

The Benefits and Costs of Social Distancing in High and Low Income Countries*

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November 17, 2020

*This work has benefited from the comments and suggestions of two anonymous reviewers. All errors are our own.

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Abstract

Background: Widespread social distancing and lockdowns of everyday activity have been the primary policy prescription across many countries throughout the COVID-19 pandemic. Despite their uniformity, these measures may be differentially valuable for different countries.

Methods: We use a compartmental epidemiological model to project the spread of COVID-19 across policy scenarios in high and low income countries. We embed estimates of the welfare value of disease avoidance into the epidemiological projections to estimate the return to more stringent lockdown policies.

Results: Social distancing measures that “flatten the curve” of the disease provide immense welfare value in upper-income countries. However, social distancing policies would deliver significantly less value in lower-income countries that have younger populations, which are less vulnerable to COVID-19. Equally importantly, social distancing mandates a tradeoff between disease risk and economic activity. Poorer people are less able to make those economic sacrifices.

Conclusions: The epidemiological and welfare value of social distancing is smaller in lower-income countries, and such policies may exact a heavy toll on the poorest and most vulnerable. Workers in the informal sector often lack the resources and social protections that would enable them to isolate themselves until the virus passes. By limiting these households’ ability to earn a living, social distancing can lead to an increase in hunger, deprivation, and related mortality and morbidity.

Keywords: COVID-19; social distancing; global health; pandemics; VSL; welfare economics

1 Introduction

The COVID-19 pandemic has generated furious debate about what public health measures will prove most effective at controlling the spread of the disease. Without a vaccine for the novel coronavirus, governments across the world implemented social distancing and lockdown measures designed to “flatten the curve” of the pandemic. The goal of shutting down a country is to minimize transmission rates for a sufficient duration so as to allow more targeted testing and tracking measures to be effective in slowing the spread of the virus and minimizing pressure on healthcare systems. In parallel to the implementation of these public health measures, a conversation has emerged about the economic consequences of lockdown and suppression, especially within low-income countries. With social distancing having become the universal strategy against COVID-19, a question emerges: was shuttering the economy for months a reasonable cost to pay?

The answer for the United States and other high-income countries with significant mortality risk from the coronavirus appears to be yes. By assigning an economic value to the mortality risk of COVID-19, it becomes clear that the cost of *not* intervening in high-income countries would be enormous.¹ In other words, according to any reasonable benefit-cost metric, social distancing interventions and aggressive suppression are overwhelmingly justified.

The purpose of this paper is to quantitatively explore the value of varying suppression strategies in lower- and middle-income countries. There are a number of demographic and infrastructural reasons why the benefits of lockdowns to suppress COVID-19 may co-vary with the income level of a country. Lower income countries have relatively younger populations, and the predicted mortality of COVID-19 increases sharply with age.² Therefore the majority of the population in low-income countries is predicted to face a relatively low mortality risk from the coronavirus. Conversely, the infrastructural limitations of the healthcare systems in low-income countries means that they are comparatively less capable of absorbing a rapid influx of COVID-19 patients, such that it may be infeasible to flatten the curve of the disease to fall within capacity without more significant lockdown or mitigation efforts.

The economic welfare value of reducing mortality risk from COVID-19 may also be less in lower-income countries. Because the poorest individuals and households live close to subsistence levels, they must necessarily accept higher risks to earn a living than richer people who may enjoy savings

or access social welfare systems to sustain them through a prolonged lockdown. Many more workers in low-income countries are self-employed or in the informal sector and depend on daily wages to feed their families. In the absence of strong social protection and insurance, the cost imposed by social and economic distancing may be large in terms of immediate deprivation and hunger. This difference in risk valuation reflects a necessary determination by people who are less able to trade their livelihoods for a reduction in probabilistic risk. Poorer households may not be able to comply with lockdown orders, and countries with relatively weak enforcement capacity may end up with the worst of both worlds: a shuttered formal economy, but continued informal economic activity leading to the continued spread of COVID-19.

2 Materials and Methods

We generate mortality predictions for SARS-CoV-2 epidemic trajectories across five non-pharmacological intervention scenarios using an age-structured compartmental SEIR model designed by the Imperial College London COVID-19 Response Team.³ The model simulates the spread of the novel coronavirus in each country and resultant hospitalizations and fatalities, according to that country's demographic structure and healthcare capacity. We model each country's population at the start of the pandemic, where everyone is initially susceptible. As the virus spreads, more of the population becomes exposed, then infected, and then recovers. Infected individuals either experience a mild infection or a more severe form that requires some form of hospitalization. Hospitalized cases are further split between those requiring intensive treatment and those requiring routine hospital care. The model assigns an age-specific mortality probability to individuals that receive hospital care, and a higher mortality likelihood to individuals that require but cannot receive hospital care due to capacity constraints. The speed with which the virus spreads, and the fraction of the population that is ultimately infected, is defined by the estimated infectivity (R_0) of the virus. The infectivity of the virus is determined both by its biological parameters and the density and pattern of interactions of people of different ages within each country. Estimates of the R_0 value of the virus in each country at the start of the pandemic are sourced from a previously published method using the squire model.⁴ Using the base estimates of the infectivity for COVID-19 in each country, we estimate mortality rates under different scenarios where we temporarily modify the infectivity of

the virus to represent the implementation of a social distancing policy in each country. We consider five scenarios:

1. The unmitigated spread of COVID-19, where the virus progresses through each country at a high level of infectivity.
2. The implementation of an “individual” distancing policy, similar to the case of a country like Sweden where workplaces, schools, and restaurants mostly remain open but large gatherings are discouraged, reducing infectivity by 15%.
3. A broad social distancing policy, equivalent to the closure of schools and workplaces, that reduces infectivity by 35%.
4. An even more intensive social distancing policy with targeted stay-at-home orders, “social distancing+” that reduces infectivity by 50%.
5. Full lockdown policies designed to entirely suppress social contact, closing transit and stay-at-home orders for the entire population, reducing infectivity by 60%.

In each of these scenarios we allow the policy to remain in effect for a duration of forty days, representing the average duration of most lockdown and social distancing policies around the world, with Google mobility data indicating that mobility was significantly increased after forty days from lockdown.⁵ After forty days the simulated policy is lifted and the R_0 of the virus returns to the country-specific estimated base level of infectivity it presented at the start of the pandemic. We have chosen a one-shot policy due to its relative simplicity. While rolling lockdowns have been proposed as an effective way of combating the spread of the coronavirus, we are skeptical as to the capacity of governments being able to repeatedly implement and terminate lockdown orders. In countries with limited state capacity, and the majority of the workforce in the informal sector, there are few policy tools to implement sophisticated partial lockdowns.

Our analysis includes 178 countries, which we aggregate according to their 2020 World Bank income classification: high-, upper-middle, lower-middle, and low-income economies.⁶ Data on life expectancy for each age group is given by the World Health Organization Global Health Observatory.⁷ We run a grid search at a 5-day resolution to find the most optimal timing for each social

distancing and lockdown policy in each country. In this way we only consider the impact of optimally timed policies, as though a government could have foresight over the exact date on which to implement a policy, and as such these represent a best-case scenario for policies designed to mitigate COVID-19.

FIGURE 1: What is mortality risk from COVID-19 by country?

