

Global Equity Challenges in
COVID-19 Vaccine Purchasing

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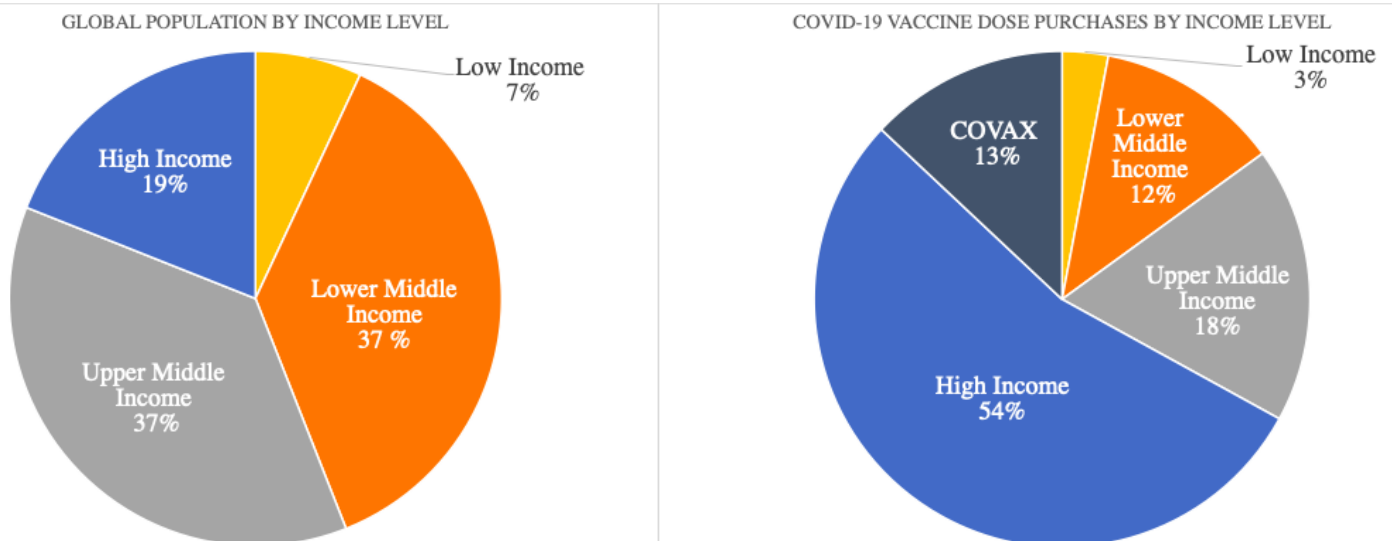
Abstract

A rush to preemptively secure COVID-19 vaccines resulted in high income countries hoarding an excess supply while low- and middle-income countries are prevented from equitable access. Previous work on equity in vaccine purchasing has compared cases per million of COVID-19 to vaccination coverage but does not reflect urgent pressures placed on healthcare systems. This analysis investigates vaccination coverage against three measures of COVID-19 burden: deaths per 100,000 population, general hospital capacity reached, and ICU capacity reached, in order to identify the countries overburdened and underrepresented in vaccine purchasing. Publicly available data from the Duke Launch & Scale Speedometer, IHME COVID-19 projections, and Johns Hopkins COVID-19 mortality reports are used for this analysis. While non-high-income countries comprised 64% of this dataset, they represented 93% of countries in ICU crisis, 87% in general hospital capacity crisis, and 85% in a mortality crisis. This data provides evidence for the creation of a priority list for equitable global allocation of vaccines to low- and middle-income countries. High income countries can be incentivized to redistribute their excess vaccine supplies by reframing measures of pandemic progress away from nationalistic targets.

Introduction

The onset of the COVID-19 pandemic initiated a global race among pharmaceutical companies to produce vaccine candidates, with countries and global coalitions eager to reserve a supply of doses before many of these candidates were officially approved. Advance purchase agreements prior to vaccine production enabled countries to negotiate deals with pharmaceutical companies directly.¹ As a consequence, high income countries with the ability to leverage purchasing power and investments into vaccine research & development were able to preemptively secure the majority of COVID-19 doses.² Fewer doses available for low and middle income countries (LMICs) prevents equitable global allocation of COVID-19 vaccines; high income countries have secured 54% of all 8.5 billion COVID-19 vaccine doses purchased to date yet account for only 19% of the global adult population (Figure 1).³

Figure 1: Global Population Share versus Vaccine Purchases By Income Level (via KFF) ³



