worst hit sector of all is the global tourism sector. The United Nations World Tourism Organization recently released a report (UNWTO, 2020) on the devastating impacts the pandemic has had on the sector:

- 100-120 million jobs at risk
- Loss of around USD 1 billion in exports from tourism
- International tourism set back about 20 years
- Devastating impacts on small island developing states highly dependent on tourism.

7. Conclusions and recommendations

This paper has reviewed the impacts of COVID-19, and our response, for 124 countries in the world in terms of both excess death and changes in the quality of life during the first six months of the pandemic. Our main conclusion is that there is no trade-off between life and death, economy and health, or livelihoods and lives, because the countries that did worst in one dimension also did worst in the other dimension. However, even countries that managed the pandemic extremely well, have suffered large adverse spill-over effects from the bad pandemic management in other countries.

The paper explored many potential explanations for the huge differences in health outcomes between countries, discarding most of them:

- **Early seeding of the virus** seems to have made little difference, since some the first infected countries (Japan and South Korea) have seen very low death rates, while one of the last countries to be infected (Bolivia) has one of the highest death rates in the world.
- **The age structure of the population** is not significantly correlated with mortality rates across countries. Japan, with the oldest population in the world, has seen very low death rates, while Peru, with a relatively young population, had the highest COVID-19 induced excess death rate in the world during the first six months of the pandemic.
- **Co-morbidities** have a very important effect at the individual level, but they cannot explain differences between countries. Spain and Italy were supposedly the world's healthiest countries, according to the Healthiest Country Index (HCI), but they have experienced some of the highest

COVID-19 death rates. In contrast, many African countries did poorly in the HCI, but very well in the COVID-19 pandemic. Obesity prevalence does have a significant cross-country correlation with excess mortality, however.

- **82 other potential explanatory factors** also proved unable to convincingly explain cross-country differences. We checked all 83 sustainable development indicators included in the Sustainable Development Report 2020, that had data for almost all of our 124 countries, and correlations were either weak, or clearly spurious.
- **Reduced mobility to work places** had by far the strongest correlation with excess death rates during the first six months of the pandemic ($\rho = 0.49$).
- **Vitamin D deficiency and stress,** due to lockdowns and reduced income, might help explain the higher death rates in countries with severe lockdowns. Unfortunately, we do not have cross-country data to demonstrate that debilitated immune systems is a key drivers of differences in mortality between countries.

By far, the variable that has the strongest cross-country correlation with COVID-19 mortality is reduction in mobility, especially reduction in mobility related to work places. Of course, a strong negative correlation does not prove that lockdowns cause excess mortality, as causality might go in the other direction. Certainly, you can't go to work if you are dead. You may also feel discouraged from going to work if you have to step over dead people lying the streets, as was seen in some of the worst hit countries, such as Ecuador[29] and Bolivia[30]. It would also be entirely understandable if governments impose tighter restrictions in countries where COVID-19 cases are increasing rapidly, threatening to overwhelm health systems, in which case expected deaths would cause lower mobility. So it is perfectly possible that the direction of causality goes from deaths (or fear of deaths) to decreased mobility.

However, it is at least as likely that the causality goes in the opposite direction, especially since the hardest hit countries locked down very early[31]. In addition, given that less than 0.1% of workers died, that could not explain reduction in mobility related to work places, which was more than a hundred times larger. Dead people in the streets were fortunately also rare and limited to a few weeks, not many months.

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[29] See, for example, https://www.aa.com.tr/en/world/ecuador-bodies-of-coronavirus-victims-are-on-streets/1791407.

[30] See, for example, https://www.dw.com/es/alarma-crece-en-bolivia-por-muertos-en-las-calles/a-54061929.

[31] For example, Bolivia had been watching how the virus spread to more than one hundred countries before registering its first imported case on March 10th. Within a week, borders were so hermetically closed, that not even Bolivians stranded at the border were allowed in (https://eldeber.com.bo/pais/bolivianos-en-la-frontera-con-chile-claman-por-volver-y-el-gobierno-les-responde-que-no_171695), schools were closed, and everybody, except essential workers, were prohibited from leaving their homes, except once a week, in the morning, to get supplies, on a rotating schedule depending on your ID number, and there was police and military in the street to enforce the lockdown. Afternoons and weekends, nobody were allowed outside. Children were not allowed outside at all for six months. Facemasks have been compulsory throughout the pandemic, and, surprisingly, there was no shortage at any time. Compliance with rules was high. Indeed, some hospital staff in New York would have envied many supermarket customers in Bolivia with full protective equipment, including surgical masks, face shields and full body suits.