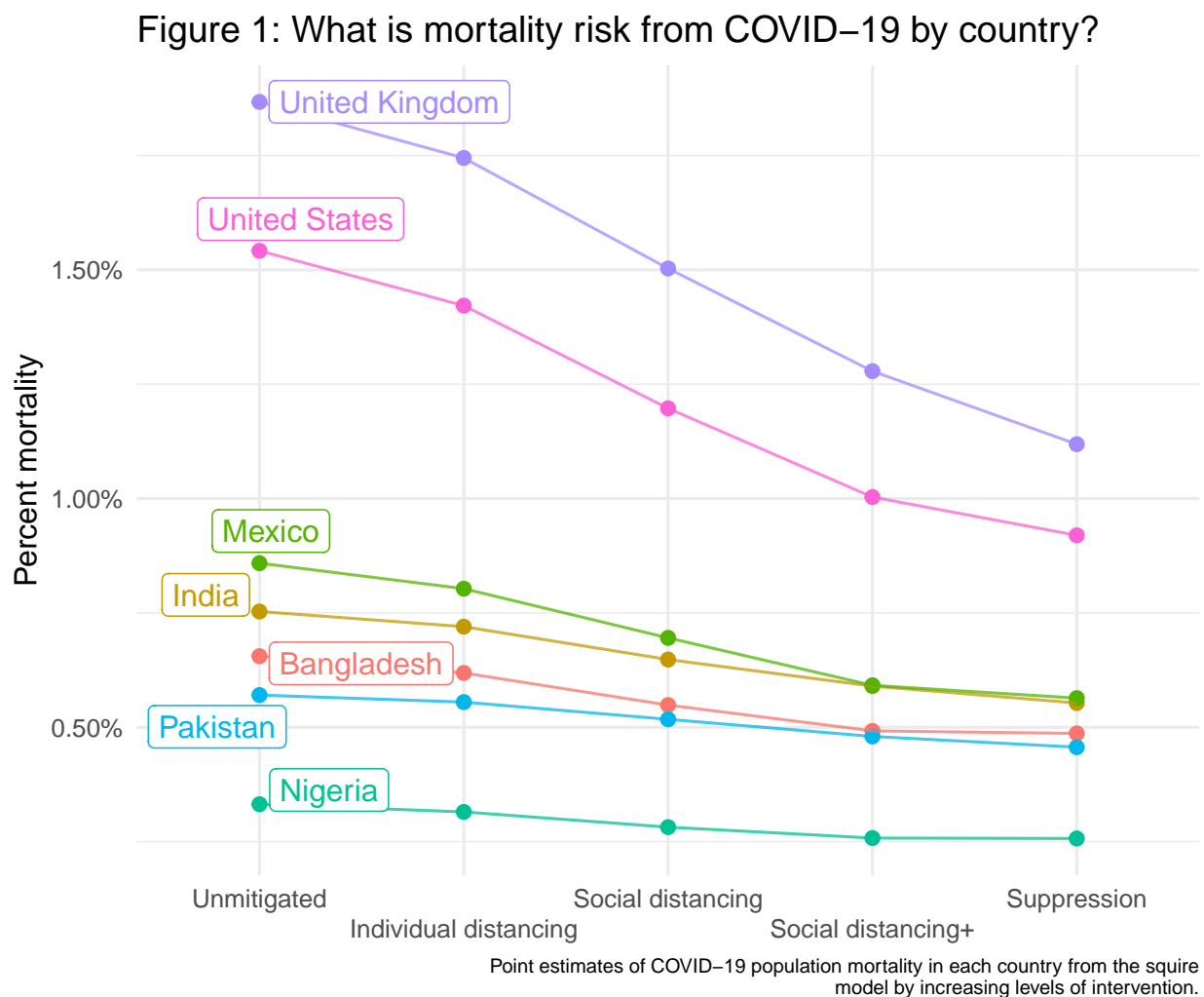
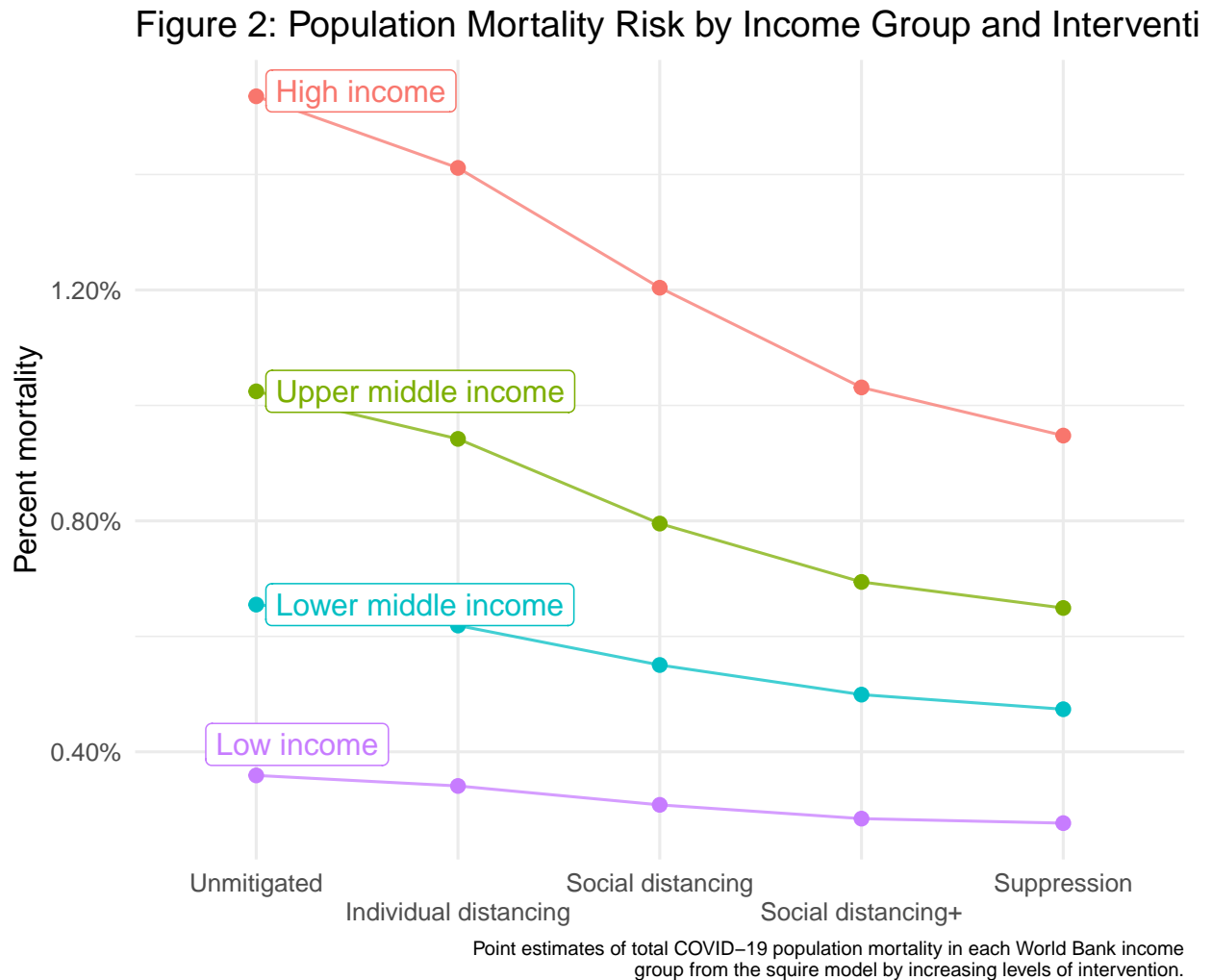


Figure 1 shows predicted mortality from the spread of COVID-19 for a set of countries. For higher-income countries like the United Kingdom and the United States the model predicts that the unmitigated spread of COVID-19 would lead to more than 1.5% of the population dying. In the same scenario in lower-income countries, such as Nigeria, Pakistan, and Bangladesh, predicted mortality is approximately half that. Moreover, while mortality falls sharply in the United States and the

FIGURE 2: Mortality Risk by Income Group and Intervention



United Kingdom when social distancing measures are imposed, the change in mortality is far less responsive in lower-income countries. We aggregate total predicted mortality under each scenario by total population across all four income groups in Figure 2, finding that expected mortality is lower in lower-income countries despite their comparatively more limited health care systems.

2.1 Demographic risk profiles

The primary cause of the divergent mortality risk between countries of higher and lower income levels from COVID-19 is their demographic structure. High-income countries tend to have lower fertility rates and older populations; low-income countries tend to have higher fertility rates and

younger populations. This is important because the mortality risk of COVID-19 varies considerably by age. Younger people appear to face relatively low mortality risk from the virus, and the mortality rate increases sharply among the elderly. Age-specific mortality parameter estimates are given in Figure 3. The proportion of cases requiring hospitalization increases with age, up to nearly 20% of the elderly, those age 75 and above. Of the patients hospitalized, a subset will require critical care, such as mechanical ventilation. We set a mortality rate of 50% across all ages for those requiring and receiving critical care, and a mortality rate of 95% for those requiring but not receiving critical care. For patients hospitalized but not requiring critical care, the mortality rate is low for those under the age of 60, reaching nearly 60% among the elderly. For people that would require but cannot receive hospital care due to capacity constraints, their likelihood of dying doubles, up to a maximum of 90%.^{2,3}

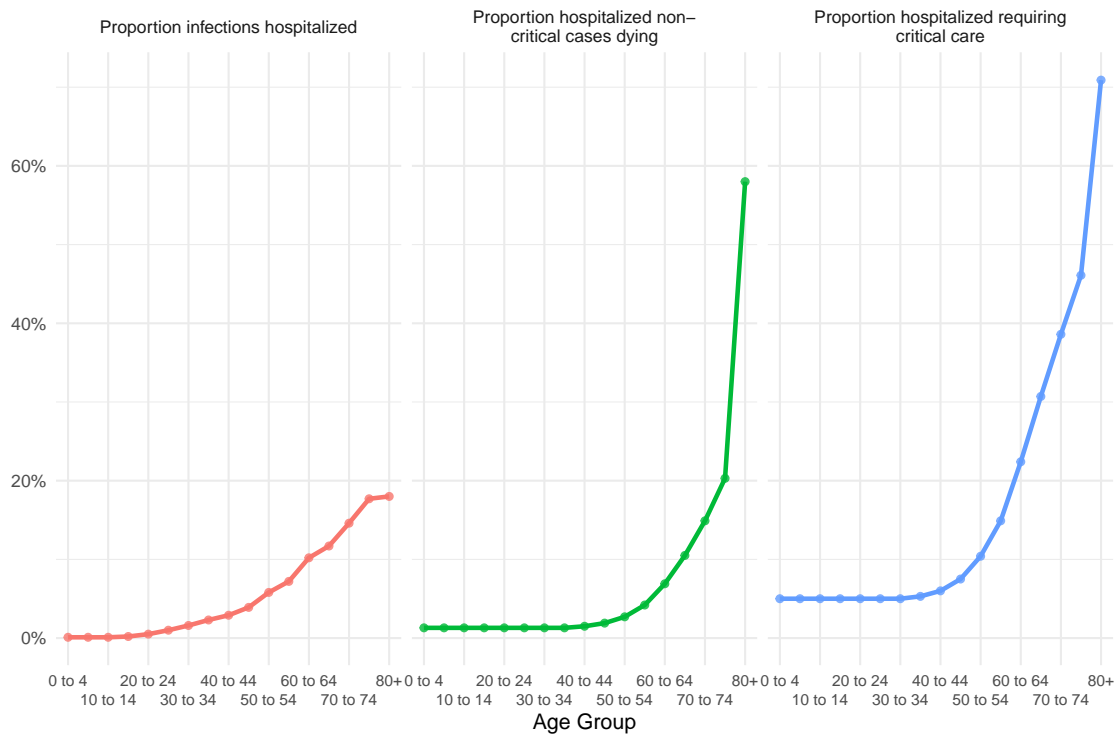
A question that we cannot fully answer at this time is the likelihood of death for an infection that would require but does not receive hospital care. As there are currently no effective treatments for COVID-19 it is unclear whether non-critical cases are receiving lifesaving care in hospitals, or whether the support they receive only increases their comfort without significantly modifying their likelihood of dying.¹ We consider a range of parameters for excess mortality in Section 3. A second concern is that the epidemiological model does not account for the higher burden of infectious diseases and chronic illness in low-income countries, particularly in children. If these factors negatively interact with COVID-19 this could lead to an under-estimate of mortality in low-income countries.^{8,3}

In Figure 4 we show the distribution of age groups in each population across countries that are classified as either high- or low-income. Each point represents the fraction of the population within that age range in a country. Where the population structure in higher income countries is more evenly distributed across the entire age range, the population in lower-income countries is heavily skewed younger. This skewness means that lower income countries have a much smaller fraction of their population that is predicted to be hospitalized or die from COVID-19 if they contract the virus.

¹We discussed the change in mortality for severe cases of COVID-19 conditional on the availability of hospital resources extensively with doctors working in hospitals in the United Kingdom, the United States, Brazil, Ethiopia, Nigeria, Bangladesh. The doctors emphasized the difficulty of even defining which cases needed to be hospitalized, as well as the difficulty of understanding how hospital treatment improved survival.

