Burden of Covid-19 restrictions: National, regional and global estimates

Günther Fink,[a,b]* Fabrizio Tediosi,[a,c] and Stefan Felder[b]

[a]Swiss Tropical and Public Health Institute, Kreuzstrasse 2, 4123 Allschwil, Switzerland
[b]Faculty of Business and Economics, University of Basel, Basel, Switzerland
[c]University of Basel, Switzerland

eClinicalMedicine 2022;45: 101305
Published online 18 February 2022
https://doi.org/10.1016/j.eclinm.2022.101305

Summary

Background A growing literature has documented the high global morbidity, mortality and mental health burden associated with the current Covid-19 pandemic. In this paper, we aimed to quantify the total utility and quality of life loss resulting from Covid-19-related government restrictions imposed at the national, regional and global levels.

Methods We conducted quality of life online surveys in France, India, Italy, UK and the United States of America between June 21st and September 13th 2021, and used regression models to estimate the average quality of life loss due to light and severe restrictions in these countries. We then combined estimated disutility weights from the pooled sample with the latest data on Covid-19 restrictions exposure in each country to estimate the total disutility generated by restrictions at the national, regional and global level. We also embedded a discrete choice experiment (DCE) into the online survey to estimate average willingness to pay to avoid specific restrictions.

Findings A total of 947 surveys were completed. Thirty-five percent of respondents were female, and 69.5% were between 18 and 39 years old. The weighted average utility weight was 0.71 (95% CIs 0.69−0.74) for light restrictions, and 0.65 (0.63−0.68) for severe restrictions. At the global scale, this implies a total loss of 3259 million QALYs (95% 3021, 3496) as of September 6th, 2021, with the highest burden in lower and upper middle-income countries. Utility losses appear to be particularly large for closures of schools and daycares as well as restaurants and bars, and seem relatively small for wearing masks and travel restrictions.

Interpretation The results presented here suggest that the QALY losses due to restrictions are substantial. Future mitigation strategies should try to balance potential reductions in disease transmission achievable through specific measures against their respective impact on quality of life. Additional research is needed to determine differences in restriction-specific disutilities across countries, and to determine optimal policy responses to similar future disease threats.

Funding No funding was received for this project.

Keywords: Covid-19; Restrictions; QALY; Cost-effectiveness; Quality of life

Introduction

The Covid-19 pandemic has resulted in unprecedented social, economic and health systems disruptions globally. According to the latest estimates, 20.5 million years of life have been lost to Covid-19 to date,[1] and millions of new cases continue to be recorded each week despite the rollout of vaccines in many countries and the continued use of masks as well as preventive measures in most settings.[2]

Measures to reduce the spread of Covid-19 have been of paramount importance to avoid major health system breakdowns and to limit excess mortality during peak infection periods as those seen in Northern Italy in April of 2020[3] or in India approximately one year later.[4] While these measures are widely considered a success from an epidemiological and public health perspective,[5,6] they also have come at a substantial cost. The direct economic cost of Covid-19 measures have been estimated at USD 7.7 trillion for the US alone[7] and have resulted in unprecedented increases in government debt in many countries.[8,9]

A large number of studies has attempted to assess the cost-effectiveness of measures imposed to restrict

*Corresponding author at: Swiss Tropical and Public Health Institute, Kreuzstrasse 2, 4123 Allschwil, Switzerland.
E-mail address: guenther.fink@swisstph.ch (G. Fink).

Research in context

Evidence before this study

While a large literature has documented the health and economic impact of the current Covid-19 epidemic, relatively little is known regarding the impact of government-imposted restrictions to contian the pandemic. We searched PubMed for related studies on November 26, 2021, combining "Covid-19" with either "utility" or "restrictions" or "QALYs". No search restrictions were made with respect to language or time of publications. We also conducted a basic google search using the same terms to look for gray or unpublished literature. While a large number of studies were found analyzing the disease or economic impact of restrictions, no study was found directly assessing the disutility generated by government restrictions.

Added value of this study

The results presented in this paper suggest that the QALY losses due to restrictions likely exceed substantially the years of life lost due to Covd-19. Utility losses appear to be particularly large for closures of schools and daycares as well as restaurants and bars, while the quality of life loss due to wearing masks and travel restrictions appears minor.

Implications of all the available evidence

Decision models merely comparing the economic cost of government restrictions to potential lives saved are likely to severely underestimate the true cost generated by non-pharmaceutical interventions. As more data becomes available regarding the transmission and health impact of specific measures, effectiveness estimates should be carefully weighed against the financial and population-level quality of life impacts of each restriction in the next phase of the current epidemic or similar future epidemics.

Sars-CoV-2 transmission.[10] Most of the existing cost-effectiveness assessments either compare estimated life years gained to the financial cost of measures faced by governments,[11,12] or estimate the relative cost per life year saved for different containment strategies.[13] Both approaches essentially abstract from the loss in the quality of life experienced by individuals and families, including lost early life learning opportunities,[14] limited access to schooling, loss of employment and, in some cases, complete social isolation. The impact of these restrictions are partially visible in the increased incidence of loneliness,[15] increased prevalence of mental health problems both among adolescents[16] and adults[17] as well as a general deterioration of living conditions, particularly in low income settings.[18] However, the reductions in general well-being go well beyond these specific dimensions of well-being. Life under Covid-19 restrictions entails not only lack of personal and physical contact and frequent social isolation, but also having to combine home office work with child care duties, being deprived of access to sports and entertainment facilities, and frequently also not getting access to specialized medical services.

For decision making in health, the importance of incorporating quality of life (on top of morbidity and mortality impacts) into decision models has long been recognized. In general, the well-being of individuals or patients with specific health conditions or restrictions is established through purposely designed surveys that quantify the subjective valuation of specific states relative to a healthy life. In standardized quality of life surveys, states are defined over a specific health condition such as blindness or paraplegia, and survey respondents asked to indicate how much they value life with this condition relative to a fully healthy life through a series of time tradeoff (TTO) questions.[19] These responses and relative valuations can then be used to quantify the quality-adjusted life years (QALYs) lost due to a specific condition or the QALY gains of treatment. In this paper, we follow this approach to quantify the QALY loss due to government- (rather than disease-) driven restrictions on everyday life.