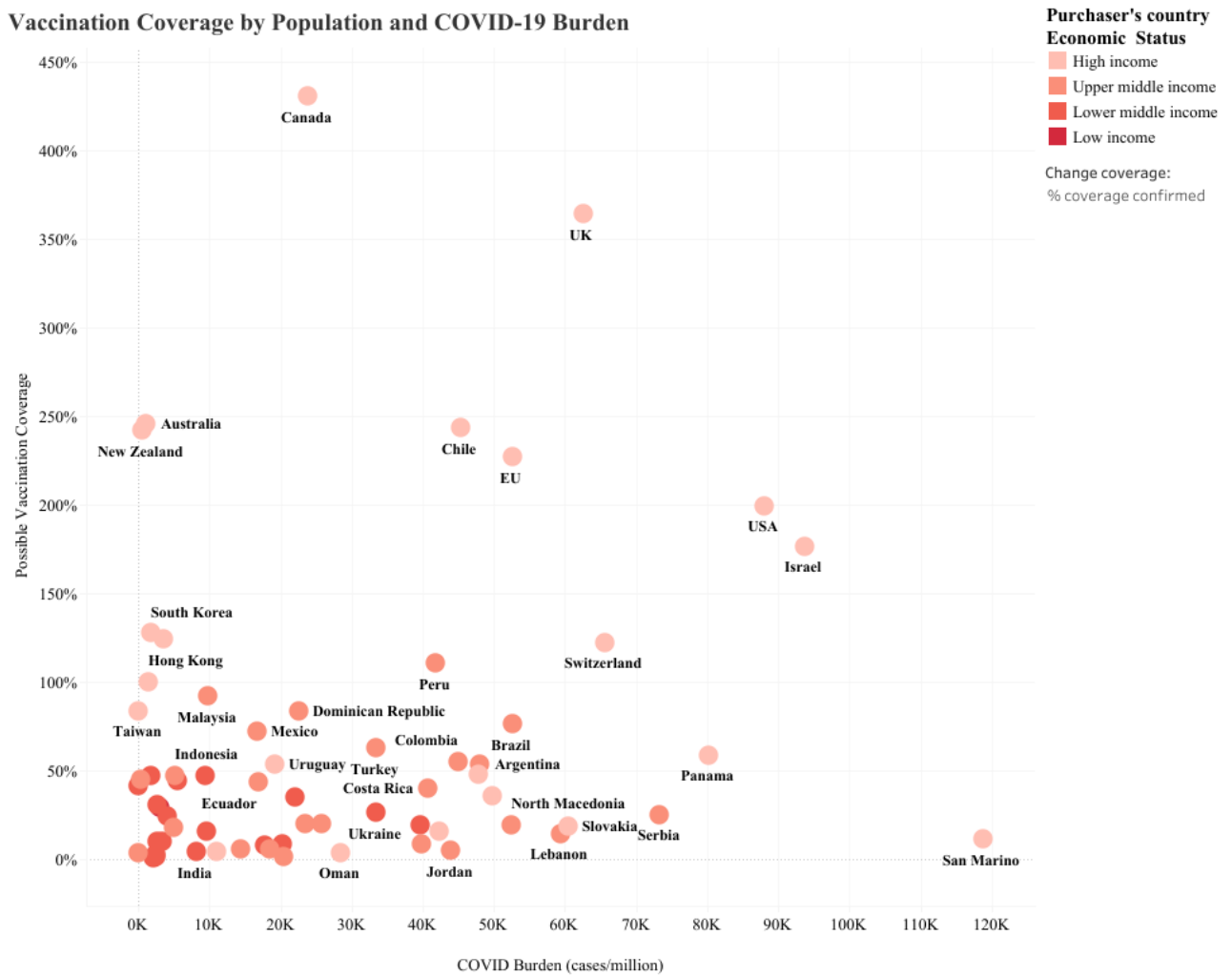
High income countries were incentivized to purchase as many vaccine doses as possible across the wide pool of candidates to guarantee coverage for their populations. Canada, for example, advance-purchased enough doses to vaccinate its population almost five times over.² With little incentive to share from their advance-purchase stocks, global equity concerns arise as vaccination eligibility expands to the general populations in high income countries. In contrast, many frontline healthcare workers in LMICs are still unable to receive protection.⁴ Current models based on manufacturing capacity estimate that there will not be enough COVID-19 vaccines to cover the world's population until 2023 or 2024,² and the impacts of the pandemic will be exacerbated in the LMICs affected by inequities in global vaccine purchasing and access.

Global alliances and multilateral partnerships will improve access to vaccines for LMICs but cannot fully resolve the inequity present. Most notably, the COVID-19 Vaccines Global Access Initiative (COVAX) was created by the World Health Organization, Gavi, and the Coalition for Epidemic Preparedness Innovations as a global mechanism to facilitate equitable vaccine access. COVAX aims to provide LMICs with enough doses to cover 20% of their populations, which significantly improves coverage in the countries unable to create bilateral deals with pharmaceutical companies.⁵ However, even factoring in the doses purchased by COVAX, more than half of adult populations in LMICs will remain unable to receive vaccinations.³ Given that more than 80% of global adults could have been vaccinated with equitable allocation of purchases,³ inequities in vaccine access will continue to persist unless high income countries are incentivized to redistribute their advance purchase commitment stock.