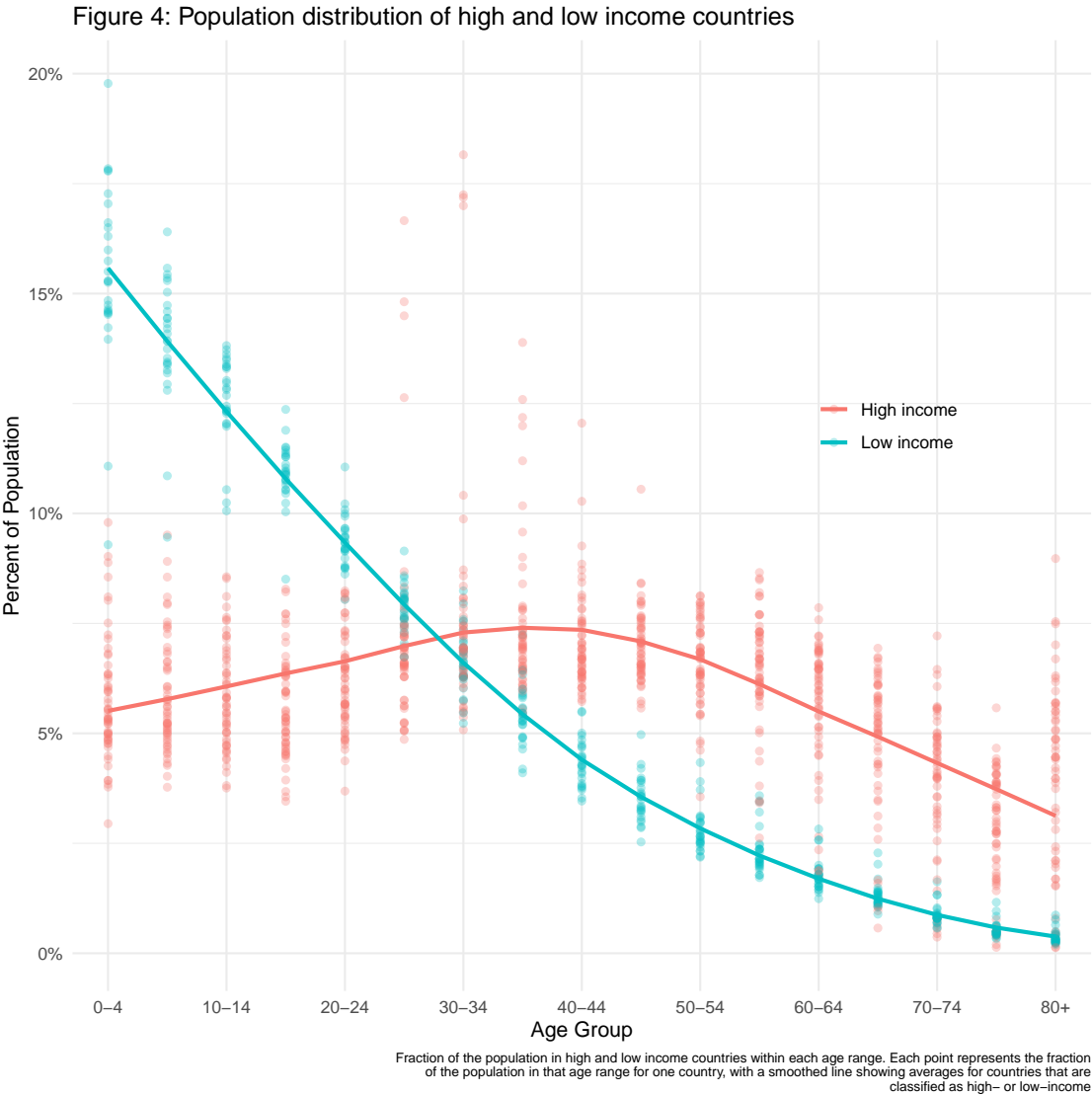
FIGURE 3: Estimated Risks of COVID-19 by Age Group

Figure 3: Estimated Risks of COVID-19 by Age Group



Estimated risk of COVID-19 hospitalization and conditional mortality as given in Verity et al. (2020). The risk of hospitalization climbs dramatically with age, and cases requiring hospitalization are assigned a separate mortality likelihood based on whether or not they require critical care.

FIGURE 4: Population distribution of high and low income countries



2.2 Medical system capacity

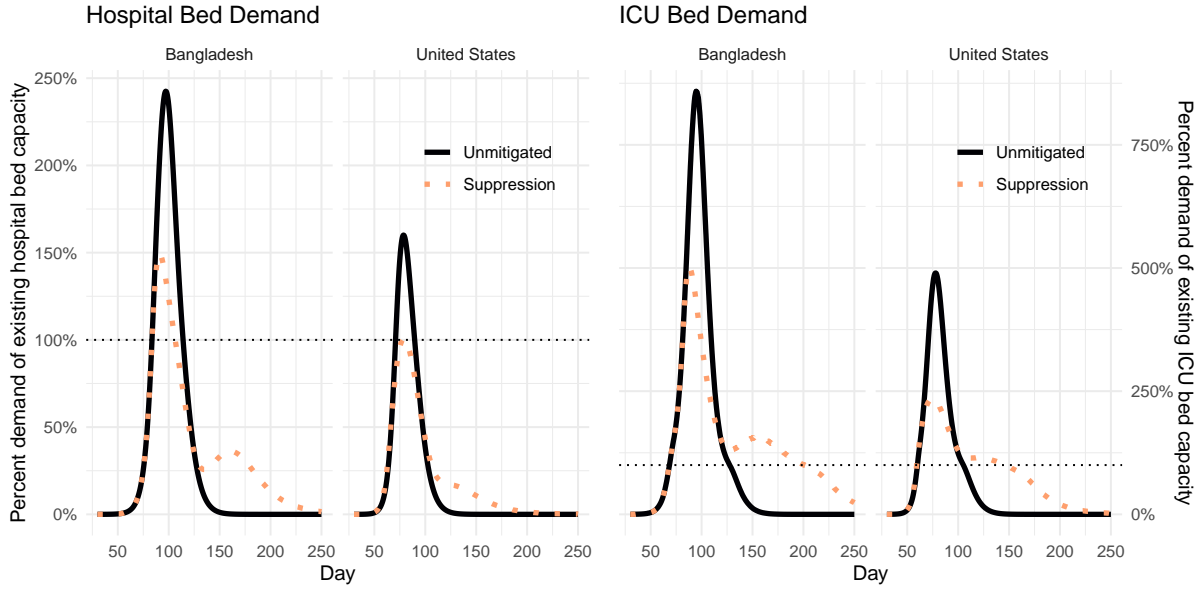
The spread of COVID-19 has threatened to overwhelm the medical system of many countries. One benefit to social distancing policies that reduce infectivity, flattening the curve of the disease's trajectory, is to spread the number of infections across a longer period of time, allowing more patients to be accommodated by existing infrastructure. In lower-income countries with more limited healthcare capacity—proxied by the number of hospital and ICU beds—it may be impossible to sufficiently flatten the curve of COVID-19 sufficiently so that patient demand can be met.

In Figure 5 we plot the estimated demand for healthcare under two scenarios as a percentage of existing capacity in a high- and low-income country, Bangladesh and the United States, respectively. The first scenario involves the unmitigated spread of COVID-19 in both countries, and the second involves the suppression scenario: intensive lockdown policies that reduce the virus infectivity by 60% for a period of forty days. Assuming identically implemented and effective policies in both countries, suppression is effective at allowing existing U.S. healthcare infrastructure to accommodate demand, while the healthcare infrastructure in Bangladesh is overwhelmed in either case. In Bangladesh the unmitigated spread of COVID-19 leads to excess demand that peaks at nearly 250% of hospital bed capacity; under an intensive social distancing policy excess demand peaks at approximately 160%. In the United States an identical policy would drop peak demand from 160% of capacity to approximately 100%. Suppression effectively brings hospital demand down to capacity in the United States, Bangladesh demand would still exceed capacity by nearly 50% in the most stringent lockdown.

Increasing social distancing measures save an increasing number of lives as shown in the projected mortality rates in figures 1 and 2.⁹ We are interested in determining the relative value of distancing and lockdown measures in different countries. To do so we embed country-specific estimates of the welfare value of risk reduction, the value of a statistical life (VSL) and the value of a statistical life-year (VSLY), into our mortality predictions.^{10,11} This allows us to translate between the change in predicted mortality and the social welfare benefit this would provide each country.

It is important to emphasize that social distancing policies are a form of risk reduction. We can predict in expectation how many lives each policy may save, but we cannot know exactly which person will benefit. Social distancing is designed to limit the extent and rate of the spread of COVID-

FIGURE 5: Hospital and ICU demand in Bangladesh and the U.S.



19 in each country, reducing aggregate mortality from the disease. To provide a valuation for this probabilistic reduction we use the VSL, a metric of the economic value of risk. The VSL is derived from studies of how individuals accept mortality risks, whether as a result of their occupation or from external environmental sources or disease, on a regular basis when appropriately compensated. Adding up the value that people assign to small changes in probabilistic risk provides an estimate of the monetary welfare value that people assign to saving one such *statistical* life. The VSL is in no way a measurement of the economic productivity that a person provides, but rather is based on how individuals themselves assign value to the risks they face.²

3 Results

Figure 6 displays the estimated dollar value of total losses from deaths under each intervention scenario when the VSL estimates are embedded in the mortality predictions.¹⁰ The cost of leaving COVID-19 uncontrolled in the United States is unambiguously large. This is due to higher predicted mortality rates in the United States relative to other countries and the higher base VSL. In comparison to U.S. losses, the dollar costs of uncontrolled COVID-19 in large countries such as

²One way of understanding the VSL is through a recent strike by Instacart workers in the United States during this pandemic, who are demanding an additional \$5 in hazard pay per order as compensation for their increased exposure to the disease.¹²

Pakistan or Nigeria look minuscule. A more relevant question for any country-specific policy is the total cost of COVID-19 mortality under each scenario relative to that country's own GDP.