Given that we had no effective treatments nor a vaccine during the first six months of the pandemic, the only thing that made a real difference in the risk of death was the immune system of each person. The proper functioning of the immune system depends on a lot of factors, some of which cannot be changed (age, sex, and genetics), but others which may be quickly adversely affected by quarantine (e.g. vitamin D deficiency, stress, smoking, drinking, lack of exercise, insomnia, and depression).

The analysis in this paper suggests that if lockdowns are not outright harmful in terms of deaths, at least they are ineffective at reducing deaths from COVID-19. They also have tremendously harmful side effects that extend way beyond the people locked down. Lockdowns only make sense when you are seriously trying to eradicate a virus from the face of this planet, in a coordinated fashion, or if you are sufficiently rich and self-sufficient to manage until the population of your country can be fully vaccinated.

The paper made an effort to put the life and death effects of the pandemic into perspective. We found that about 15 million life years were lost due to COVID-19 during the first six months of the pandemic, but that at least three times that is lost during any six-month period due to children dying from diarrhea. The 15 million life years lost corresponds to a setback of about 14 hours, as approximately 28 million life years are added every day simply from babies being born. There is considerable heterogeneity in deaths, however, with some countries being much harder hit. In three countries, COVID-19 now tops all other causes of death: Peru, Bolivia, and Ecuador.[32]

In terms of quality of life, the setbacks have been orders of magnitude greater. Global GDP is currently estimated to have been set back about three years and global poverty about five years; the equivalent of 400 million full-time jobs were lost during the first six months of the pandemic, resulting in much hardship and despair; education inequalities have grown, with likely permanent adverse effects on the most disadvantaged children; routine immunization has dropped, potentially leading to increased future suffering and death from normally avoidable diseases; and the global tourism industry has been set back about 20 years.

The sharp contrast between the relatively modest losses of quantity of life (setbacks measured in hours) and the huge losses in quality of life (setbacks measured in years), suggests that our reactions to the pandemic have been disproportionate, with the cure causing significantly more harm than the disease at the global level.

By early October 2020, seven months into the pandemic, the WHO estimated that only about 10% of the global population had been exposed to COVID-19 (Keaten, 2020). This is about 20 times more than the

[32] Explore this interactive visualization of mortality data by cause and country: https://www.worldlifeexpectancy.com/selected-deaths-vs-covid-19-bolivia.

officially confirmed cases, but, if they are right[33], it implies that we still have a very long road ahead of us. We urgently need to make some course-corrections in order not to do irreparable harm to our younger generations, and in order not to completely reverse progress on the Sustainable Development Goals.

6.1 What we should have done: Prevention

Prevention is always the first choice in disaster risk management. Approximately 60% of all human infectious diseases are zoonoses, meaning diseases that originate in animals (Fathke, 2014). We could have significantly reduced the risk of a lethal zoonotic virus appearing by not killing and eating billions of wild or domesticated animals every single day (Zampa, 2018).

Short of the whole world going vegan, we should at the very least be carefully monitoring emerging zoonotic viruses, and pay attention to these warnings. For example, Menachery et al. (2015) warned in the title of their 2015 paper that "A SARS-like cluster of circulating bat coronaviruses shows potential for human emergence." Global monitoring networks exist, and with new digital technologies they can be made vastly more efficient (Milinovich et al., 2014). These global structures have been quite successful at managing many recent threats, such as the original MERS-CoV of 2003[34], the 2009 H1N1 flu pandemic[35], the 2012 MERS-CoV[36], and the 2014-2016 Ebola outbreak[37].

The countries that reacted immediately on the early warnings coming out of China about a novel Coronavirus, and quickly ramped up testing capacity in order to facilitate widespread early screening, isolation and contact tracing, were able to detect and contain outbreaks without the need for lockdowns, school closures or other major interruptions of everyday life while at the same time preventing excess deaths. South Korea, Taiwan, Vietnam, Singapore, Hong Kong, and Iceland are examples of countries that successfully applied this ideal strategy. The world would have avoided millions of deaths and there would

[33] The WHO estimates are based on anti-body tests around the world, but some researchers believe the majority of people defeat the virus with their innate immune system, before even developing antibodies (e.g. Doshi, 2020; Lipsitch et al., 2020; Sette and Crotty, 2020). This would imply that a much larger share of the world population has been exposed to the virus, and that we are closer to the end of the pandemic.

[34] SARS-CoV was first detected in Asia in February of 2003. It spread to more than two dozen countries, infected 8098 persons, of which 9.6% died, before it was successfully contained and eradicated (https://www.cdc.gov/sars/about/fs-sars.html).