Existing work that highlights the global inequity in vaccine purchasing has focused on comparing COVID-19 burden to the potential vaccination coverage in each country made possible through their existing purchase deals.² By visualizing country data in terms of national

income level classification (Figure 2)², countries with a high number of COVID cases yet little vaccination coverage are easily identified.

Figure 2: Global Vaccine Purchasing Inequity (via Duke Launch & Scale Speedometer)²



While the study referenced above measured national COVID-19 burden in terms of cases per million, this indicator does not reflect the capacities of individual countries in managing the pandemic nor the urgency with which they require assistance. Few reports have analyzed vaccine equity using COVID-19 burden from the perspective of clinical need. This investigation aims to build on previous work by visualizing the inequity in global COVID-19 vaccine purchasing

using three nuanced measures of burden beyond prevalence. COVID-19 mortality as well as the general and emergency ICU hospital capacity reached in each country will be compared to vaccination coverage in order to understand the pressures on national healthcare system infrastructure. Data stratification by income level will place focus on the global inequities in vaccination purchasing, and this thesis will highlight the importance of prioritizing vaccine access for LMICs that are underequipped in managing the pandemic. Policy recommendations and areas of opportunity for improving global equity in vaccine allocation will be further explored, particularly in the context of incentivizing redistribution from high income countries to relieve global emergencies.

Methods

In this analysis, national vaccine purchase deals were compared to three measures of COVID-19 burden for each country: COVID-19 deaths per 100K population, the percentage of general hospital capacity reached as a result of COVID-19 patients, and the percentage of ICU hospital capacity reached as a result of COVID-19 patients. In each analysis component, countries were stratified by national income level according to World Bank classifications.⁶ All data were obtained from publicly accessible sources, and this analysis did not require prior approval from Institutional Review Boards.

COVID-19 Deaths Per 100K Population

National data on the number of COVID-19 Deaths Per 100K population were obtained from a mortality analysis ⁷ conducted by the Johns Hopkins University of Medicine's Coronavirus Resource Center on March 17th, 2021. This report did not provide data on COVID-19 mortality for Hong Kong and Palestine. These values were manually calculated based on population size reported by the World Bank and COVID-19 deaths reported by Worldometers^{8,9} as of March 17th, 2021.

General Hospital & ICU Hospital Capacity

The values for the general hospital capacity reached in each country as a result of COVID-19 patients were calculated using data from the Institute for Health Metrics and Evaluation (IHME), an independent global health research center at the University of Washington. For each country, the IHME reports a projection over time of the number of general hospital beds needed for COVID-19 patients alongside the overall number of hospital beds

available.¹⁰ Using values from March 17th, 2021 for every country, a snapshot of general hospital capacity was obtained by calculating the percentage of hospital beds taken by COVID-19 patients from those available to reflect the abilities of national health systems in handling the COVID-19 pandemic.

Similarly, ICU and emergency hospital resource capacity were estimated by the IHME in terms of the number of ICU beds required by COVID-19 patients alongside the total number of ICU beds present in each country.¹⁰ March 17th, 2021 values were also used to calculate the percentage of ICU capacity reached in each country.

IHME national data had gaps in general hospital and ICU hospital resource capacity for both the United States of America and India. While both beds needed and available were reported on a national level for other countries, the IHME only reported general and ICU beds needed nationally for the US and did not indicate national hospital and ICU beds available overall. Instead, values for the numbers of beds available were reported on a state-by-state basis. These values were aggregated manually to determine the national hospital and ICU capacity in the US for comparison against the number of beds needed. In the case of India, national hospital and ICU beds needed were reported, but capacity values were not available nationally or on the state level. As such, information on general hospital and ICU capacity in India was obtained from a study¹¹ by the Center for Disease Dynamics, Economics, and Policy published in April 2020.

Vaccination Coverage

National vaccine purchase deals were represented by the variable “Vaccination Coverage”, which describes the percentage of each country’s national population that is currently

covered to be potentially vaccinated based on the number of doses set to be acquired from existing COVID-19 vaccine purchase deals. This data was obtained with permission from the Launch & Scale Speedometer, a program of the Duke University Global Health Innovation Center.² Values for percent vaccination coverage per country were reported as of March 12th, 2021.

In the data published by the Launch & Scale Speedometer, the African Union and European Union were reported as entities, given that these regional organizations negotiated purchases with vaccine manufacturers on behalf of their member countries. For this analysis, these organizations were disaggregated in order to examine COVID burden on the national level. The European Union consists of 27 member states,¹² and countries already disaggregated by the Launch & Scale speedometer dataset (due to the presence of national vaccine purchase deals independent of the EU) were excluded. Similarly, the data for the African Union was disaggregated into its 55 member states,¹³ excluding those already reported independently by Launch & Scale and countries for which the IHME had no data reported.