FIGURE 6

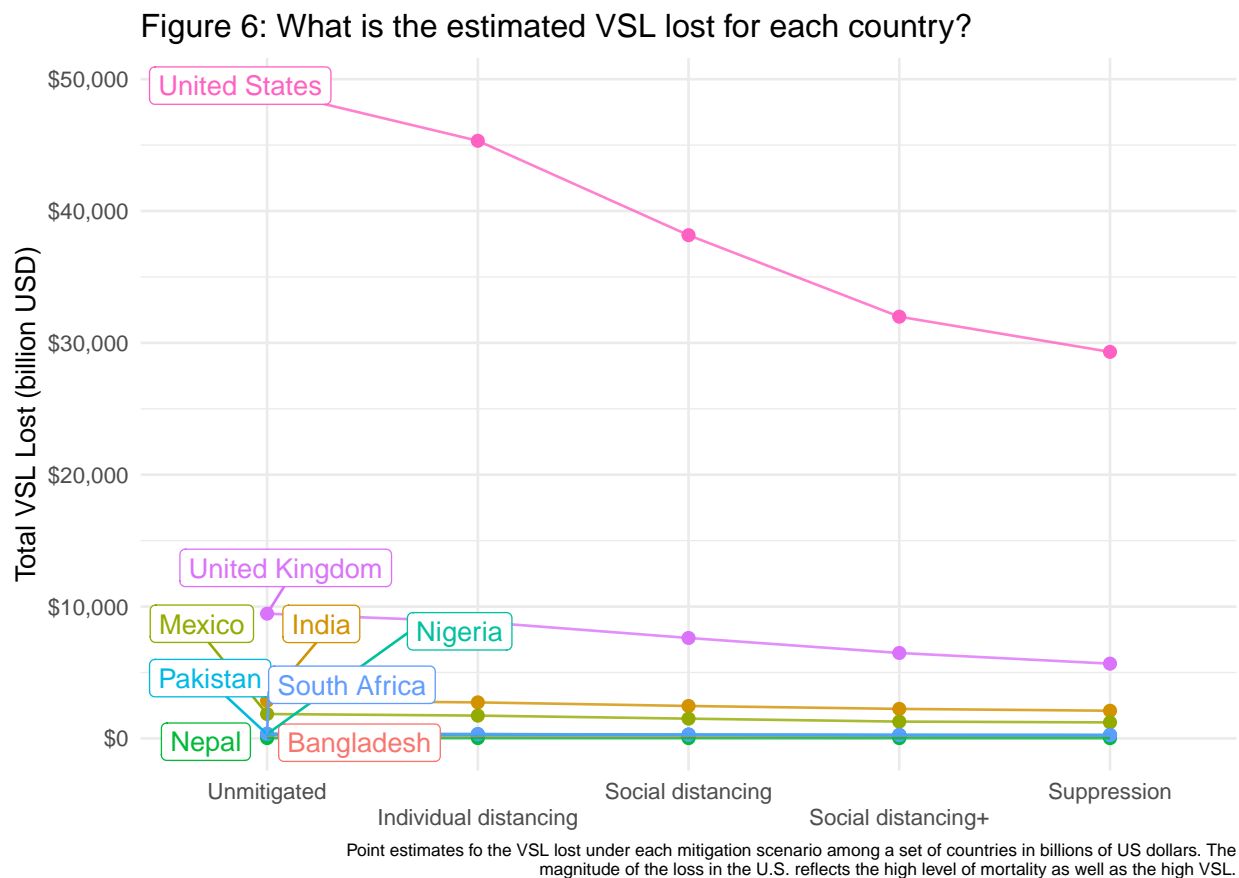
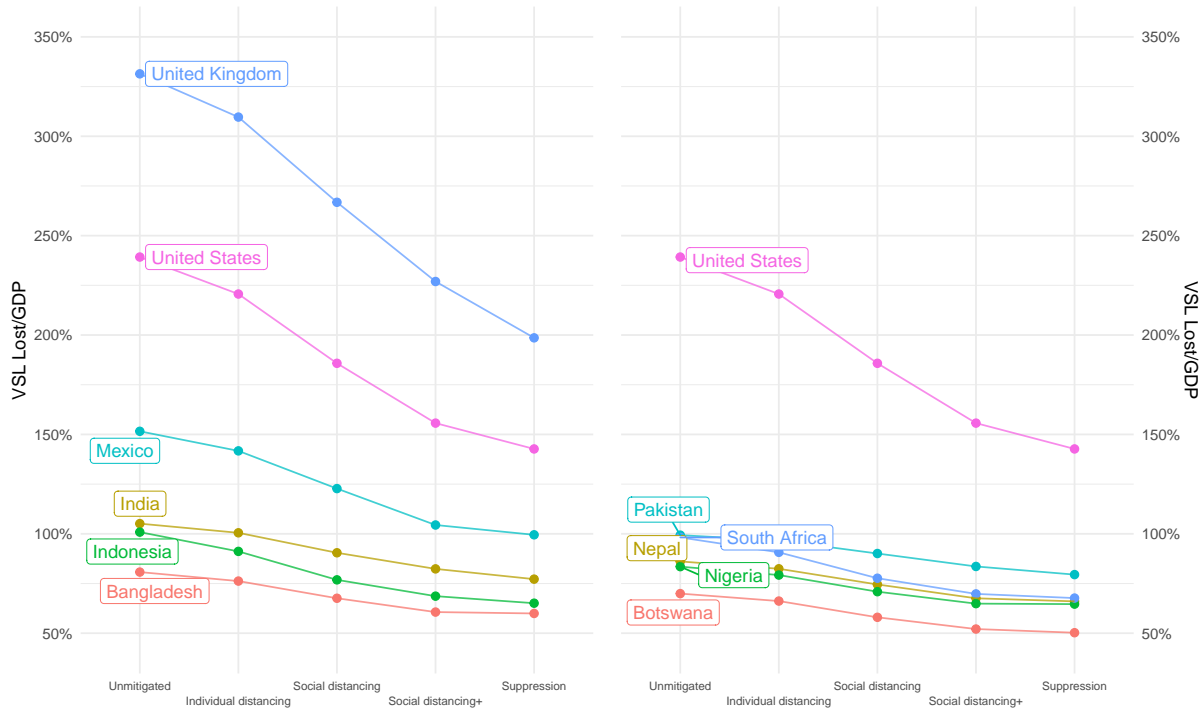


Figure 7 shows a comparison of the VSL lost by scenario and country as a fraction of GDP, with the United States benchmarking losses in high-income countries. Without mitigation efforts COVID-19 imposes a large relative welfare cost in high-income countries—nearly 250% of the GDP of the United States. In contrast, in the unmitigated scenario the losses in India, Bangladesh, Pakistan, Nigeria, Nepal are less than half as large in comparison, even when scaled against their own GDP.

The other lesson from Figure 7 is that moving from a policy of doing nothing to imposing social distancing yields a large welfare improvement in high-income countries. We show the estimated marginal value of an increasing social distancing policy in Table 1. The marginal value of imposing even minor individual distancing measures in high-income countries is large, approximately 22%

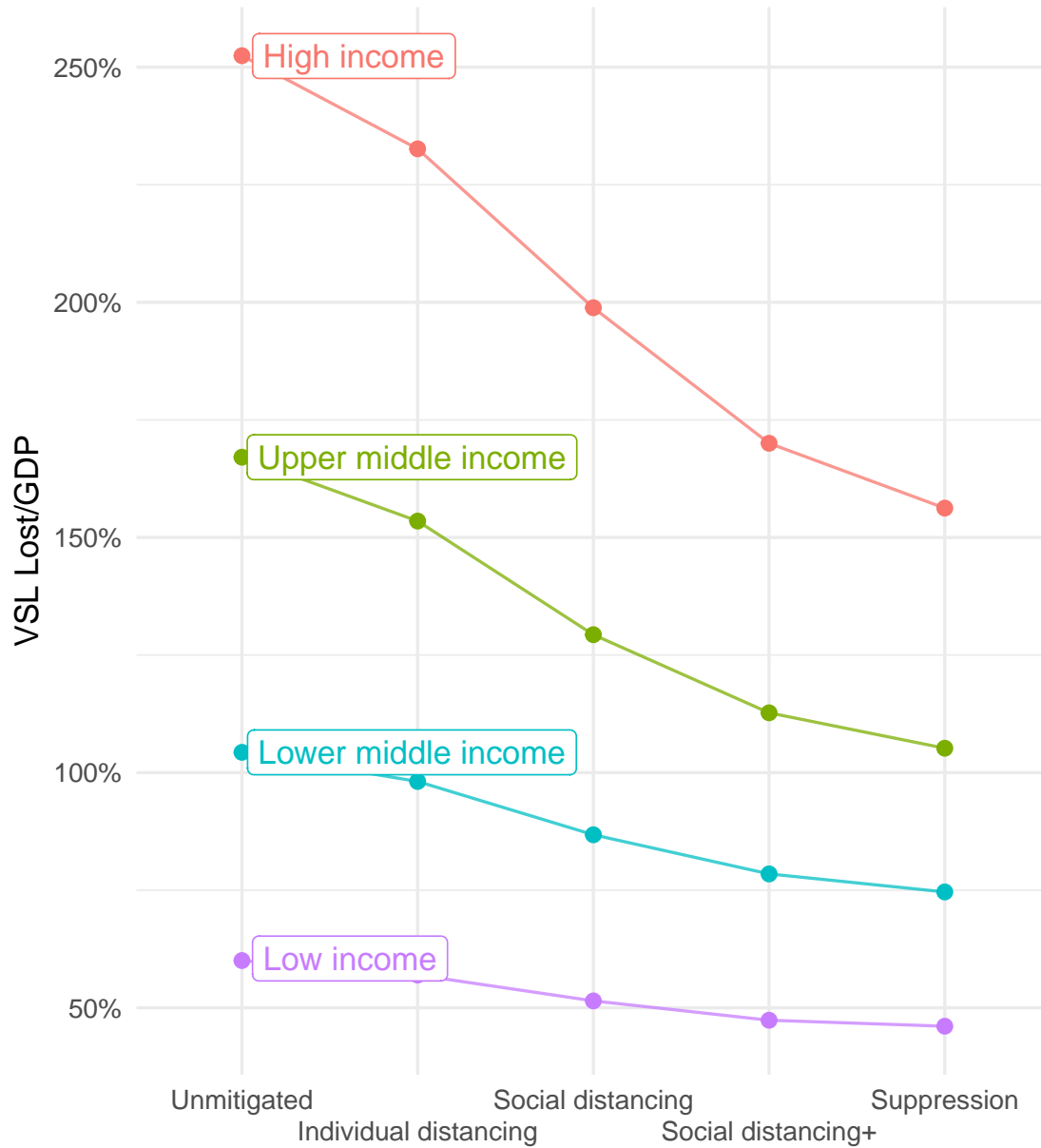
FIGURE 7: What is the relative VSL lost for each country?



and 19% of GDP in the United Kingdom and the United States, respectively. An identical policy in Mexico only yields a welfare benefit of approximately 10% of its GDP, and 4.5% of GDP in Bangladesh. Moving from a policy of individual distancing to one of full social distancing policy, decreasing the infectivity of COVID-19 to 35% of its base value for a period of 40 days, yields a welfare value increase equivalent to 43% of the UK's annual GDP and 35% in the United States. The same increase in policy stance in India yields a welfare increase equivalent to 10% of its GDP, and in Bangladesh 9% of its GDP. Increasing social distancing measures yield significant welfare improvement in higher-income countries, in lower-income countries this value declines quickly. The non-monotonicity in welfare improvement for some countries moving from social distancing+ to suppression is due to a larger second wave of the virus: reducing transmission by too much too quickly can lead to even more deaths than a less stringent policy. A strict lockdown may merely end up shifting the peak of the virus a month into the future, without significantly reducing overall mortality.

FIGURE 8: Estimated Value of COVID-19 Intervention by Income Group

Figure 8: Estimated Value of COVID-19 Intervention by



It estimates of the total VSL of predicted mortality in each income group in each scenario over income group's total GDP.