The main objective of this paper is to quantify the total quality of life loss resulting from Covid-19-related government restrictions imposed at the national, regional and global levels.

Methods

Study design

This study uses data from cross-sectional surveys conducted in France, India, Italy, the UK and the US to estimate the relative utility of life with and without restrictions, and then computes the national, regional, and global burden of Covid-19 restrictions to date.

To compare this burden to the mortality impact to date, we downloaded the latest excess mortality estimates from the Institute of Health Metrics and Evaluation.[20] Data on population size and age structure were taken from the World Population Prospects database (https://population.un.org/wpp/). Crude mortality rates were taken from the World Development Indicators database (https://data.worldbank.org/). Data on Covid-19 restrictions were retrieved from the Oxford Covid-19 Government Response Tracker (https://doi.org/10.1038/s41562-021-01079-8).[2]

Data collection and survey participants

We conducted anonymous online surveys in France, India, Italy, UK and the United State of America using Amazon's Mechanical Turk (MTurk). MTurk is an online platform where volunteer workers sign up for survey or other computational tasks. MTurk has been used in a growing number of studies, and is considered an affordable and reliable source of human participants.[21] We developed survey instruments, programmed using the Open Data Kit (ODK) surveys software package and posted them online on MTurk. All surveys were completed between June 21st and September 13th 2021.

Sample size and power calculations

Targeted sample size was $N = 200$ per country; this size was established to quantify average country level disutility weights with a standard error of 0.02, assuming a mean valuation of 0.7 with a standard deviation of 0.3.

Inclusion / exclusion criteria

All MTurk workers aged 18 and older residents in one of the target countries were invited to participate in the survey. Following MTurk guidelines, participants received a compensation of USD 2 for completing the survey.

Primary outcome variables

The primary outcome variable of interest was the total number of QALYs lost due to Covid-19 restrictions. Following standard QALY procedures,[19] we estimated the utility weight associated with each given state through a series of standardized TTO questions. In most existing QALY surveys, evaluated states are designed over a specific health condition such as blindness or paraplegia, and survey respondents are then asked to indicate how much utility they get from life with this condition relative to a fully healthy life. Utility weights are then normalized such that perfect health equates to a value of 1, and death is assigned a utility of 0.

In our survey, each state was defined over a set of restrictions. Specifically, we considered the following six policies: wearing masks in public spaces; closure of bars, clubs and restaurants; restrictions on international travels; home office; school closures; and restrictions on private meetings. In a first step, subjects were asked to complete a series of standard TTO questions related to paraplegia. Paraplegia questions are commonly used in QALY validation studies, and were introduced both to familiarize subjects with TTO questions, and to be able to compare average utility weights in this population to those seen in other studies. Next, study participants were introduced to a light and a severe Covid-19 restrictions scenario. Light restrictions included wearing masks in public spaces, restricted access to bars and restaurants and limited international travels. Severe restrictions included all of the light restrictions as well as mandatory home office, remote schooling and the inability to hold private meetings.

We considered two alternative framings for the TTO questions: (i) a Covid-19 specific framing, in which we asked subjects to trade off 12 months under a specified set of restrictions against x months of their usual life (with x ranging between 0 and 12 months); (ii) a neutral framing, in which we asked subjects to trade off x years of healthy life against 10 years of life with specific restrictions not linked to Covid-19. No differences were found between the neutral (end-of-life) and the Covid-19- specific framing (Supplemental Materials Fig. S1). We also considered a standard-gamble setup, but dropped this option after the initial piloting due to the difficulty in defining the age-specific probabilities of possible states.

The original survey questions (in English) are provided in Supplemental Appendix A1. Translations to French and Italian were made by the research team.

In order to quantify the respondents' willingness to pay (WTP) for the avoidance of specific restrictions, we invited all study participants to also participate in a discrete choice experiment (DCE). As part of this DCE, we asked subjects to choose between bundles of living conditions involving restrictions on everyday life as well as pre-specified incomes. To ensure an efficient design of the DCE, we used the *idefix* package in the *R* statistical software suite.[22] Each vignette comprised two choice sets describing living conditions in two hypothetical countries from which subjects had to choose their preferred option. Each choice set contained an income that either corresponded to the median, the 25th or the 75th percentile of the respective country, as well as up to six restrictions from the following list: (1) restricted travelling, (2) restaurants, bars and clubs closed, (3) daycare and schools closed, (4) mandatory mask wearing in public, (5) gym and fitness activities closed and (6) private parties, weddings and concerts not allowed. A total of 24 choice set pairs were generated and divided into four blocks with six pairs each. Each study subject was then randomly assigned one block with six decisions. Further details on the DCE are provided in Supplemental Appendix A2.

To measure subjective assessments of government policies to date, we asked subjects: "What is your overall view on governmental pandemic restrictions during the past 18 months?", offering five answers: 1 "too strict" 2 "somewhat too strict" 3 "balanced" 4 "rather too much freedom" 5 "too much freedom".

Statistical analysis

We started by estimating average utility weights with mild and severe restrictions in the pooled sample, and compared it to the reported utility weights for paraplegia. We estimated utility weights for the sample overall, as well as by country, gender and age group. To ensure representativeness within countries, post stratification weights were computed for each age (20–39, 40–59, 60+), gender (male, female) and education (high school or less, some college, completed college) cell. To derive these weights, the population count in each cell as of the last census was divided by the number of surveys collected in the respective group.

For the pooled sample estimate, we normalized the sum of weights to one within each country, assigning an equal overall weight to each country in our sample.