[35] H1N1pdm09 was first reported in California in April of 2009. It had spread to more than 70 countries by June 11, when it was declared a pandemic. About half a million people worldwide died from H1N1pdm09 virus infection during the first year, of whom 80% were younger than 65. Vaccines were developed and widely deployed in January of 2010, months after the second wave had come and gone. The H1N1pdm09 virus continues to circulate as a seasonal flu virus, killing people every year (https://www.cdc.gov/flu/pandemic-resources/2009-h1n1-pandemic.html, https://www.cdc.gov/h1n1flu/cdcresponse.htm).

[36] The first known case of MERS-CoV occurred in Jordan in April of 2012, likely jumping from camels to humans. With a case fatality rate above 30% it is highly lethal, and has fortunately not managed to spread widely. It has not yet been eradicated, nor is there a treatment or a vaccine available. The biggest outbreak outside the Middle East was in South Korea (https://www.cdc.gov/coronavirus/mers/about/index.html).

[37] The Ebola virus was first described in 1976 in what is now the Democratic Republic of Congo, but the biggest Ebola virus outbreak ever experienced started in Guinea in 2014 and spread to other countries in West Africa, infecting around 26 thousand persons and killing 11,325 of them. It still exists in DRC to this date. With an average case fatality rate of close to 50%, the virus is highly lethal, and only spreads through the bodily fluids of an infected person, which means that outbreaks can be controlled with solid public health measures (https://www.cdc.gov/vhf/ebola/index.html).

be at least a hundred million less people living in poverty by the end of this year, if all countries had reacted like them.

Countries that did not react quickly, but only started worrying when the WHO belatedly declared COVID-19 a pandemic on 11 March 2020, completely missed the opportunity to apply this ideal strategy of handling the virus. Once the virus was spreading widely in communities across the world, mostly by asymptomatic individuals, the optimal strategy of screening, contact tracing, isolation and eradication became infeasible.

6.2 What we need to do now: Total harm reduction

At this point in time, with half a million new COVID-19 cases being officially recorded every day, and many millions of undetected cases undoubtedly occurring as well, we have to switch to a new strategy of total harm reduction. However difficult it is, we have to acknowledge that we failed at containing and suppressing the SARS-CoV-2 virus, and that trying to do so at this point in time will probably cause more harm than the virus itself would cause. Let's be thankful that this time the infection fatality rate turned out to be much lower than initially feared (Ioannidis, 2020), and let's pledge to do much better next time.

Total harm reduction requires a holistic, global approach to dealing with the pandemic, as all our decisions have far reaching effects on every aspect of life across the world. Epidemiologists are extremely important for doing what we should have done (as outlined in section 6.1 above), but their field of expertize is too narrow for dealing with what now needs to be done. For that purpose, public health experts are much better positioned, as they are trained to take into account the multiple dimensions of a health crisis, including psychological effects, long term developmental impacts on children, and effective methods of communication and community engagement. For an even broader view of the diverse indirect effects and trade-offs across sectors and across borders, economics training is needed. We should definitely listen to the scientists and the experts, but to get the full perspective and move towards total harm reduction, we have to make sure to include a broad range of experts, from many different disciplines and from different parts of the world.

Our conclusions, from reviewing the evidence presented in this paper, and from having lived through one of the strictest lockdowns in the world, with one of the highest per capita fatality rates, are the following:

First, let's immediately work to optimize the immune system of every single person, so that it can fight the virus as effectively as possible, and in this way avoid the need for hospitalization, and prevent death. In the short run, this means providing key nutritional supplements, especially vitamins A, C, D, E, B2, B6, B12, folic acid, iron, selenium, and zinc. As the northern hemisphere enters the winter season, vitamin D supplements are especially critical right now. In the medium term it means promoting access to healthy and nutritious diets, as well as active lifestyles with plenty of access to nature. We should all look to Japan for inspiration, as they have the longest life-expectancy in the world, and their COVID-19 infection fatality rate is close to 0 despite widespread COVID-19 infection. Boosting the immune system also means reducing extreme stress due to lack of access to basic means of survival. Asking rich people to work from their comfortable homes with gardens and Internet and not go to the theater for some months is relatively harmless, but locking up self-employed people or daily workers in poor countries, preventing them from earning money for food and shelter, is just cruel. In Bolivia, it took exactly 30 days of strict quarantine before the first little girl committed suicide because of hunger[38]. Suicides due to economic despair are expected to increase dramatically around the world over the next year (The Economist, 2020b).