TABLE 1: Marginal Value of COVID-19 Interventions (Δ VSL/GDP)

Strategy	Income Group								
	High		Upper-Middle		Lower-Middle				Low
	UK	US	Mexico	S. Africa	India	Bangladesh	Pakistan	Nigeria	Nepal
Unmitigated	–	–	–	–	–	–	–	–	–
Individual distancing	21.7	18.6	9.8	7.5	4.6	4.5	2.7	4.2	3.7
Social distancing	42.9	34.8	19.0	13.0	10.0	8.6	6.6	8.4	7.9
Social distancing+	39.8	30.1	18.3	7.9	8.1	7.0	6.5	6.0	7.0
Suppression	28.3	13.0	4.9	2.1	5.2	0.7	4.1	0.2	1.5

3.1 Value of Statistical Life-Years

The VSL is most appropriately used to assign value to mortality risk reduction when the benefits are spread across a population. In the case of COVID-19 however, the majority of risk reduction is concentrated among the elderly. As shown in Figure 3, the risk of hospitalization and dying from the coronavirus increase sharply with age. If social distancing and lockdown policies reduce mortality risk differentially across age groups, we may wish to account for the number of expected life *years* saved under any policy. This is not to privilege saving young versus old lives, but rather to provide a more granular metric by which to estimate the welfare value of risk reduction.

The value of a statistical life year (VSLY) is derived by dividing the country specific population-averaged VSL by the life expectancy of a working-age person, someone between the ages of 20-64.¹¹ Population averaged life expectancy for each income group is shown in Figure 9, with working ages of 20-64 shaded in gray. We see that life expectancy declines linearly with age, and a clear separation in life expectancy at all ages between income groups.

In Figure 10 we reproduce our analysis from Section 3 using VSLY. Continuing to use the United States as the benchmark for high-income countries, we see that the value of social distancing remains significantly higher in higher-income countries. However, there is a pronounced level shift in the welfare value of social distancing when the mortality risk reduction is measured using the VSL, figure 7, or the VSLY, 10. Accounting for the risk profile of COVID-19—where the majority of risk reduction is accrued by the elderly—means that there are relatively few years saved in expectation by lockdown and suppression policies. Accordingly, this metric provides a significant lower estimation of the the welfare value of interventions that reduce the risk of COVID-19.

FIGURE 9: Population Averaged Life Expectancy by Income Group Classification

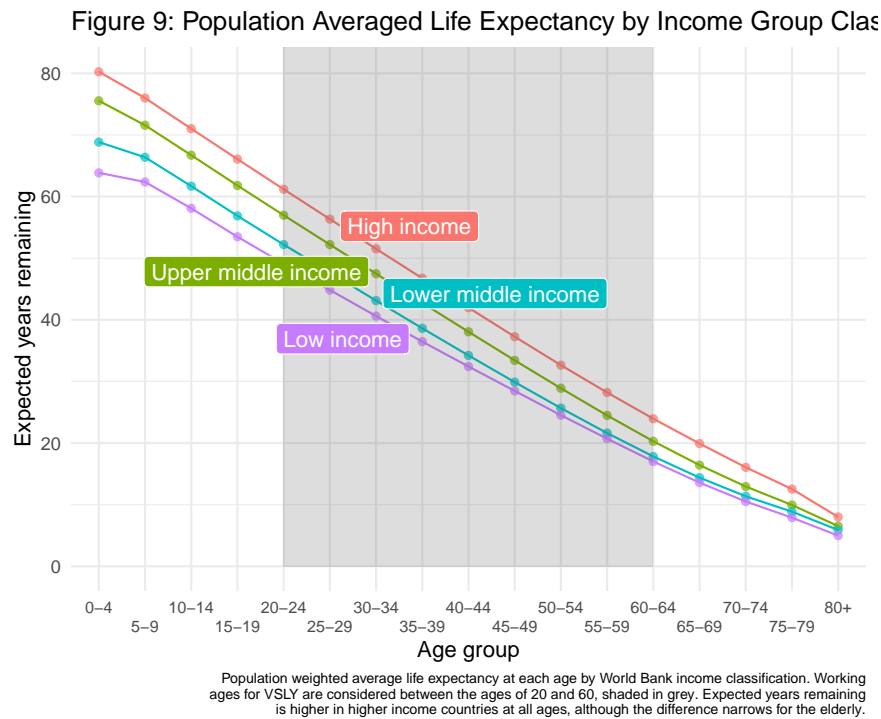


FIGURE 10: What is the value of social distancing for each country?

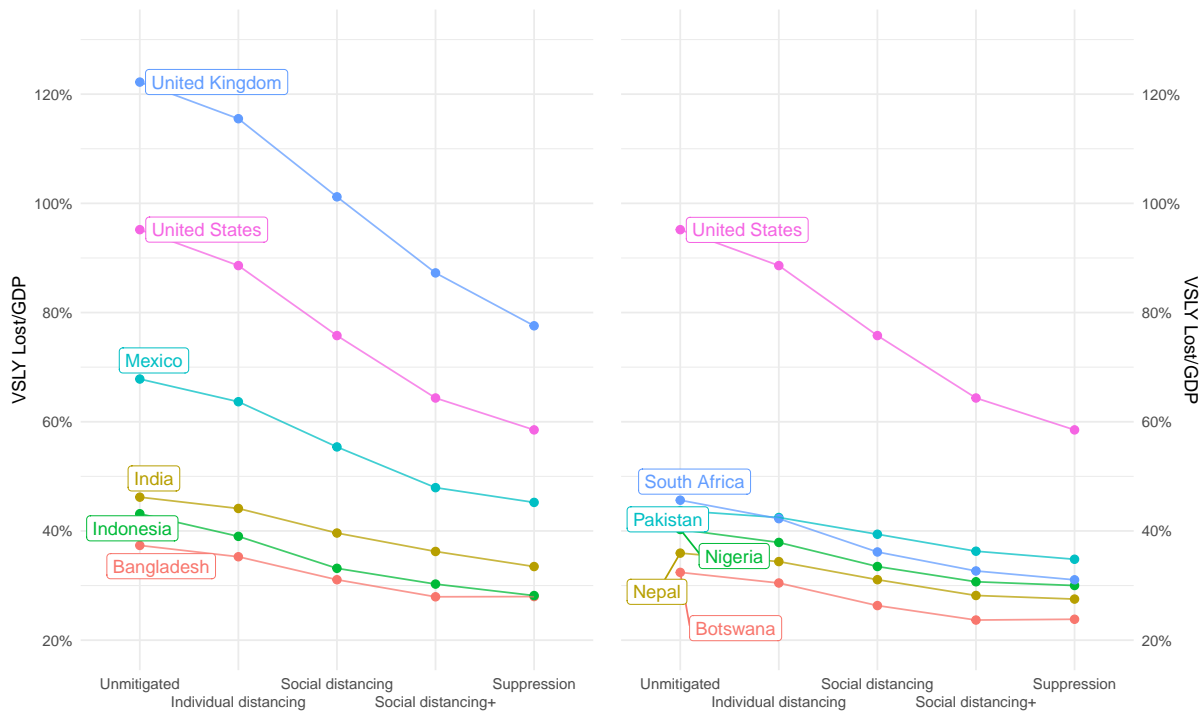


TABLE 2: Marginal Value of COVID-19 Interventions (Δ VSLY/GDP)

Strategy	Income Group								
	High		Upper-Middle		Lower-Middle				Low
	UK	US	Mexico	S. Africa	India	Bangladesh	Pakistan	Nigeria	Nepal
Unmitigated	–	–	–	–	–	–	–	–	–
Individual distancing	6.7	6.6	4.2	3.4	2.1	2.1	1.2	2.4	1.6
Social distancing	14.3	12.8	8.3	6.1	4.5	4.2	3.1	4.4	3.3
Social distancing+	13.9	11.4	7.5	3.5	3.4	3.1	3.1	2.8	2.9
Suppression	9.7	5.8	2.7	1.6	2.8	0.0	1.5	0.7	0.7

The marginal value of an increasing policy stance remains small in lower-income countries. Where we estimate social distancing to provide a welfare value equivalent to approximately 20% of GDP in countries like the United Kingdom and the United States, an identical policy produces a welfare gain of less than 10% in lower-middle and low-income countries as shown in Figure 11 and Table 2. Using the VSLY instead of the VSL corroborates our conclusion that the value of social distancing and other measures to suppress COVID-19 is unequally distributed between higher- and lower-income countries.

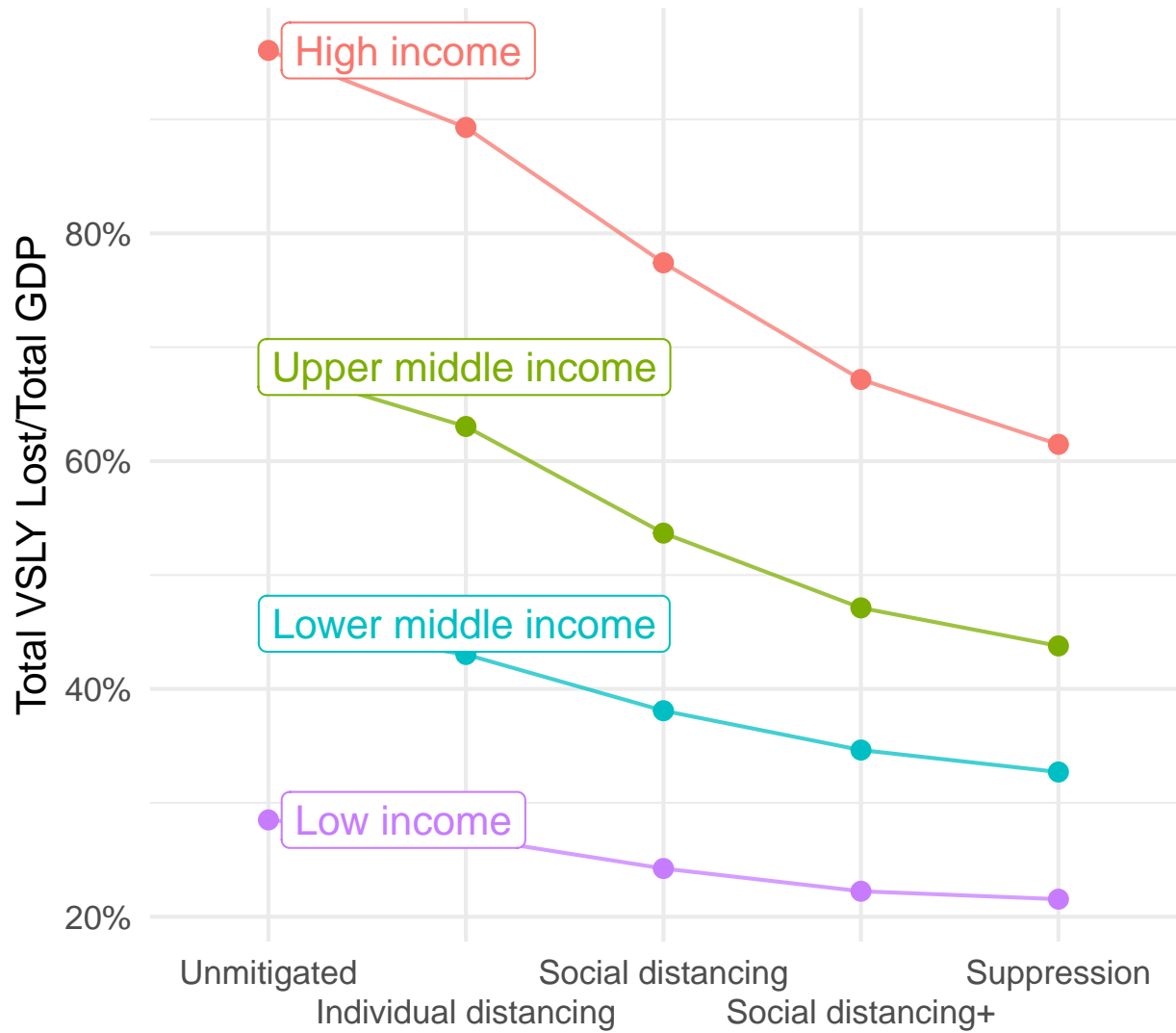
Beyond the level shift when evaluating the value of social distancing policies in high- and low-income countries, our conclusion about the relative value of these interventions remain the same. There is a steep welfare gradient for high-income countries implementing increasingly suppressive measures. We estimate a much smaller marginal value to each intervention for lower-income countries, where lower life expectancies means that identical measures save fewer years.