We then combined our utility estimates with data on population size and on the duration of light and severe Covid-19 restrictions in each country to generate national, regional and global estimates of the total utility loss to date. To provide a reference point and benchmark for these estimates, we used the latest excess mortality estimates from the Institute of Health Metrics and Evaluation[20] up to 6th September 2021 (accessed on 17st of November 2021). To translate estimated deaths into Years of Life Lost (YLL), we multiplied the number of Covid-19 deaths with the average life expectancies among individuals dying from Covid-19 estimated by Pifarré i Arolas et al.[1] across countries. For countries where no data on conditional life expectancy were available in this data set, we used the mean life expectancies reported in the sub-region. For Central Asian countries, we used average life expectancy from Western Asia. For Melanesia, we used estimates from Oceania. To account for pre-existing morbidities in the general population, we used average age-specific utility estimates from the UK[23] for all countries.

We also computed counterfactual mortality under the assumption that countries would not have imposed any restrictions. To quantify the hypothetical health effects under this scenario, we assumed that the entire population would have been infected and experienced the most recently reported age-specific case-fatality rates shown in Supplemental Materials Fig. S2.[24] To account for additional mortality due to health system shortages, we assumed a 25% increase in the average all cause-mortality experienced in the 2010–2019 period as well as residual life expectancies identical to those used for Covid-19 deaths.

To estimate the relative disutility from each specific measure, we analyzed responses from the DCE using a random utility framework and conditional logistic regression models as recommended for standard consumer choice models.[25] Estimated marginal effects in the choice model were scaled by the marginal effects obtained for the median income to obtain estimated WTP for (preventing) restrictions.

Last, to capture general valuations of policies imposed to contain Covid-19, we graphically summarize average respondents' approval ratings separately for each country.

Ethical considerations

All surveys were completed anonymously online. All respondents provided consent to the use of data for research by ticking a box before the questionnaire starts. Due to the absence of identifiable data, the requirement for ethics approval was waived by the Swiss national ethics commission (EKNZ Req 2021.00616).

Role of the funding source

No funding was received for this study.

Results

Online survey respondent characteristics

A total of 947 persons completed the survey across the five countries. Thirty-five percent of respondents were female, and 69.5% were between 18 and 39 years old (mean age 36.3 years). Fifteen percent had completed high school or less, 9% had completed some college, and 76% of respondents had completed at least undergraduate studies. Thirty-two percent of respondents had a child under age 6, and 89% of respondents had at least one parent who was still alive. Descriptive statistics by country are provided in Supplemental Materials Table S1.

Average utility weights

The weighted average utility weight was 0.71 (95% CIs 0.69–0.74) for light restrictions, 0.65 (0.63–0.68) for severe restrictions, and 0.49 (0.47–0.51) for paraplegia. As shown in Figure 1, QALY utility weights were relatively similar across countries. Lowest average utility weights were found in France, and highest weights in India. Highest disutility was found for the 40–49 age group and lowest disutility for individuals 70+. For gender, no differences were found overall, but patterns varied quite substantially across countries (Figure 2b). Supplemental Materials Figure 3 shows the full empirical distribution of (individual-level) relative utilities by country.

Excess mortality and exposure to restrictions

Excess mortality estimates were available for 165 countries. 10 countries were dropped because data on restrictions were not available, and 2 countries were dropped because there were no population data in the World Population Prospect, resulting in a final sample of 153 countries. The combined population of these countries was 7.6 billion, corresponding to 97.7% of the total global population.

A full list of countries is provided in Supplemental Materials Tables S2 and S3. Figure 3 summarizes the extent of Covid-19 related restrictions up to 6th September 2021 as compiled by the Oxford Covid-19 Government Response Tracker.[2] On average, countries experienced 5.3 months of light (Stringency Index between 20 and 60) and 12.3 month of severe

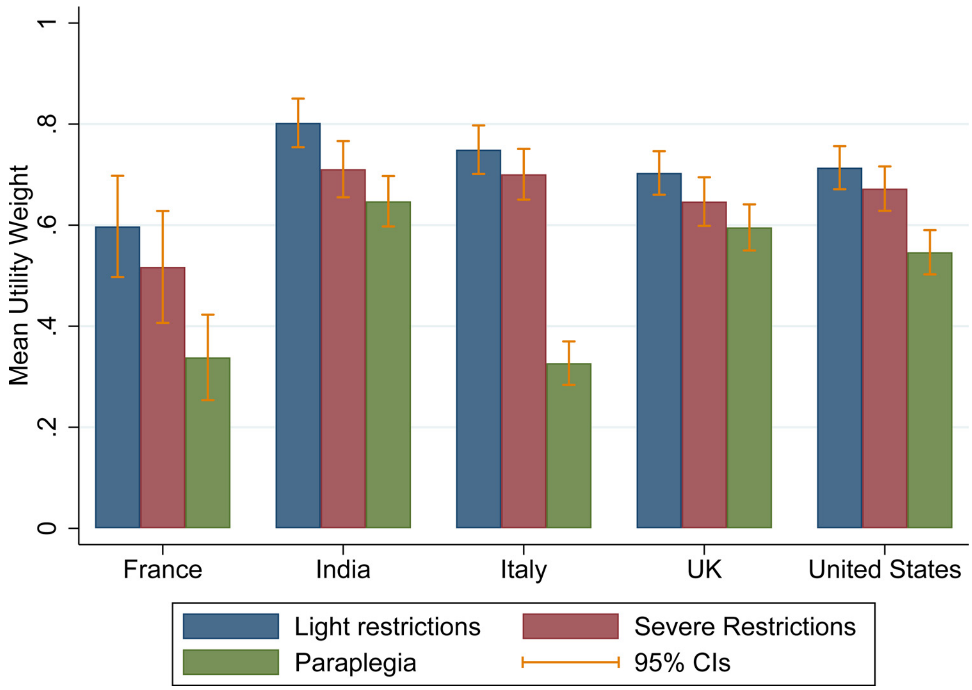


Figure 1. Mean utility weights for light restrictions, severe restrictions and paraplegia by country.
Light restrictions: wearing masks in public spaces, restricted access to bars and restaurants, limited international travels. Severe restrictions: wearing masks in public spaces, restricted access to bars and restaurants, limited international travels. Mandatory home office, remote schooling and the inability to hold private meetings. Sampling weights were used to make the data representative of each country in terms of the overall distribution of age, sex, and educational attainment. 95% confidence intervals around estimated mean utility weights are shown on top of the bar charts.

restrictions (Index over 60) between January 1, 2020 and September 6, 2021. The two countries with fewest restrictions overall to date were Nicaragua and Central African Republic (no data on any Covid-19 outcomes are available for Tanzania); the countries with the longest severe restrictions were Jamaica, Chile, Argentina and Gabon, Supplemental Materials Figs. S4 and S5 provide separate country-level maps for light and severe restrictions.