Second, we should absolutely prioritize getting all children back in school. Quality public education is our most important strategy for reducing inequality of opportunity and promoting long-run sustainable development across the world. Even mediocre public education can be a life-line for disadvantaged children, providing much needed meals and protection from domestic violence. Children are at extremely low risk of a bad COVID-19 outcome, and scattered evidence suggests that schools are not important drivers of infection and death (Couzin-Frankel, Vogel and Weiland, 2020). Sweden and Bolivia both have close to 11 million inhabitants, but have implemented diametrically opposite school strategies during the pandemic, with very different outcomes. Sweden didn't close schools, nor made children wear masks or socially distance, whereas in Bolivia the whole school year was cancelled[39] and there has been no in-person classes at all since mid-March. Despite this, just in La Paz, one of the nine states in Bolivia, at least 80 teachers have died from COVID-19 so far[40]. In contrast, Vogel (2020) identified only a handful of cases of Swedish teachers or school staff having died from COVID-19. Keeping teachers out of schools and away from students is clearly not enough to keep them safe from COVID.

Third, we have to insist on the importance of physical distancing, hand hygiene, masks, ventilation and other simple, cheap and sustainable measures of reducing the spread of the virus and reducing the viral load received by those infected. For the foreseeable future, we have to curb our natural reflexes to shake hands, hug, or kiss cheeks, and instead bow or bump elbows. We have to clean our hands before and after touching a potentially infected surface, such as a supermarket cart, a cash machine, or a door handle. We have to wear masks in public transportation, supermarkets, banks, and other places where a lot of strangers gather and cannot maintain physical distance. Big, indoor crowds should be prohibited in order to avoid potential super-spreader events.

[38] See https://www.lostiempos.com/actualidad/pais/20200422/tragica-muerte-menor-enluta-familia-humilde-montero-piden-ayuda-entierro.

[39] See https://www.dw.com/es/bolivia-anticipa-clausura-del-a%C3%B1o-escolar-por-la-pandemia/a-54409941#:~:text=El%20gobierno%20boliviano%20anunci%C3%B3%20el,los%20ni%C3%B1os%20no%20tienen%20internet.

[40] See https://www.paginasiete.bo/sociedad/2020/9/30/80-profesores-murieron-por-covid-19-en-la-paz-269906.html.

It is important that all these measures are tolerable over quite a long time. If we put too many restrictions on people, their social activities will be driven underground, with potentially adverse effects. For example, a 9 pm curfew may easily backfire, as young people, who perceive almost no risk from COVID-19, might organize sleep-over house parties from 9 pm to 9 am behind closed doors and windows, instead of going out for a few hours with a few friends to a well-ventilated restaurant or bar with good hygiene and physical distancing. As much social interaction and physical activity as possible should be done outdoors, so prohibiting people from jogging in parks, taking their toddlers to playgrounds, hiking in nature, or playing tennis, is clearly counter-productive. All of this was prohibited in Bolivia during the first six months of the pandemic.

Fourth, we need to promote more balanced communication about this pandemic. Peter Drucker once said "You can't manage what you don't measure", and that is very true. But if one issue gets measured and reported in excruciating detail every hour of every day while other equally important issues get measured annually with several years of delay, that will inevitably distort priorities. When Lauren Gardner, associate professor at the Department of Civil and Systems Engineering at Johns Hopkins Whiting School of Engineering, created the absolutely brilliant interactive web-based COVID-19 dashboard to track the coronavirus outbreak across the world in real time[41], there is no way she could have foreseen the catastrophic unintended side-effects it would have. Having access to enormous amounts of data in such a user-friendly and visually attractive format, but without context and perspective, caused news media, governments, and the public in general to panic and react disproportionately, depriving billions of children of education and interaction with their friends, causing hundreds of millions of people to lose their jobs or their small businesses, and causing hundreds of millions of people to be plunged into poverty.

Extreme precautions were indeed warranted in the beginning of the pandemic when case fatality rates appeared very high. But by now it is abundantly clear that the vast majority of infections are asymptomatic, that lockdowns are either ineffective or outright counterproductive, and that we urgently need a more holistic perspective that takes into account all aspects of people's lives, so that we can implement policies that minimize total harm and not just COVID-19 cases.

The change of direction necessary is an extremely bitter pill to swallow for many people, because it means that we have to admit that our obsession with controlling the spread of the virus has done much more harm that the virus itself will ever do. But we really have to swallow this unpleasant pill in order to save the world and get back on track to advance our goals of eliminating poverty and hunger, providing quality education for all, reducing inequality, solving the problem of climate change, etc. .

[41] See https://coronavirus.jhu.edu/map.html.