4 Discussion

Underpinning the relatively modest estimated value of mitigation and suppression policies in lower-income countries are three critical factors. First, in low-income countries there are proportionally more young people, who face lower risks from COVID-19. Second, the relatively low hospital and ICU capacity at baseline in lower-income countries means that flattening the mortality curve is unlikely to be sufficient to prevent hospitals from being overwhelmed. Third, the economic opportunity cost of social distancing is larger in lower-income countries, and the VSL is therefore lower. Simply put, rich people can more easily meet their basic needs while social distancing, while

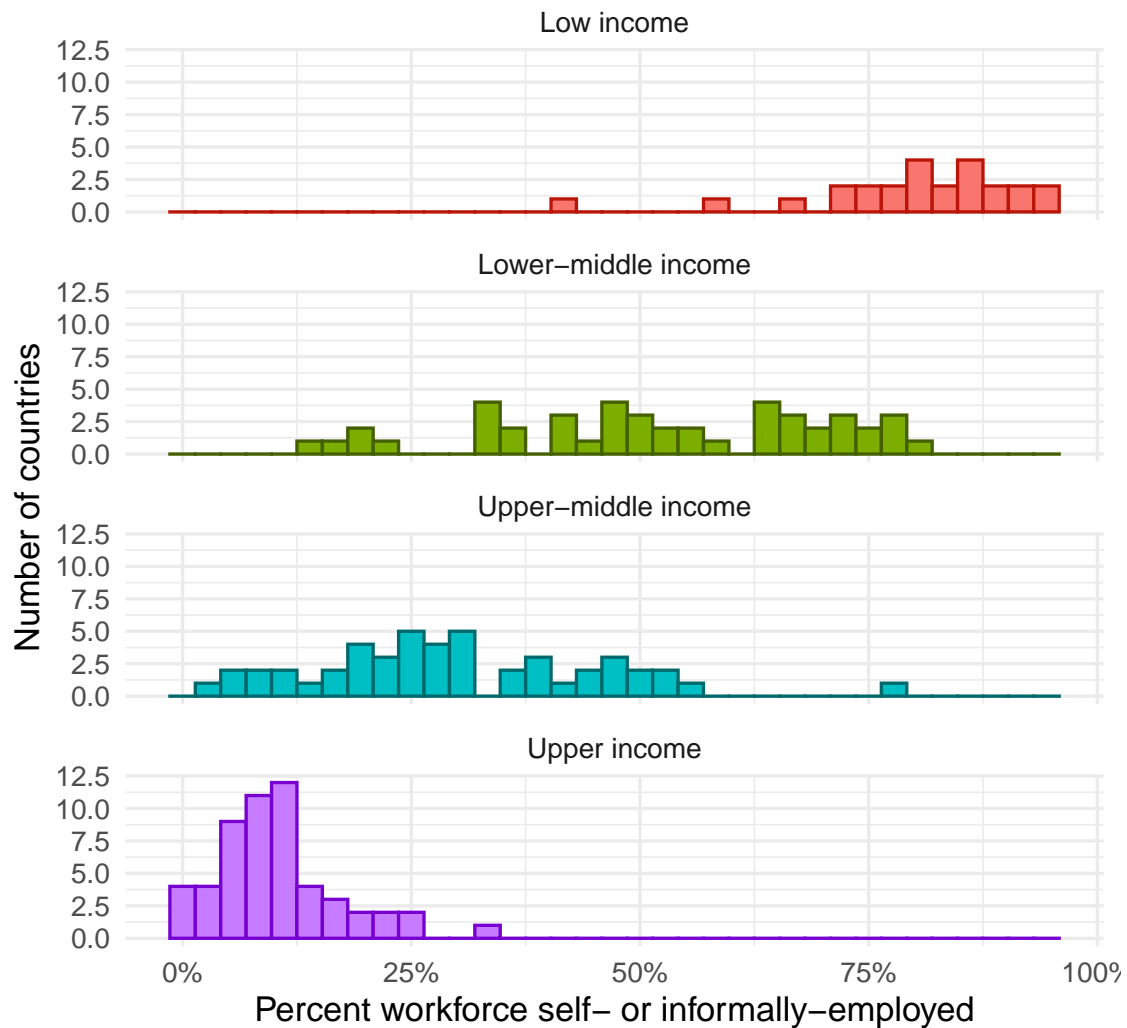
FIGURE 11: VSLY by income group

Figure 11: VSLY by Income Group



Total VSLY over GDP in each income group. A value of 100% indicates a welfare loss equal to 100% of that income group's yearly GDP

FIGURE 12: Distribution of self- or informally employed workforce by income group



a poor person may need to prioritize income-generating opportunities to put food on their family's table.

Workers in low-income countries are also more vulnerable to the disruption of the economy. These workers are more likely to rely on a daily cash wage, and work in occupations that cannot be done while social distancing. Figure 12 shows the distribution of the percentage of workers either self- or informally-employed. Such workers do not always appear in government and bureaucratic records. So even if a social insurance policy were implemented in these countries, it is uncertain how quickly such people could be located, if at all, to deliver relief benefits to them.

The social distancing and suppression interventions pioneered in Wuhan, China, and enacted throughout Europe and the United States, have relied on government support systems. Many workers throughout Europe received their salaries, and U.S. taxpayers will receive a stimulus check. By contrast, efforts by the Indian government to impose a lock-down appear to have had significant negative consequences for the most vulnerable members of its population. Interviews with workers from the informal sector tell a story of impending poverty, evictions, and hunger, as their incomes and work opportunities have been curtailed. Migrant laborers in India's largest cities, now without access to employment, are without food or shelter. Many are in the process of literally walking back to their homes, with deaths along the journey already being reported.³

The COVID-19 pandemic represents a serious threat in every country. A policy response is necessary, the benefits to each policy must be carefully weighed against the economic cost and risks imposed on that society. The most widely-cited model of COVID-19 transmission and mortality indicates that based on our present understanding of the disease, that we should expect fewer deaths in low-income countries under a range of policy scenarios.⁸ Much of this result is based on differences in the age distribution across countries, because our present understanding is that COVID-19 mortality risk increases dramatically with age. It is uncertain whether this relationship will remain robust in lower-income countries where younger people have higher rates of certain chronic illnesses and endemic diseases. Given the later start date of epidemics in lower income countries, extensive data characterising the interaction between COVID-19 and these comorbidities is lacking. Current research suggests that comorbidities such as obesity, diabetes, and chronic obstructive pulmonary disease (COPD) may lead to increased severity of the coronavirus.^{17,18,19} Equally concerning is the disruption to the routine care that lockdown orders present to the management of these other diseases in lower-income countries; childhood immunizations, malarial, and HIV have all been substantially disrupted.^{20,21,22} Therefore, lower-income countries may see higher levels of mortality from the lack of treatment and management of other endemic diseases in the case of widespread social distancing and lockdown. Given the deeper concerns about the risks that economic shutdowns pose on the most vulnerable members of low-income societies,²³ it remains unclear whether the value of

³See: Abi-Habib and Yasir [13, 14], BBC [15], and Tewari [16]. Abi-Habib and Yasir [14] quote one migrant laborer saying: "You fear the disease, living on the streets. But I fear hunger more, not corona." Another migrant construction worker is quoted saying "I earn 600 rupees every day and I have five people to feed. We will run out of food in a few days. I know the risk of coronavirus, but I can't see my children hungry."¹⁵

the most stringent suppression policies in low-income countries outweighs the uncertain economic costs.

We know that workers in low-income countries are younger and less likely to develop a severe infection due to COVID-19. We know that workers are also more vulnerable to economic disruption, and may be unable to adhere to lockdown orders. Various government and non-governmental organizations are currently playing an important role to avert outright starvation during the pandemic by providing free meals, food supplies, and fuel to poor households. Supply chains within countries have been disrupted by lockdown measures, making it increasingly difficult to deliver food.²⁴ Indeed, the recent example of the severe but ineffective lockdown in India demonstrates our concern about the capacity of states to enforce suppression strategies, and that imperfect compliance may lead to an increase in transmission to other vulnerable populations.²⁵

A Robustness checks

A.1 Alternative estimates of the VSL

We re-estimate the relative value of lockdowns and social distancing interventions using an alternative estimate of the VSL for low- and middle-income countries, which uses a higher income elasticity for mortality risk valuation.¹¹ In Figure 13 we show estimates of the relative VSL lost for each country under each intervention. The shaded points represent estimates using the VSL from Robinson, Hammitt, and O’Keeffe [11], the triangles represent estimates from our primary analysis using the estimates from Viscusi and Masterman [10]. In Botswana, India, and Indonesia the relative value of intervention increases; in Bangladesh and Nigeria the relative value falls.

We show the difference between the relative value of each policy between our primary specification and using the VSL estimates in Robinson, Hammitt, and O’Keeffe [11] for middle- and low-income countries in Figure 14. On average our preferred specification finds the relative value of interventions to be 9% higher than if we used the alternative VSL estimates.