In order to allocate the COVID-19 vaccine doses purchased by the African and European Unions to individual countries, the doses acquired from purchase deals were apportioned to member states based on national population size in accordance with existing distribution plans.¹⁴ In the case of the African Union, doses allocated by COVAX were also used to determine the percentage of each country's population that would be potentially vaccinated based on existing arrangements.¹⁵ The number of doses afforded to each country was translated into a number of persons able to be vaccinated, which was dependent on the proportion of vaccines that were single dose (Johnson & Johnson) and two doses per person (Pfizer, Moderna, AstraZeneca, etc.).

Results

Out of 129 countries analyzed, 46 are high income (36%), 24 are upper-middle income (19%), 16 are lower-middle income (12%), and 43 are low income (33%). Non-high-income countries comprise 64% of analyzed countries as a group. Visualizations of vaccination coverage against the various measures of COVID-19 burden demonstrate that non-high-income countries disproportionately experience a combination of severe clinical need and low vaccination coverage for their populations, and thus deserve prioritization if equitable allocation is to be achieved. Each visualization is presented initially in its entirety to demonstrate the range of data observed and once again with a focus on countries under the 100% vaccination coverage level.

Vaccination Coverage and ICU Capacity

The analysis of vaccination coverage with respect to the percentage of ICU capacity reached provides the most salient representation of urgent pressure placed on national healthcare systems. Figure 3a demonstrates that the COVID-19 pandemic overwhelmed national emergency capacities to a widely varying extent, with Peru as a clear outlier experiencing a burden over 3000% of its ICU hospital capacity. In order to identify the countries overburdened and underrepresented in vaccine purchasing, Figure 3b isolates countries that have reached 100% or greater of their ICU capacity and are still under 100% vaccination coverage of their population from doses purchased. 43 countries out of the 129 analyzed were determined to qualify within this “crisis zone” criteria. While non-high-income countries made up 64% of all countries analyzed in this dataset, they represented 93% (40/43) of the countries above 100% ICU capacity and below 100% vaccination coverage. In addition, 67% of “crisis zone” countries were low income (29/43), despite 33% representation of this income group in the dataset.

Figure 3A: Vaccination Coverage vs ICU Capacity Reached (All)