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Appendix A: Key variables for calculating the ΔDeath variable for the first six months of the pandemic

Africa	Population 2020	Life expectancy at birth	Age (mean)	Residual life expectancy (mean)	Expected residual life years pre-Covid (million years)	Number of official Covid deaths, 12/03/2020-11/09/2020	Total number of excess deaths, 12/03/2020-11/09/2020	Excess deaths per million, 12/03/2020-11/09/2020	Average life years lost per death	Life years lost to Covid, 12/03/2020-11/09/2020	DDeath (%)	Dates excess death	Source excess deaths
Angola	32,866,268	64.0	20.8	49.1	1,613	126	126	3.8	15.5	1,951	0.000		
Bahrain	1,701,583	72.8	31.8	43.1	73	204	204	119.9	19.6	4,005	0.005		
Benin	12,123,198	64.4	22.8	48.9	593	40	40	3.3	14.2	567	0.000		
Botswana	2,351,625	69.0	26.6	46.1	108	10	10	4.3	14.4	144	0.000		
Burkina Faso	20,903,278	61.3	21.4	48.5	1,014	56	56	2.7	15.3	858	0.000		
Cabo Verde	555,988	75.3	29.0	49.7	28	43	43	77.3	14.2	610	0.002		
Cameroon	26,545,864	63.4	22.3	47.2	1,252	415	415	15.6	15.0	6,244	0.000		
Cote d'Ivoire	26,378,275	62.5	22.5	47.2	1,244	119	119	4.5	15.0	1,788	0.000		
Egypt	102,334,403	70.5	27.3	46.2	4,725	5,589	5,589	54.6	12.6	70,615	0.001		
Gabon	2,225,728	67.7	25.0	47.5	106	53	53	23.8	14.3	756	0.001		
Ghana	31,072,945	65.7	24.7	46.4	1,441	283	283	9.1	15.2	4,313	0.000		
Iraq	40,222,503	77.0	24.3	56.4	2,270	7,808	7,808	194.1	20.0	156,091	0.007		
Israel	8,655,541	82.7	33.1	51.0	441	1,077	1,749	202.1	10.8	18,827	0.004	15 Mar - 6 Sep	Roser et al. (2020)
Jordan	10,203,140	78.9	26.6	54.5	556	20	20	2.0	17.6	353	0.000		
Kenya	53,771,300	65.8	23.4	47.4	2,548	612	612	11.4	16.3	9,961	0.000		
Kuwait	4,270,563	72.8	31.8	43.1	184	556	556	130.2	19.6	10,916	0.006		
Lebanon	6,825,442	77.5	31.7	47.8	326	218	218	31.9	13.9	3,020	0.001		
Mali	20,250,834	61.2	20.6	50.4	1,021	128	128	6.3	15.7	2,012	0.000		
Mauritius	1,271,767	74.7	37.7	40.5	52	10	10	7.9	12.5	125	0.000		
Morocco	36,910,558	73.5	31.4	45.6	1,684	1,491	1,491	40.4	13.6	20,218	0.001		
Mozambique	31,255,435	58.2	21.6	43.9	1,373	31	31	1.0	13.3	412	0.000		
Namibia	2,540,916	66.4	24.7	46.7	119	96	96	37.8	15.1	1,451	0.001		
Niger	24,206,636	62.6	19.9	50.8	1,229	69	69	2.9	15.4	1,059	0.000		
Nigeria	206,139,587	63.9	22.2	50.6	10,427	1,075	1,075	5.2	17.6	18,897	0.000		
Oman	5,106,622	72.8	31.8	43.1	220	762	762	149.2	19.6	14,961	0.007		
Qatar	2,881,060	72.8	31.8	43.1	124	205	205	71.2	19.6	4,025	0.003		
Rwanda	12,952,209	68.3	23.6	49.6	642	22	22	1.7	15.6	343	0.000		
Saudi Arabia	34,813,867	72.8	31.8	43.1	1,502	4,189	4,189	120.3	19.6	82,244	0.005		
Senegal	16,743,930	68.0	22.5	50.1	839	293	293	17.5	14.8	4,332	0.001		
South Africa	59,308,690	66.4	29.1	43.0	2,548	15,265	39,400	664.3	15.0	592,325	0.023	4 Mar - 15 Sep	Financial Times
Tanzania	59,734,213	66.7	22.0	50.6	3,021	21	21	0.4	16.3	343	0.000		
Togo	8,278,737	64.5	23.1	47.5	393	37	37	4.5	15.6	576	0.000		
Uganda	45,741,000	65.7	20.4	50.9	2,326	48	48	1.0	15.1	725	0.000		
United Arab Emirates	9,890,400	72.8	31.8	43.1	427	398	398	40.2	19.6	7,814	0.002		
Yemen	29,825,968	68.1	23.2	49.7	1,482	580	580	19.4	15.6	9,023	0.001		
Zambia	18,383,956	63.2	21.2	47.9	881	300	300	16.3	15.5	4,658	0.001		
Zimbabwe	14,862,927	61.4	22.6	44.6	663	222	222	14.9	13.1	2,906	0.000		