FIGURE 13: Alternative VSL

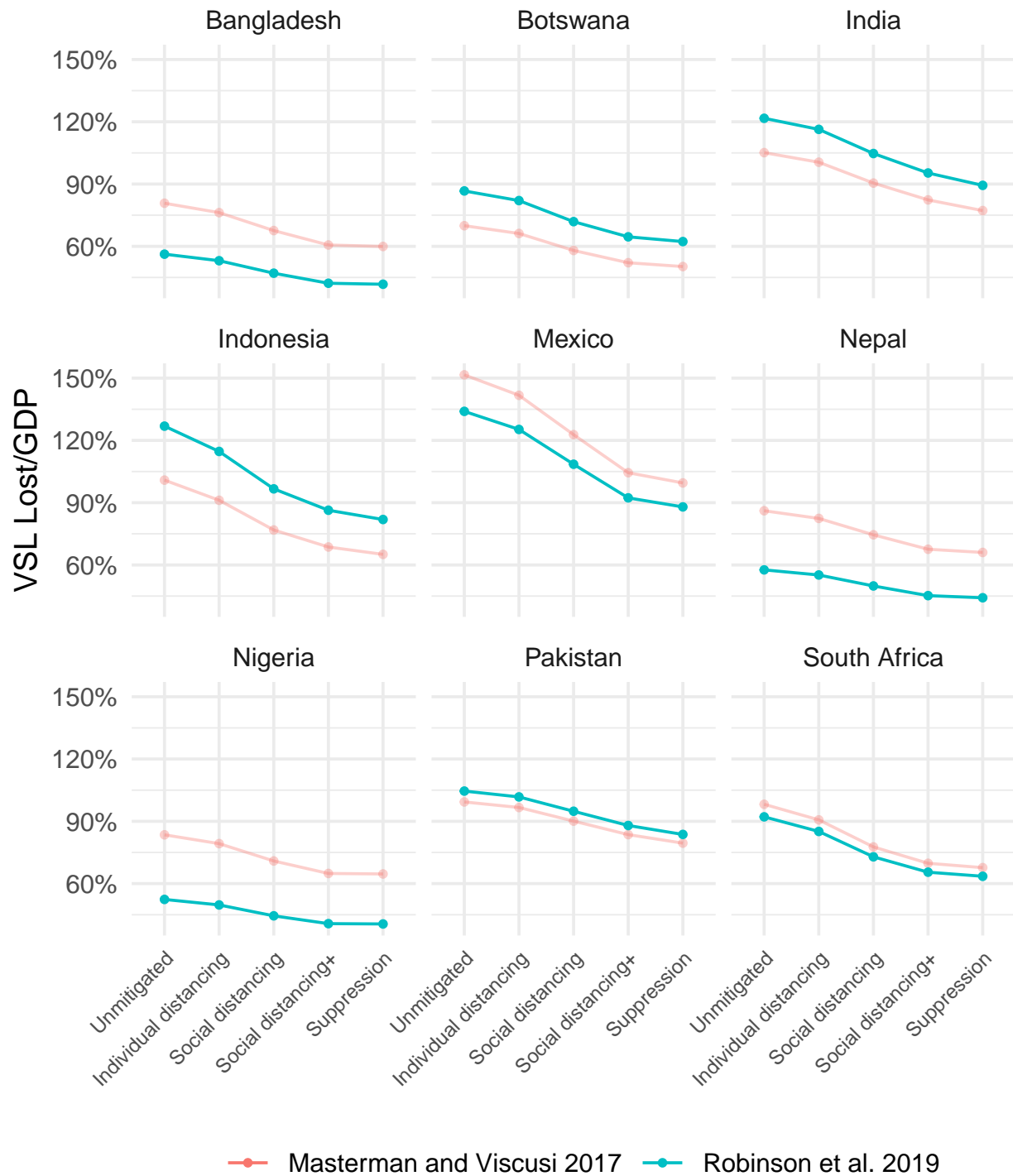
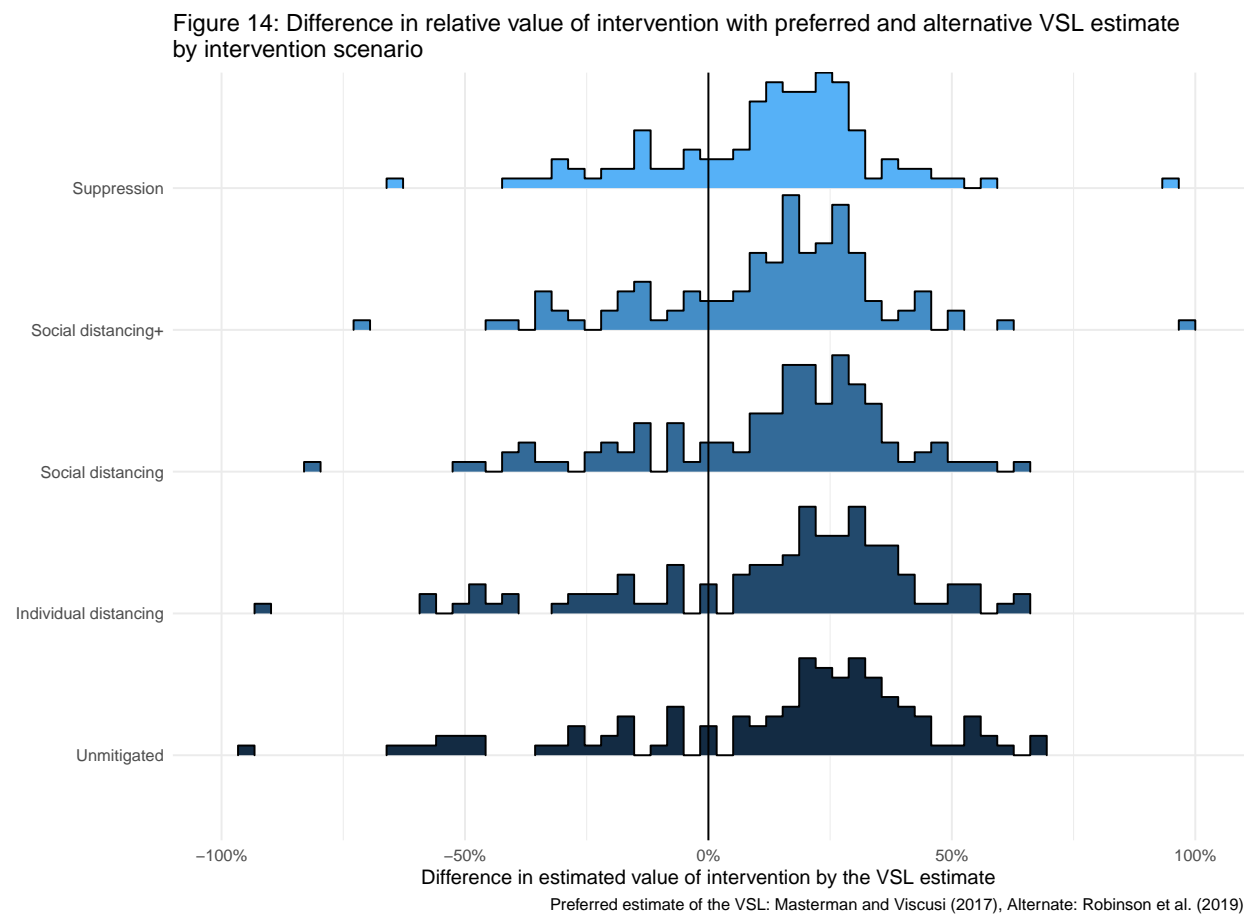


FIGURE 14: Difference in Relative Value of Interventions Using Preferred and Alternative VSL Estimates



A.2 Alternative excess mortality demand parameters

The epidemiological model distinguishes between COVID-19 cases that are severe—requiring hospitalization—and those that are critical—requiring intensive care. An open question is the likelihood of death for people who require but cannot access hospital or ICU care. In our primary specification we set the age-specific excess mortality parameter to be 100% that of people receiving hospital care, up to a mortality rate of 90%. For example, where the likelihood of a severe cases leading to death is 1.3% for a patient ages 0 to 39, we set the probability of death to 2.6% for patients in this same range that cannot access a hospital bed. Similarly a hospitalized patient age 80 and above dies 58% of the time, and without a hospital bed they die 90% of the time in our preferred specification.^{2,3}

As there is presently no effective treatment for COVID-19, much of what is provided to patients in hospitals is considered supportive care. Supplemental oxygen provides relief to patients, but it is unclear whether it leads to a higher survival rate. Of course, if COVID-19 leads to other complications, hospitals are effective at treating those, which can dramatically reduce mortality.

We re-estimate mortality in our model across the same five scenarios using alternative excess mortality rates for severe non-hospitalized cases of four, six, and ten times that of hospitalized cases. We show these excess mortality rates by age group relative to the baseline rate of hospitalized severe cases (x1) in Figure 15. The relative value of social distancing in each scenario by excess mortality parameter is shown for a set of countries in Figure 16. The value of social distancing increases in the likelihood of death without hospital care. The peak of COVID-19 becomes proportionally more deadly when a patient requires but cannot access a hospital bed, increasing the value of “flattening the curve.” Figure 17 shows the distribution of the relative value of social distancing by income group, suppression strategy, and excess mortality parameter. Our estimate of the relative value of social distancing is the most sensitive to this parameter in countries that are high and lower middle income. In these countries the efficacy of hospital treatment, or the lack thereof, is a hugely important factor on which to condition the implementation of social distancing policies.