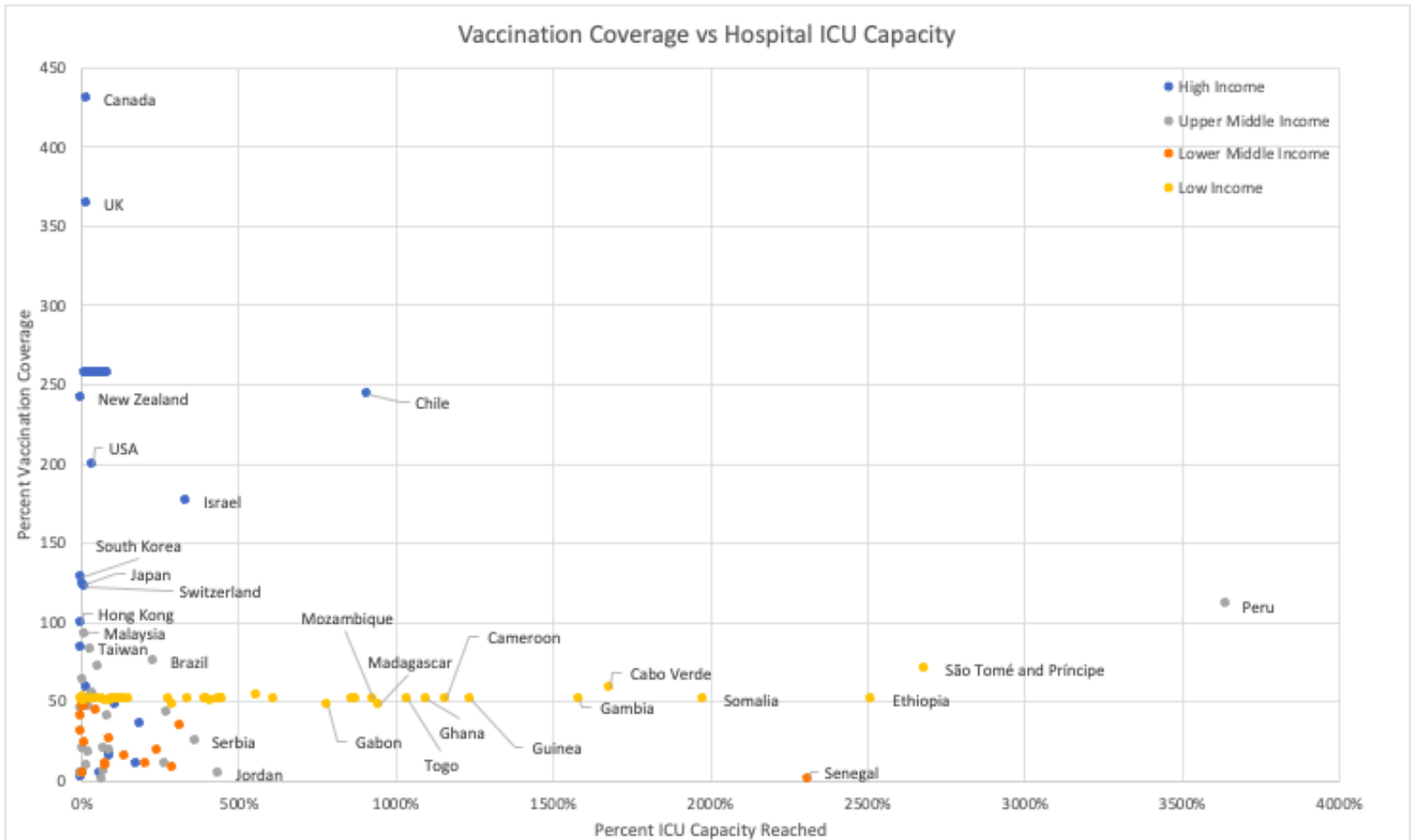
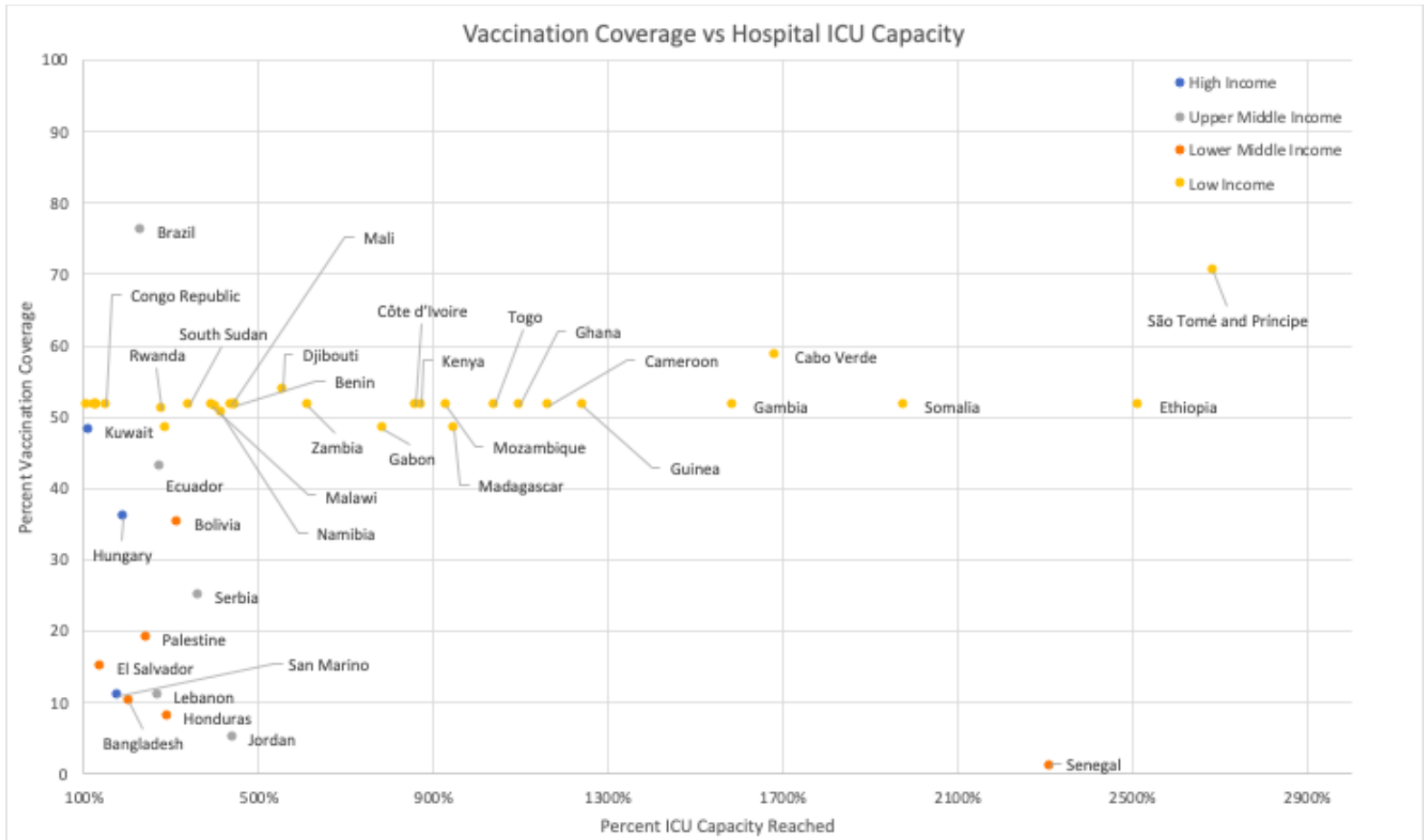