Americas	Population 2020	Life expectancy at birth	Age (mean)	Residual life expectancy (mean)	Expected residual life years pre-Covid (million years)	Number of official Covid deaths, 12/03/2020-11/09/2020	Total number of excess deaths, 12/03/2020-11/09/2020	Excess deaths per million, 12/03/2020-11/09/2020	Average life years lost per death	Life years lost to Covid, 12/03/2020-11/09/2020	DDeath (%)	Dates excess death	Source excess deaths
Argentina	45,195,777	76.5	33.7	45.6	2,059	10,712	10,712	237.0	11.4	122,179	0.006		
Barbados	287,371	73.2	30.7	46.9	13	7	7	24.4	12.8	90	0.001		
Belize	397,621	74.1	28.0	49.5	20	19	19	47.8	14.5	275	0.001		
Bolivia	11,673,029	72.9	29.0	47.5	554	7,193	22,900	1961.8	10.9	249,403	0.045	Mar - Aug	New York Times
Brazil	212,559,409	75.6	34.5	44.8	9,528	129,522	129,522	609.3	13.5	1,753,737	0.018		
Canada	37,742,157	81.8	41.1	43.0	1,625	9,162	9,162	242.8	10.9	100,254	0.006		
Chile	19,116,209	79.4	36.6	45.1	863	11,781	12,700	664.4	10.9	138,934	0.016	7 Apr - 16 Sep	Financial Times
Colombia	50,882,884	80.2	33.3	50.0	2,544	22,275	22,275	437.8	15.7	348,914	0.014		
Costa Rica	5,094,114	79.4	34.9	47.0	239	567	567	111.3	13.9	7,902	0.003		
Dominican Republic	10,847,904	73.2	30.7	46.9	509	1,926	1,926	177.5	12.8	24,689	0.005		
Ecuador	17,643,060	76.6	30.5	49.3	869	10,749	35,900	2034.8	13.2	472,626	0.054	29 Feb - 16 Sep	Financial Times
El Salvador	6,486,201	73.8	30.9	46.5	301	777	777	119.8	12.5	9,730	0.003		
Guatemala	17,915,567	72.6	26.1	50.5	905	2,918	2,918	162.9	13.5	39,464	0.004		
Haiti	11,402,533	64.6	27.0	44.1	502	215	215	18.9	11.7	2,519	0.001		
Honduras	9,904,608	74.0	27.3	49.5	490	2,049	2,049	206.9	13.6	27,967	0.006		
Jamaica	2,961,161	74.3	33.0	44.9	133	40	40	13.5	12.7	509	0.000		
Mexico	128,932,753	75.6	31.4	47.3	6,095	69,649	122,100	947.0	13.3	1,623,520	0.027	16 Mar - 2 Aug	New York Times
Nicaragua	6,624,554	79.1	28.7	53.0	351	144	144	21.7	16.5	2,373	0.001		
Panama	4,314,768	79.2	31.9	50.5	218	2,126	2,126	492.7	12.2	25,985	0.012		
Paraguay	7,132,530	76.2	29.1	49.6	354	485	485	68.0	14.1	6,818	0.002		
Peru	32,971,846	80.2	32.5	50.5	1,667	30,344	86,700	2629.5	15.6	1,355,292	0.081	Mar - Sep	New York Times
Trinidad and Tobago	1,399,491	74.1	36.5	41.9	59	43	43	30.7	12.0	516	0.001		
United States	331,002,647	78.4	39.1	42.4	14,048	191,761	286,866	866.7	10.2	2,930,181	0.021	1 Mar - 13 Sep	Roser et al. (2020)
Uruguay	3,473,727	76.9	37.4	42.7	148	45	45	13.0	8.8	394	0.000		