FIGURE 15: Alternative Parameters for Excess Mortality Rates by Age

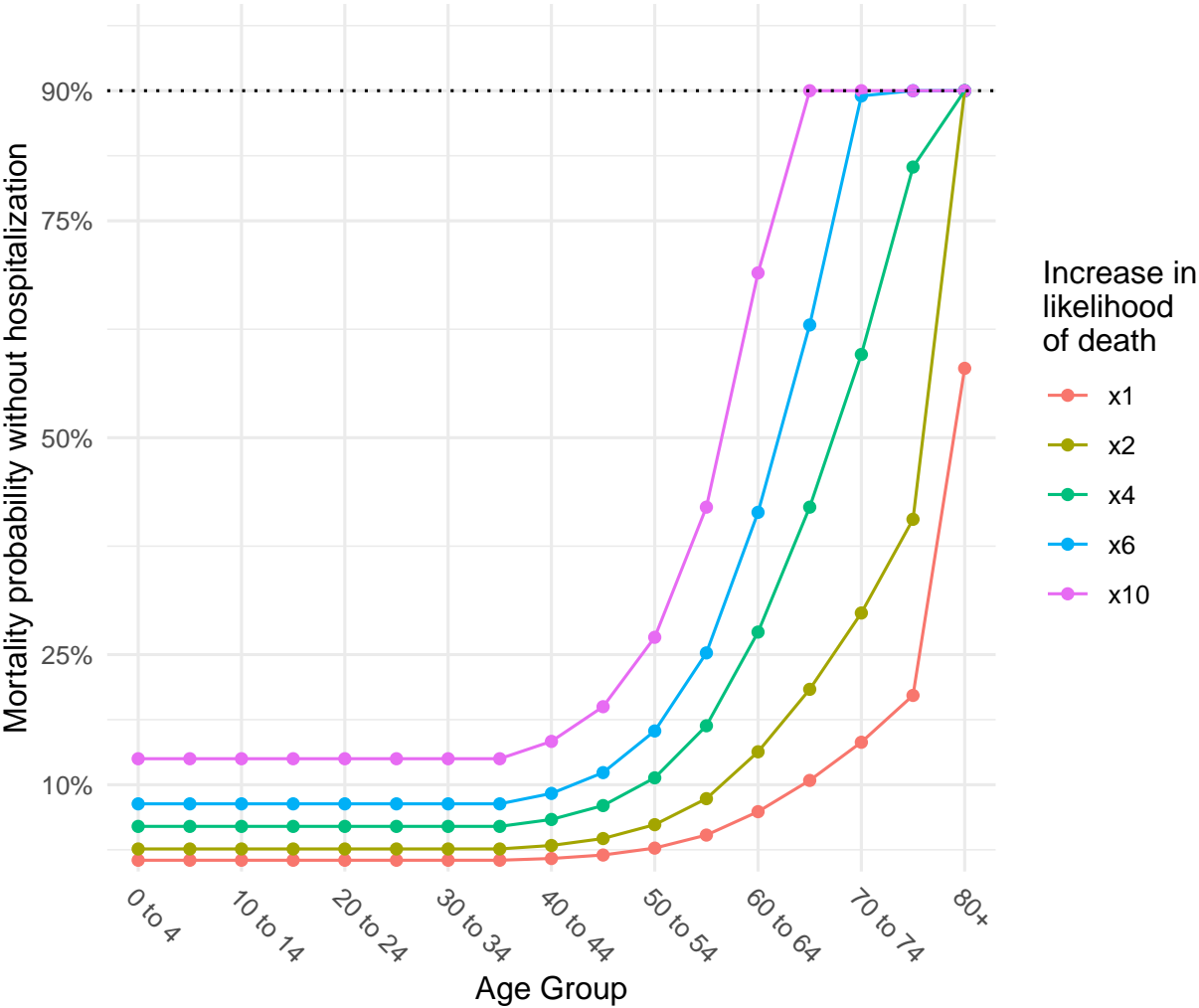


FIGURE 16: Change in Relative Value of VSL by Excess Mortality Measures

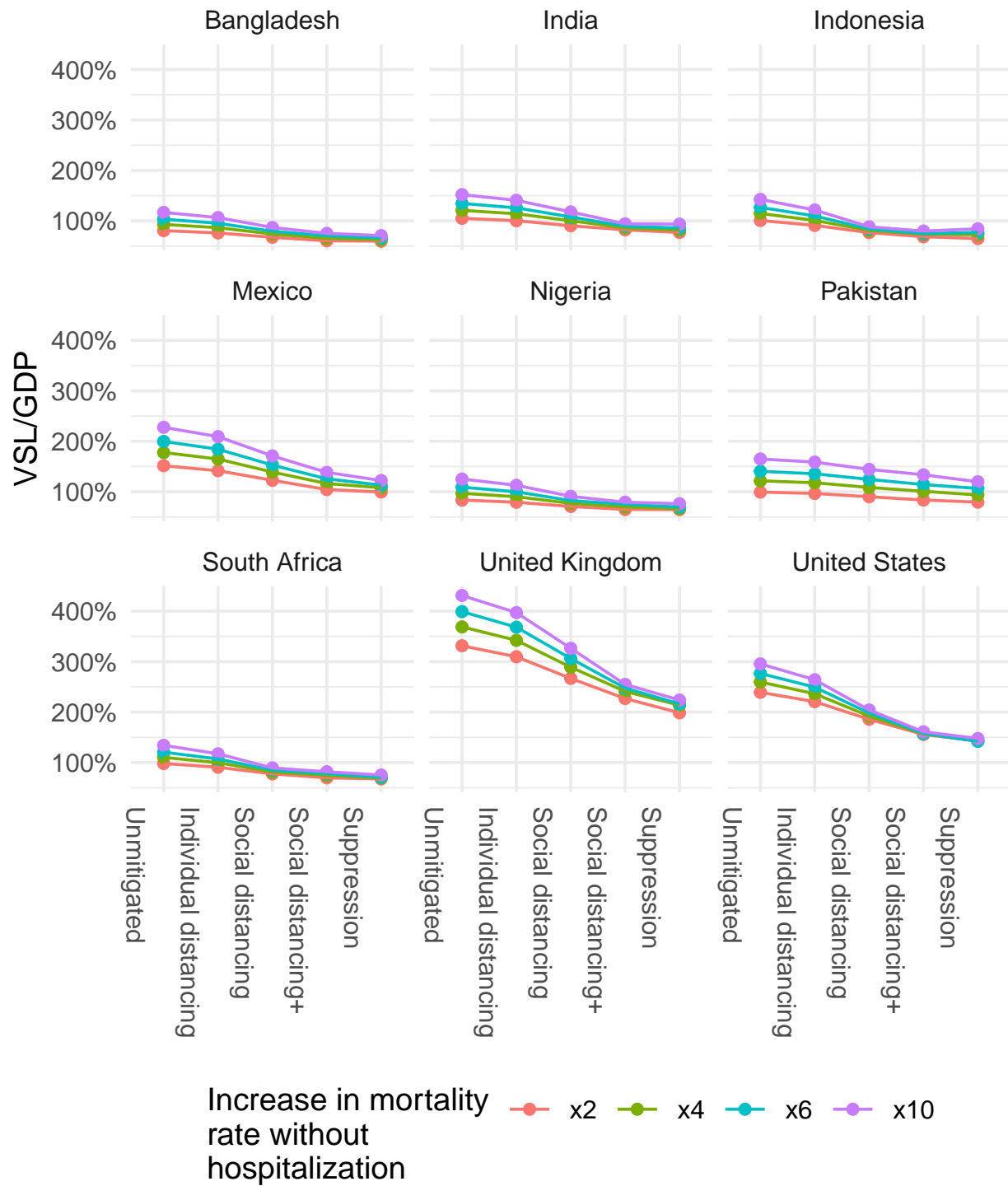
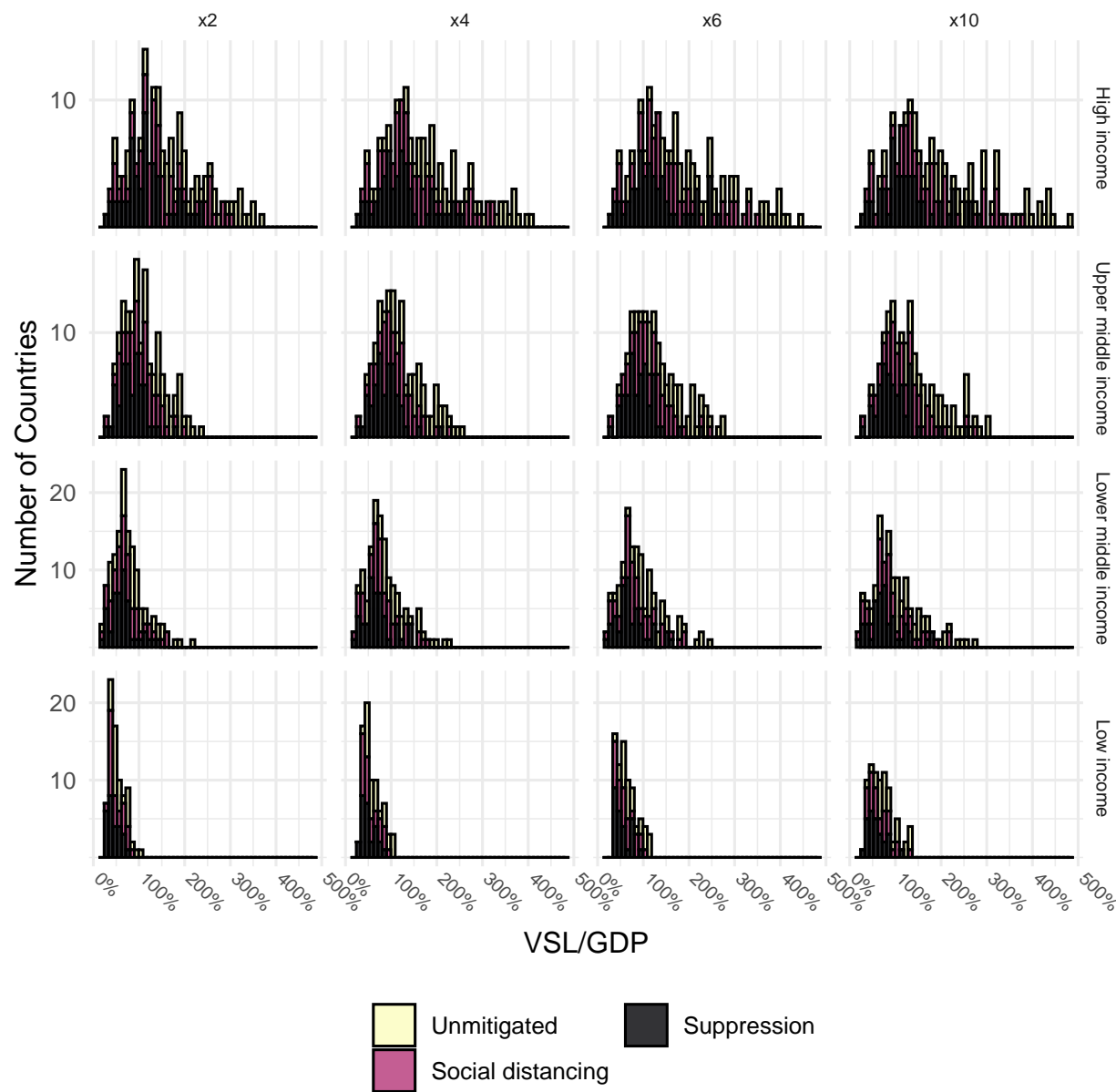


FIGURE 17: Relative Value of Social Distancing by Income Group and Excess Mortality Parameter



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