Figure 3B: Under 100% Vaccination Coverage vs Over 100% ICU Capacity Reached



Vaccination Coverage and General Hospital Capacity

In contrast to ICU capacity, Figure 4a demonstrates that general hospital capacity was overwhelmed in countries to a lesser extent, with the maximum in this dataset observed at 180% capacity in Senegal. Only 5 countries out of the 129 analyzed experienced 100% or greater general hospital capacity: Senegal (lower middle income), Peru (upper middle income), Ethiopia (low income), Jordan (upper middle income), and Honduras (lower middle income). No high-income countries in this dataset experienced 100% or greater general hospital capacity due to COVID-19 patients. However, overall hospital capacity values for COVID-19 patients under 100% still represent significant pressure placed on health systems as resources are diverted to compensate for overwhelmed emergency capacity. As such, the identification of countries overburdened and underrepresented in vaccine purchasing was adjusted in this analysis component; Figure 4b again focuses on countries below 100% vaccination coverage and also isolates those that have reached 20% or higher general hospital capacity in order to identify a “crisis zone”. 47 countries qualified under these criteria, with non-high-income countries again disproportionately comprising 87% in the area of concern (41/47). Low-income countries represented 40% of those above 20% general hospital capacity and below 100% vaccination coverage (19/47).

Figure 4A: Vaccination Coverage vs General Hospital Capacity Reached (All)