Asia-Pacific	Population 2020	Life expectancy at birth	Age (mean)	Residual life expectancy (mean)	Expected residual life years pre-Covid (million years)	Number of official Covid deaths, 12/03/2020-11/09/2020	Total number of excess deaths, 12/03/2020-11/09/2020	Excess deaths per million, 12/03/2020-11/09/2020	Average life years lost per death	Life years lost to Covid, 12/03/2020-11/09/2020	DDeath (%)	Dates excess death	Source excess deaths
Afghanistan	38,928,341	71.7	31.7	43.4	1,688	1,420	1,420	36.5	12.2	17,384	0.001		
Australia	25,499,881	82.2	38.7	45.5	1,160	785	785	30.8	10.7	8,381	0.001		
Bangladesh	164,689,383	72.5	29.5	47.5	7,822	4,634	4,634	28.1	13.8	64,071	0.001		
Cambodia	16,718,971	74.5	33.4	44.1	737	-	-	0.0	13.2	-	0.000		
Fiji	896,444	67.9	29.8	42.0	38	2	2	2.2	13.2	26	0.000		
India	1,380,004,385	68.9	30.5	43.5	60,005	76,271	76,271	55.3	12.6	959,634	0.002		
Indonesia	273,523,621	71.3	31.2	43.9	12,008	8,455	8,455	30.9	13.6	114,672	0.001		
Japan	126,476,458	84.0	47.0	39.4	4,986	1,400	1,400	11.1	9.8	13,695	0.000		
Kazakhstan	18,776,707	71.7	31.7	43.4	814	1,952	1,952	104.0	12.2	23,897	0.003		
Kyrgyzstan	6,524,191	72.8	27.9	47.9	312	1,063	1,063	162.9	15.0	15,934	0.005		
Laos	7,275,556	67.3	26.9	46.5	338	-	-	0.0	13.2	-	0.000		
Malaysia	32,365,998	74.7	31.7	45.2	1,462	128	128	4.0	13.5	1,728	0.000		
Mongolia	3,278,292	68.8	28.8	43.9	144	-	-	0.0	13.2	-	0.000		
Myanmar	54,409,794	68.4	30.9	43.0	2,340	14	14	0.3	13.9	194	0.000		
Nepal	29,136,808	70.9	28.2	46.5	1,355	317	317	10.9	13.3	4,225	0.000		
New Zealand	4,822,233	82.2	38.7	45.5	219	24	24	5.0	10.7	256	0.000		
Pakistan	220,892,331	66.0	25.9	46.2	10,216	6,370	6,370	28.8	12.8	81,599	0.001		
Papua New Guinea	8,947,027	58.8	25.6	39.1	350	5	5	0.6	13.2	66	0.000		
Philippines	109,581,085	69.5	28.5	44.9	4,922	4,065	4,065	37.1	12.6	51,399	0.001		
Singapore	5,850,343	82.5	42.2	42.2	247	27	27	4.6	12.3	331	0.000		
South Korea	51,269,183	82.5	42.2	42.2	2,162	290	(1,498)	-29.2	12.3	(18,366)	-0.001	1 Mar - 30 Aug	Roser et al. (2020)
Sri Lanka	21,413,250	77.4	34.8	45.1	966	12	12	0.6	13.5	162	0.000		
Tajikistan	9,537,642	70.9	25.1	50.2	479	72	72	7.5	16.4	1,182	0.000		
Thailand	69,799,978	78.0	39.0	42.9	2,994	57	57	0.8	14.4	822	0.000		
Vietnam	97,338,583	74.5	33.4	44.1	4,291	35	35	0.4	13.2	460	0.000		