Estimated loss in QALYs

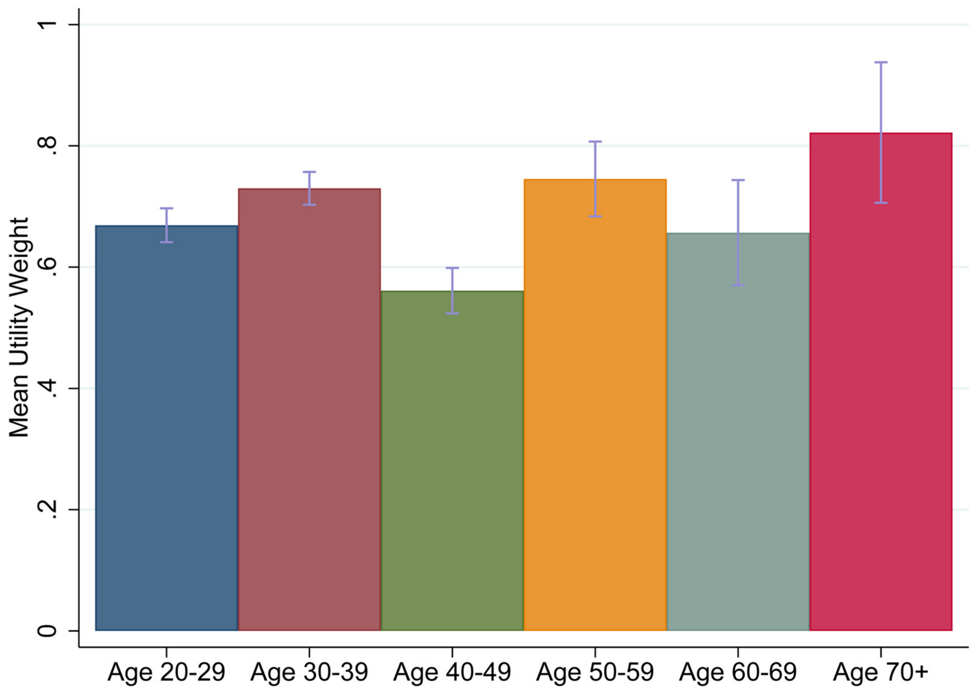
Globally, an estimated total of 3259 million QALYs (95% CIs 3021, 3496) have been lost to date due to light or severe restrictions (Table 1); the majority of this burden is concentrated in upper and lower middle income countries due to their large populations as well as long average duration of severe restrictions.

Table 2 compares the estimated global QALY losses to actual and counterfactual health impacts. As of September 2021, an estimated total of 202 million life years have been lost due to Covid-19 – the majority of these losses occurred in lower middle income countries; India alone accounts for more than one quarter of this toll with an estimated excess mortality of 56 million YLL (Supplemental Materials Table S3). In the absence of any restrictions, we estimate that Covid-19 would have caused a total of 855 million life years lost globally, with the largest burden for upper-middle income countries. China, with currently more than 200 million inhabitants older than 60 years, would likely have faced 10.3 million deaths and 173 million YLL.

Globally, the combined cost incurred so far (QALYs due to restrictions plus life years lost) exceeds the maximum plausible mortality impact of Covid-19 by a factor of 3.1, with particularly high ratios for Africa (5.2:1) and low-income countries (5.5:1) where mortality impacts are comparatively small due to the relatively young age structure.

Willingness to pay for avoiding restrictions

Figure 4 shows that across all countries, subjects were willing to give up 26% (95% CI 0.15–0.38) of their annual salary to avoid school closures and willing to give up 19.5% (95% CI 0.20–0.27) avoid closures of restaurants, bars and clubs. Lowest WTP was observed for removing travel restrictions (4%, 95% CI -0.03 –0.10) and wearing masks in public (-0.05% (95% CI -0.12, 0.03). Full details on the specific questions asked as well as the choice sets given to study participants are provided in the Supplemental Materials Appendix A2.



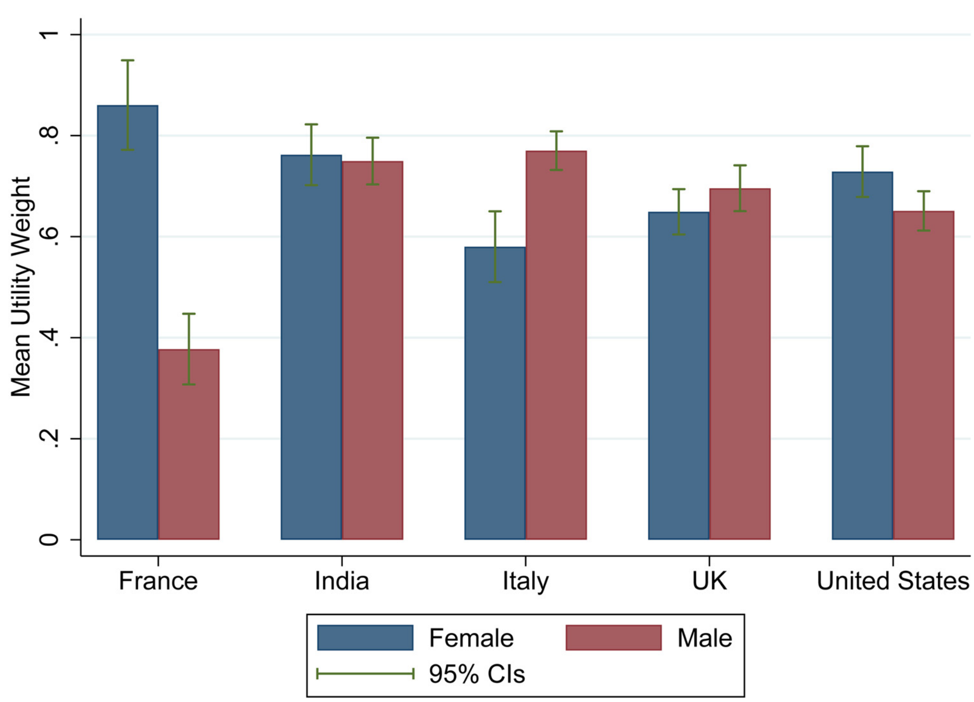


Figure 2. Utility weights by age group and gender.