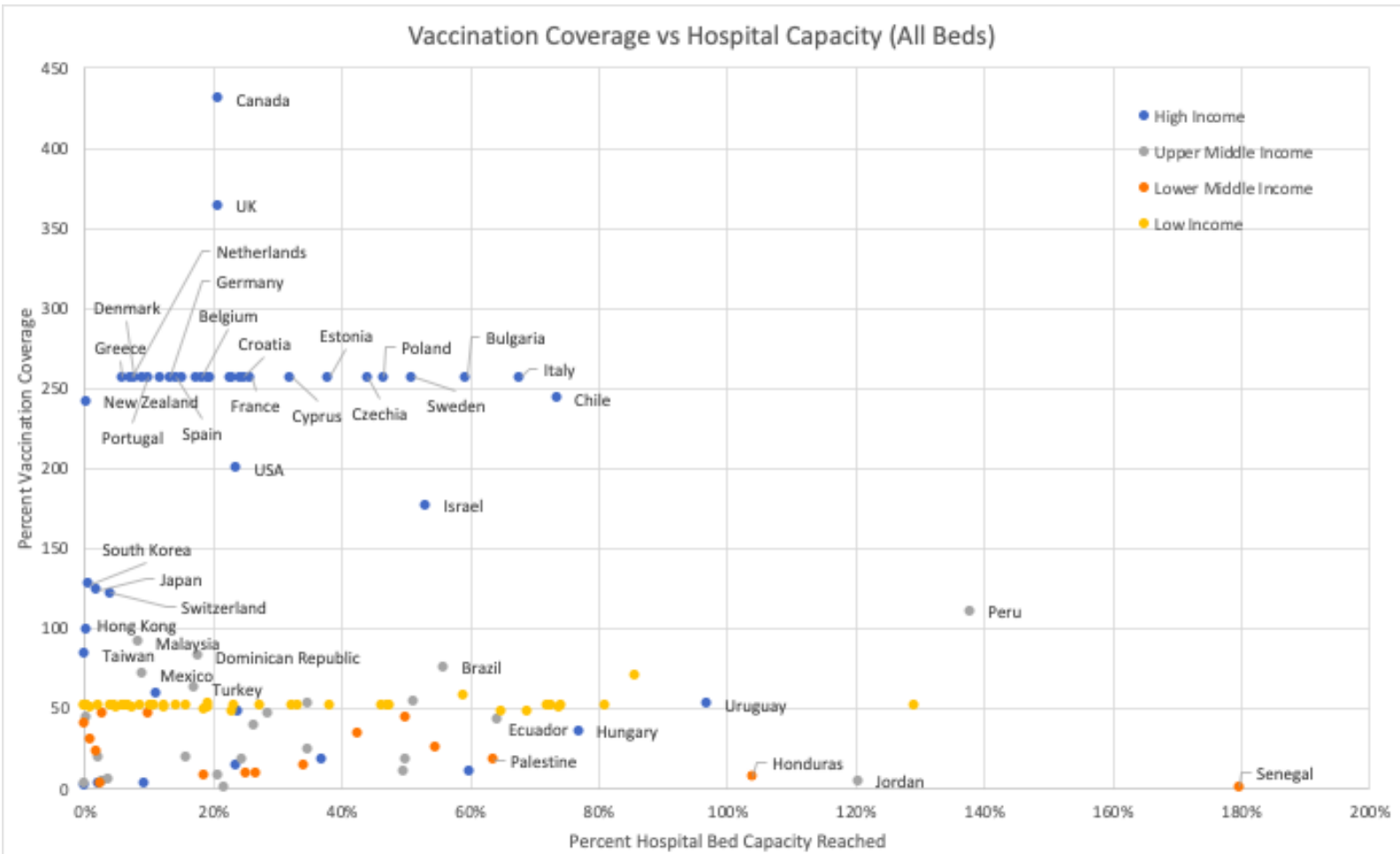
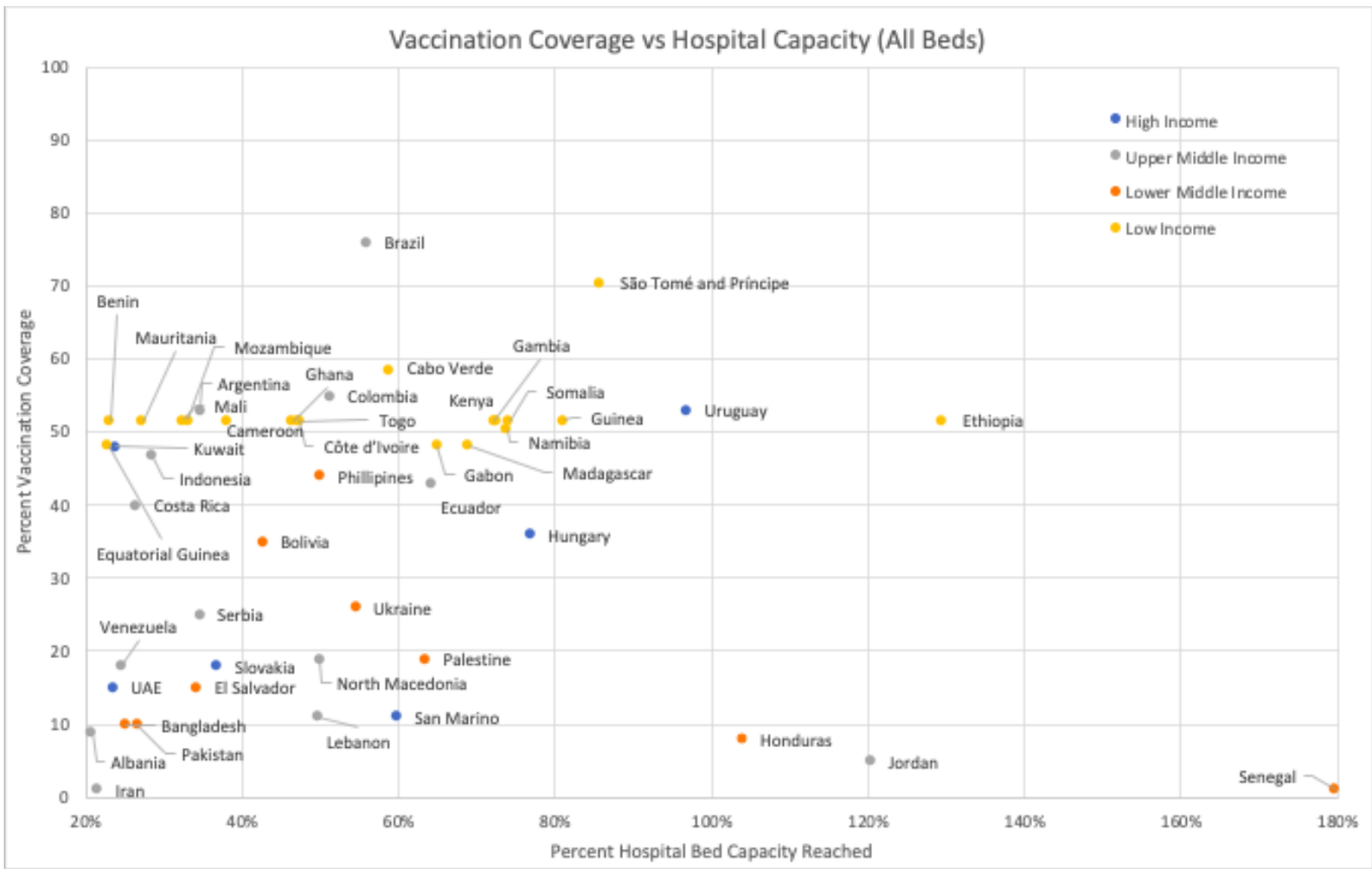