Europe	Population 2020	Life expectancy at birth	Age (mean)	Residual life expectancy (mean)	Expected residual life years pre-Covid (million years)	Number of official Covid deaths, 12/03/2020-11/09/2020	Total number of excess deaths, 12/03/2020-11/09/2020	Excess deaths per million, 12/03/2020-11/09/2020	Average life years lost per death	Life years lost to Covid, 12/03/2020-11/09/2020	DDeath (%)	Dates excess death	Source excess deaths
Austria	9,006,400	81.6	42.5	41.2	371	748	2,075	230.4	10.0	20,798	0.006	15 Mar - 13 Sep	Roser et al. (2020)
Belarus	9,449,321	73.8	40.2	37.2	351	732	732	77.5	10.3	7,567	0.002		
Belgium	11,589,616	81.2	41.4	42.0	487	9,919	9,300	802.4	9.6	89,604	0.018	15 Mar - 13 Sep	Roser et al. (2020)
Bosnia and Herzegov	3,280,815	76.5	42.0	37.2	122	680	680	207.3	10.8	7,359	0.006		
Bulgaria	6,948,445	74.7	43.4	35.1	244	706	(89)	-12.8	9.9	(883)	0.000	15 Mar - 13 Sep	Roser et al. (2020)
Croatia	4,105,268	78.3	43.3	37.7	155	208	208	50.7	8.9	1,861	0.001		
Czech Republic	10,708,982	79.0	42.2	39.1	419	448	1,032	96.4	10.0	10,293	0.002	15 Mar - 16 Aug	Roser et al. (2020)
Denmark	5,792,203	80.6	41.5	41.2	239	629	561	96.9	10.0	5,626	0.002	15 Mar - 13 Se	Roser et al. (2020)
Estonia	1,326,539	77.9	42.1	38.9	52	64	307	231.4	9.3	2,856	0.006	15 Mar - 13 Sep	Roser et al. (2020)
Finland	5,540,718	81.2	42.7	40.8	226	337	1,309	236.3	10.0	13,030	0.006	15 Mar - 13 Sep	Roser et al. (2020)
France	65,273,512	82.6	41.7	43.3	2,824	30,780	30,631	469.3	9.9	302,056	0.011	15 Mar - 16 Aug	Roser et al. (2020)
Georgia	3,989,175	72.5	38.4	37.8	151	19	19	4.8	9.5	181	0.000		
Germany	83,783,945	80.5	44.0	39.0	3,269	9,340	15,032	179.4	9.3	139,050	0.004	15 Mar - 6 Sep	Roser et al. (2020)
Greece	10,423,056	80.8	44.4	39.0	406	297	615	59.0	8.9	5,499	0.001	15 Mar - 28 Jun	Roser et al. (2020)
Hungary	9,660,350	76.6	42.4	37.2	359	630	(967)	-100.1	9.6	(9,282)	-0.003	15 Mar - 6 Sep	Roser et al. (2020)
Ireland	4,937,796	81.7	37.8	45.6	225	1,781	1,781	360.7	11.2	19,988	0.009		
Italy	60,461,828	83.0	45.3	39.8	2,405	34,956	47,487	785.4	9.6	454,988	0.019	1 Mar - 28 June	Roser et al. (2020)
Latvia	1,886,202	75.0	42.8	36.3	68	35	(133)	-70.5	8.2	(1,090)	-0.002	15 Mar - 13 Sep	Roser et al. (2020)
Lithuania	2,722,291	74.8	43.1	35.9	98	86	384	141.1	8.1	3,121	0.003	15 Mar - 13 Sep	Roser et al. (2020)
Luxembourg	625,976	81.4	39.7	43.5	27	124	175	279.6	10.4	1,827	0.007	15 Mar - 30 Aug	Roser et al. (2020)
Macedonia	2,083,380	77.0	39.1	40.6	85	634	634	304.3	13.1	8,305	0.010		
Malta	441,539	80.9	42.8	40.3	18	14	14	31.7	9.8	137	0.001		
Moldova	4,033,963	72.7	38.4	38.4	155	1,106	1,106	274.2	12.9	14,242	0.009		
Netherlands	17,134,873	81.3	42.0	41.3	708	6,236	10,832	632.2	10.1	109,195	0.015	15 Mar - 13 Sep	Roser et al. (2020)
Norway	5,421,242	82.2	40.0	43.9	238	265	60	11.1	10.3	620	0.000	15 Mar - 13 Sep	Roser et al. (2020)
Poland	37,846,605	77.8	41.7	39.0	1,476	2,159	4,297	113.5	9.8	41,985	0.003	15 Mar - 28 Jun	Roser et al. (2020)
Portugal	10,196,707	81.3	44.7	39.0	398	1,852	7,092	695.5	9.5	67,508	0.017	15 Mar - 13 Sep	Roser et al. (2020)
Romania	19,237,682	75.0	42.0	36.6	704	4,065	4,065	211.3	10.0	40,521	0.006		
Russia	145,934,460	71.9	39.6	36.9	5,387	18,263	18,263	125.1	10.5	190,897	0.004		
Serbia	8,737,370	75.3	41.2	36.7	321	729	729	83.4	9.4	6,823	0.002		
Slovakia	5,459,643	77.2	40.7	39.1	214	37	(228)	-41.8	10.3	(2,338)	-0.001	15 Mar - 30 Aug	Roser et al. (2020)
Slovenia	2,078,932	80.9	43.3	39.9	83	131	224	107.7	10.2	2,278	0.003	15 Mar - 26 Jul	Roser et al. (2020)
Spain	46,754,783	82.9	43.6	41.3	1,932	29,712	57,111	1221.5	9.8	558,727	0.029	15 Mar - 13 Sep	Roser et al. (2020)
Sweden	10,099,270	82.3	41.1	43.1	435	5,854	5,206	515.5	9.8	51,107	0.012	15 Mar - 13 Sep	Roser et al. (2020)
Switzerland	8,654,618	83.8	42.3	43.3	375	1,733	1,364	157.6	10.6	14,472	0.004	15 Mar - 13 Sep	Roser et al. (2020)
Turkey	84,339,067	79.4	33.0	49.0	4,130	6,895	6,895	81.8	15.6	107,874	0.003		
Ukraine	43,733,759	70.3	41.0	34.5	1,509	3,076	3,076	70.3	9.7	29,815	0.002		
United Kingdom	67,886,004	80.8	40.6	42.4	2,878	41,601	64,374	948.3	9.7	622,010	0.022	15 Mar - 13 Sep	Roser et al. (2020)