Figure 2 shows estimated average utility weights by age (Panel A) and gender (Panel B). Age estimates are based on the weighted pooled sample and include both light and severe restrictions. Gender estimates were computed separately for each country. 95% confidence intervals around estimated mean utility weights are shown on top of the bar charts.

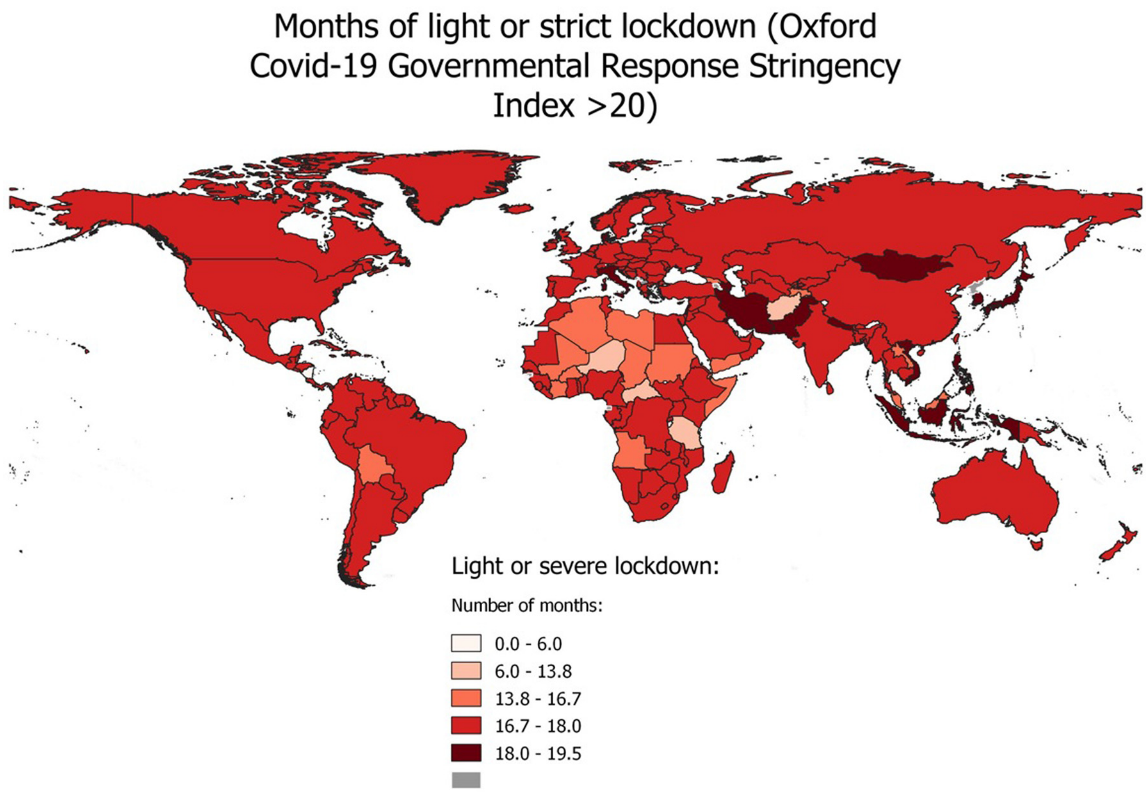


Figure 3. Months of light or severe restrictions by country between Jan 21, 2020 and Sept 6, 2021.

Figure 3 shows the number of months with light or severe restrictions between January 21, 2020 and September 6, 2021. Data source: Oxford Covid-19 Governmental Response Index Tracker (https://github.com/OxCGRT/covid-policy-tracker). Stringency indices between 20 and 60 were coded as light restrictions; stringency indices > 60 were coded as severe restrictions. Map created by authors using the World Bank's International Boundaries shapefile available at https:\\datacatalog.worldbank.org/search/dataset/0038272.

Country Group	Population (Millions)	Months of light restrictions [a)b)]	Months of severe restrictions [a)b)]	Estimated QALY loss due to restrictions	95% confidence interval
World	7615.3	5.3	12.3	3258.61	(3021.35—3495.86)
High income countries	1210.5	7.9	10	499.74	(462.80—536.68)
Upper middle income countries	2566.3	4.2	13.6	1110.59	(1030.28—1190.89)
Lower middle income countries	3216.6	4.2	13.5	1414.22	(1311.93—1516.51)
Low Income countries	622	10.4	5.8	234.06	(216.35—251.78)
Africa	1254.6	9.6	7.3	499.11	(461.66—536.57)
Asia	4565.8	3.9	13.9	2006.45	(1861.66—2151.25)
Europe	744.4	8.5	9.4	302.56	(280.10—325.02)
Latin America and the Caribbean	651.3	3.6	13.8	280.11	(259.92—300.30)
North America	368.7	4.5	13.3	158.01	(146.56—169.45)
Oceania	30.5	7.6	9.9	12.36	(11.45—13.27)

***Table 1*: Total QALYs lost due to restrictions.**

Notes: (a) Months of restrictions are population weighted. (b) Light restrictions are defined as an Oxford stringency index between 20 and 60. Severe restrictions are defined as an Oxford stringency index above 60.

Country Group	Estimated QALY loss to date Millions of QALYs	Excess mortality to date[a)] Millions of YLL	Estimated years of life lost due to Covid-19 mortality without restrictions[b)] Millions of YLL	Estimated years of life lost due to a 25% increase all-cause mortality c) Millions of YLL	Estimated ratio columns (1 + 2)/(3 + 4)
World	3258.61	201.9	854.69	258.24	3.1
High-income countries	499.74	27.64	248.66	33.34	1.9
Upper middle-income countries	1110.59	56.33	321.98	79.59	2.9
Lower middle-income countries	1414.22	109.04	263.55	121.81	4.0
Low-income countries	234.06	8.88	20.5	23.5	5.5
Africa	499.11	21.59	49.93	50.66	5.2
Asia	2006.45	104.79	498.05	150.09	3.3
Europe	302.56	24.28	147.13	27.17	1.9
Latin America and the Caribbean	280.11	39.86	84.6	19.13	3.1
North America	158.01	11.37	71.03	10.71	2.1
Oceania	12.36	0.01	3.96	0.49	2.8

***Table 2*: QALYs and life years lost due to Covid-19 mortality with and without restrictions.**
Notes: [(a)] IHME estimates. [(b)]Based on age-group specific case fatality rates shown in Supplemental Materials Fig. S2. [(c)] Based on average mortality rates observed in the 2010–2019 period. YLL per death based on Pifarré i Arolas et al.[1]

Perceived adequacy of restrictions

Figure 5 shows average respondents' feedback on government restrictions. Across all countries, the majority of respondents either indicated responses were adequate or not restrictive enough. The largest proportions of respondents finding government responses too strong were found in France (14.6%) and the US (16.4%).

Discussion

In this paper, we show that the societal burden of Covid-19 related restrictions as of September 6, 2021 amounts to more than three billion QALYs. This burden is large, and corresponds to about three times the predicted total number of life years lost in the absence of any restrictions. However, this does not imply that measures taken so far were excessive or inappropriate. In fact, as shown in Figure 5, most survey respondents felt that measures were appropriate. Nevertheless, our results do strongly suggest that the societal costs of any restrictive measures taken by governments may be larger than what is commonly acknowledged, and that most citizens would likely be willing to give up a substantial fraction of their incomes to avoid several of these measures in the future. While some measures like wearing masks in public spaces or restrictions on international travels are perceived to be only a minor burden by most study participants and can still be quite effective in reducing disease transmission,[26] the individual and social losses due to other measures such as closures of schools and the closure of bars and restaurants appear rather large. As data on the relative effectiveness of specific measures become increasingly available based on the global experience with the first three waves, effectiveness estimates should be carefully weighed against the financial and population-level impacts of each restriction in the next phase of the epidemic.

Even though this study is to our knowledge the first attempt to quantify the societal impact of Covid-19 restrictions at both the national and global level, several limitations are worth highlighting. First, we were only able to collect survey data in five countries. Even though we found only relatively small differences in the stated utility weights across these somewhat diverse countries, it is possible that larger differences in the subjective valuation of measures would be found in a larger or more diverse sets of countries. Second, while we used census-based sampling weights to create nationally representative samples, it is possible that respondents may not be fully representative of their respective age, gender, and educational attainment stratum. This may be particularly relevant for older individuals, females and young adults, where sample sizes were relatively small. We were not able to collect any data on children. Given the absence of a clear age gradient in the valuation of restrictions, applying the same average utility to children seems reasonable. It certainly appears possible that children are disproportionally affected by restrictions on schooling and leisure – future work can hopefully address this question directly.

Empirically, the differences across age, gender and educational attainment groups seem relatively small on average, which suggests that minor changes in sample composition will likely only have very small effects on the overall QALY losses estimated. The third limitation of the study is that there are currently no internationally validated questionnaires to estimate QALY utilities for states that are only indirectly health related such as Covid-19 restrictions. We piloted several version of the

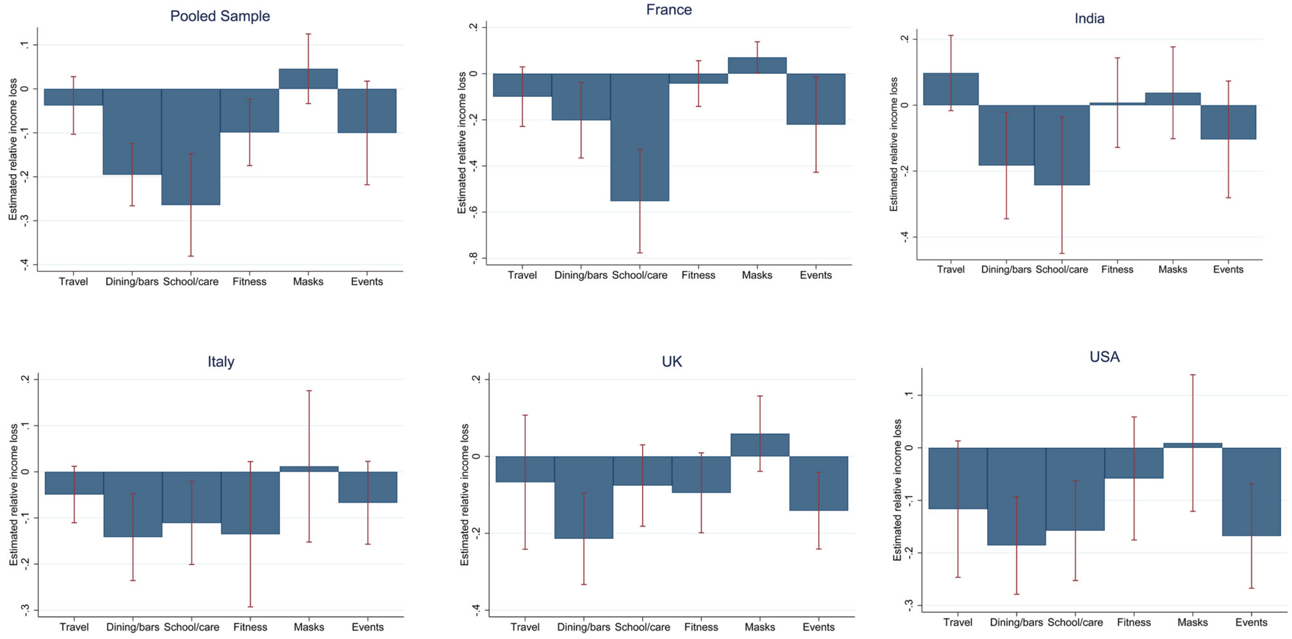


Figure 4. Estimated WTP per year (% of income) for avoiding specific restrictions.

Figures show estimated population-weighted WTP for avoiding each restriction as a proportion of incomes. A relative income loss of -0.1 implies that on average respondents are willing to give up 10% of their incomes to avoid the specific measure. Estimates are based on random utility logistic regression. For France and Italy, the median monthly salary used was Euro 2000. For India, the UK and the US, median annual salaries used as reference point were RP 260,000, UKP 30,000 and USD 50,000, respectively. 95% confidence intervals around estimated mean willingness to pay are shown on top of the bar charts.

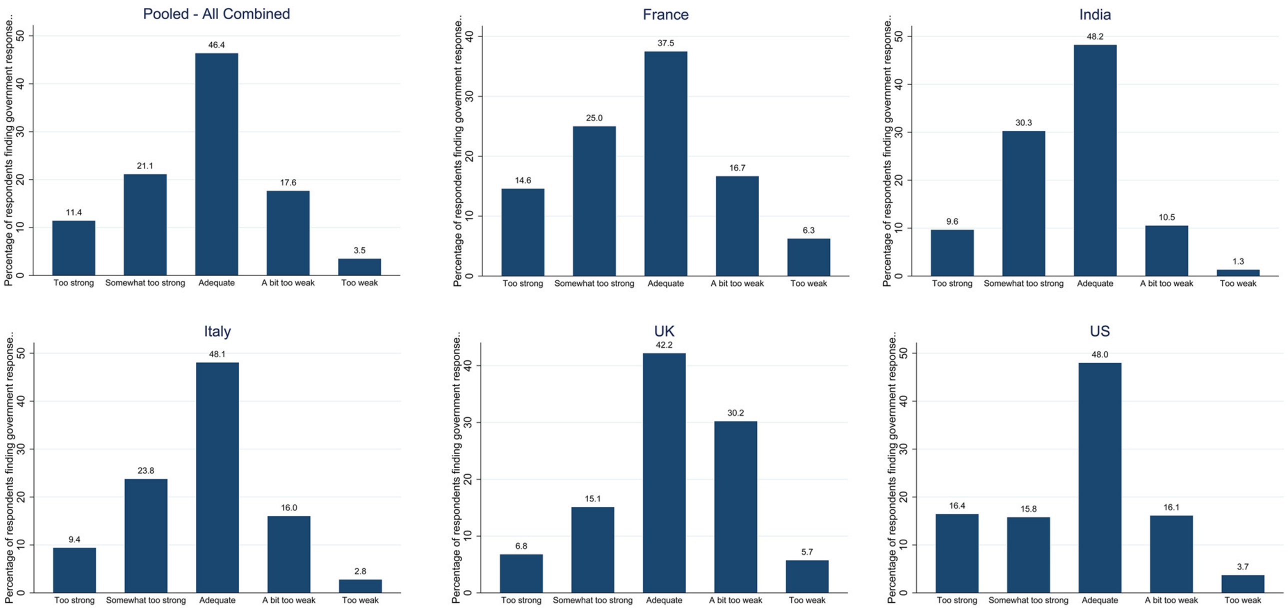


Figure 5. Respondent Approval of Government Measures.

Figures show country-specific approval ratings of government actions taken in response to Covid-19. As part of the online survey, subjects were asked “What is your overall view on governmental pandemic restrictions during the past 18 months?” The first panel shows the results from the pooled sample, the remaining 5 panels show country-specific results.

questions, and then formally tested Covid-19 vs. non Covid-19 framing in our surveys. Conceptually, framing restrictions as related to Covid-19 may lead to subjects justifying these measures as necessary and assigning lower disutility. On the other hand, it may be hard to imagine life with restrictions outside of Covid-19. Our results suggest that very similar responses are obtained with both types of framing. A related concern is that survey respondents may not be able to exactly quantify the relative utility of life with restrictions. We believe that the magnitudes reported here – about a quarter of life quality lost due to light restrictions, and about a third due to severe restrictions – is reasonable. Both states are clearly preferred to paraplegia as a more severe health state by respondents as one may expect. The average utility weight of 0.49 for paraplegia seems well aligned with estimates reported in the literature.[27] The fourth limitation is that the Covid-19 mortality data available (using excess mortality) may still underestimate the true toll of the epidemic in some countries, particularly in those with limited resources.[28] There is currently also no comparable cross-country data on the cost short and long Covid-19. A recent study from the UK suggests an average QALY loss of 0.009 per person due to acute and long-Covid-19,[29] which would imply a relatively small total morbidity cost of USD 71 million QALYs at the global scales assuming similar risks and health trajectories would apply to all other countries.

In summary, the results presented here highlight the very high societal cost of non-pharmaceutical interventions to prevent the spread of infectious diseases such as Covid-19 in terms of quality of life lost. Future policy decisions should take these societal costs into consideration, and try to balance likely reductions in disease transmission from specific measures against their impact on individual and aggregate quality of life.

Declaration of interests

All three authors declare not conflicts of interest.

Data sharing statement

All data will be made available by the authors. Data and analysis codes can be obtained by emailing the corresponding author of the paper at guenther.fink@swisstph.ch.

Funding

No funding was obtained for this study.

Author contributions

SF, GF and FT conceptualized the study. GF coordinated and supervised the data collection, conducted the data analysis and created a first draft of the manuscript. SF and FT provided input and feedback throughout the data collection, analysis and drafting phase and worked on multiple versions of the draft. All authors approved the final version of the manuscript.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.eclinm.2022.101305.

References

1 Pifarré i Arolas H, Acosta E, López-Casasnovas G, et al. Years of life lost to COVID-19 in 81 countries. *Sci Rep*. 2021;11(1):3504.
2 Hale T, Angrist N, Goldszmidt R, et al. A global panel database of pandemic policies (Oxford COVID-19 government response tracker). *Nat Hum Behav*. 2021;5(4):529–538.
3 Goumenou M, Sarigiannis D, Tsatsakis A, et al. COVID-19 in Northern Italy: an integrative overview of factors possibly influencing the sharp increase of the outbreak (Review). *Mol Med Rep*. 2020;22(1):20–32.
4 Pandey V. Coronavirus: how India descended into Covid-19 chaos. BBC News. 2021;Sect. https://www.bbc.com/news/world-asia-india-56977653.
5 Courtemanche C, Garuccio J, Le A, Pinkston J, Yelowitz A. Strong social distancing measures in the United States reduced the COVID-19 growth rate: study evaluates the impact of social distancing measures on the growth rate of confirmed COVID-19 cases across the United States. *Health Aff*. 2020;39(7):1237–1246.
6 Flaxman S, Mishra S, Gandy A, et al. Estimating the effects of non-pharmaceutical interventions on COVID-19 in Europe. *Nature*. 2020;584(7820):257–261.
7 Cutler DM, Summers LH. The COVID-19 pandemic and the $16 trillion virus. *JAMA*. 2020;324(15):1495–1496.
8 Euronews. Euro area debt soars to 98% of GDP amid COVID-19 crisis, says Eurostat. Euronews. 2021.
9 International Monetary Fund. *Global Financial Stability Report: Pre-empting a Legacy of Vulnerabilities*. Washington, DC: IMF; 2021.
10 Rezapour A, Souresrafil A, Peighambari MM, Heidarali M, Tashakori-Miyanroudi M. Economic evaluation of programs against COVID-19: a systematic review. *Int J Surg*. 2021;85:10–18.
11 Rowthorn R, Maciejowski J. A cost–benefit analysis of the COVID-19 disease. *Oxf Rev Econ Policy*. 2020. https://doi.org/10.1093/oxrep/graa030. graa030.Published online 2020 Aug 29.
12 Broughel J, Kotrous M. The benefits of coronavirus suppression: a cost-benefit analysis of the response to the first wave of COVID-19 in the United States. *PLoS One*. 2021;16:(6) e0252729.
13 Reddy KP, Shebl FM, Foote JHA, et al. Cost-effectiveness of public health strategies for COVID-19 epidemic control in South Africa: a microsimulation modelling study. *Lancet Glob Health*. 2021;9(2):e120–e129. https://doi.org/10.1016/S2214-109X(20)30452-6. Epub 2020 Nov 11.
14 McCoy DC, Cuartas J, Behrman J, et al. Global estimates of the implications of COVID-19-related preprimary school closures for children's instructional access, development, learning, and economic wellbeing. *Child Dev*. 2021;92(5):e883–e899. https://doi.org/10.1111/cdev.13658. Epub 2021 Aug 25.
15 Groarke JM, Berry E, Graham-Wisener L, McKenna-Plumley PE, McGlinchey E, Armour C. Loneliness in the UK during the COVID-19 pandemic: cross-sectional results from the COVID-19 psychological wellbeing study. *PLoS ONE*. 2020;15:(9) e0239698.
16 Singh S, Roy D, Sinha K, Parveen S, Sharma G, Joshi G. Impact of COVID-19 and lockdown on mental health of children and adolescents: a narrative review with recommendations. *Psychiatry Res*. 2020;293: 113429.
17 Xiong J, Lipsitz O, Nasri F, et al. Impact of COVID-19 pandemic on mental health in the general population: a systematic review. *J Affect Disord*. 2020;277:55–64.
18 Egger D, Miguel E, Warren SS, et al. Falling living standards during the COVID-19 crisis: quantitative evidence from nine developing countries. *Sci Adv*. 2021;7(6):eabe0997. https://doi.org/10.1126/sciadv.abe0997. Print 2021 Feb.

19 Whitehead SJ, Ali S. Health outcomes in economic evaluation: the QALY and utilities. *Br Med Bull*. 2010;96(1):5–21.
20 IHME. Estimation of total and excess mortality due to COVID-19 2021.
21 Moss A.J. Rosenweig C.R.J., Litman L. "Is it ethical to use mechanical turk for behavioral research? Relevant data from a representative survey of mturk participants and wages." PsyArXiv, 28 Apr. 2020. Web. 2020.
22 Traets F, Sanchez DG, Vandebroek M. Generating optimal designs for discrete choice experiments in R: the idefix package. *J Stat Softw*. 2020;96(3):1–41.
23 Love-Koh J, Asaria M, Cookson R, Griffin S. The social distribution of health: estimating quality-adjusted life expectancy in England. *Value Health*. 2015;18(5):655–662.
24 Levin AT, Hanage WP, Owusu-Boaitey N, Cochran KB, Walsh SP, Meyerowitz-Katz G. Assessing the age specificity of infection fatality rates for COVID-19: systematic review, meta-analysis, and public policy implications. *Eur J Epidemiol*. 2020;35(12):1123–1138.
25 McFadden D. Conditional logit analysis of qualitative choice behavior. In: Zarembka P, ed. *Frontiers in Econometrics*. New York: Academic Press; 1973:105–142.
26 Abaluck J., Kwong L.H., Styczynski A., et al. Normalizing community mask-wearing: a cluster randomized trial in Bangladesh. NBER Working Paper 2021; 10.3386/w28734.
27 Haagsma JA, Polinder S, Cassini A, Colzani E, Havelaar AH. Review of disability weight studies: comparison of methodological choices and values. *Popul Health Metr*. 2014;12:20. https://doi.org/10.1186/s12963-014-0020-2. eCollection 2014.
28 Karlinsky A, D. K. The world mortality dataset: tracking excess mortality across countries during the COVID-19 pandemic. Preprint medRxiv 2021;2021012721250604 Published 2021 Jun 4 https://doi.org/10.1101/2021.01.27.21250604.
29 Martin C, Luteijn M, Letton W, Robertson J, McDonald S. A model framework for projecting the prevalence and impact of Long-COVID in the UK. *PLoS One*. 2021;16:(12) e0260843.