Figure 4B: Under 100% Vaccination Coverage vs. Over 20% General Capacity Reached



Vaccination Coverage and Deaths per 100K Population

Figure 5A demonstrates that even high-income countries with the capacity to advance-purchase vaccines have experienced varying mortality rates from COVID-19 based on individual national management of the pandemic. For example, while New Zealand and the Czech Republic have obtained vaccines for a similar percentage of their populations, they report 0.53 deaths and 257 deaths per 100K people, respectively. Mortality rates for countries at or below 100% vaccination coverage is shown in Figure 5B. While high income countries appear to generally experience higher relative mortality rates overall, the majority of these nations do have excess vaccine stock; the mortality burden faced by LMICs is still significant given their lack of vaccination coverage. Non-high-income countries make up 85% (17/20) of those under 100% vaccination coverage and with a mortality rate above 50 deaths per 100,000. Only one low-income country experienced a mortality rate above 50 deaths per 100,000.

Figure 5A: Vaccination Coverage vs COVID-19 Mortality (All)

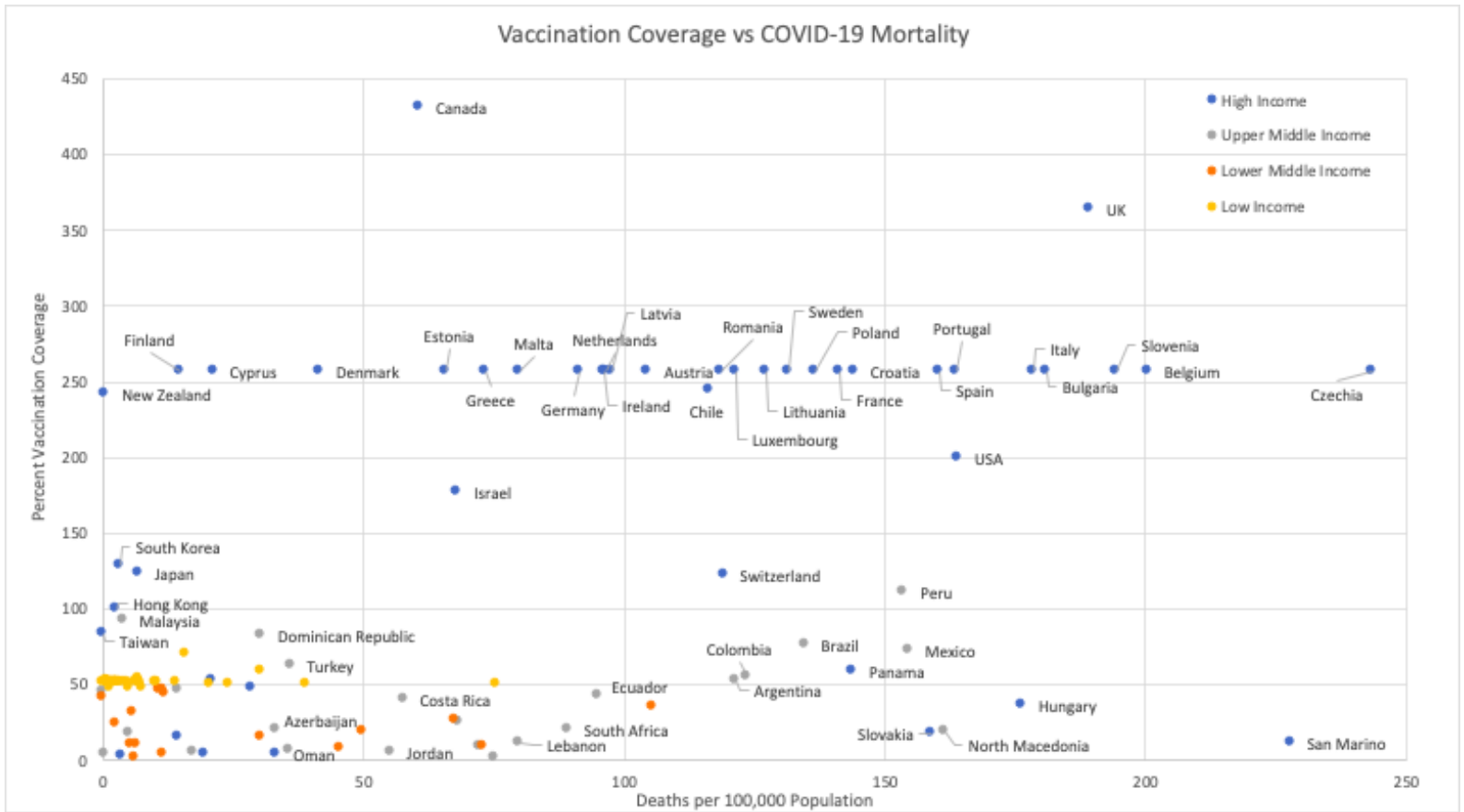
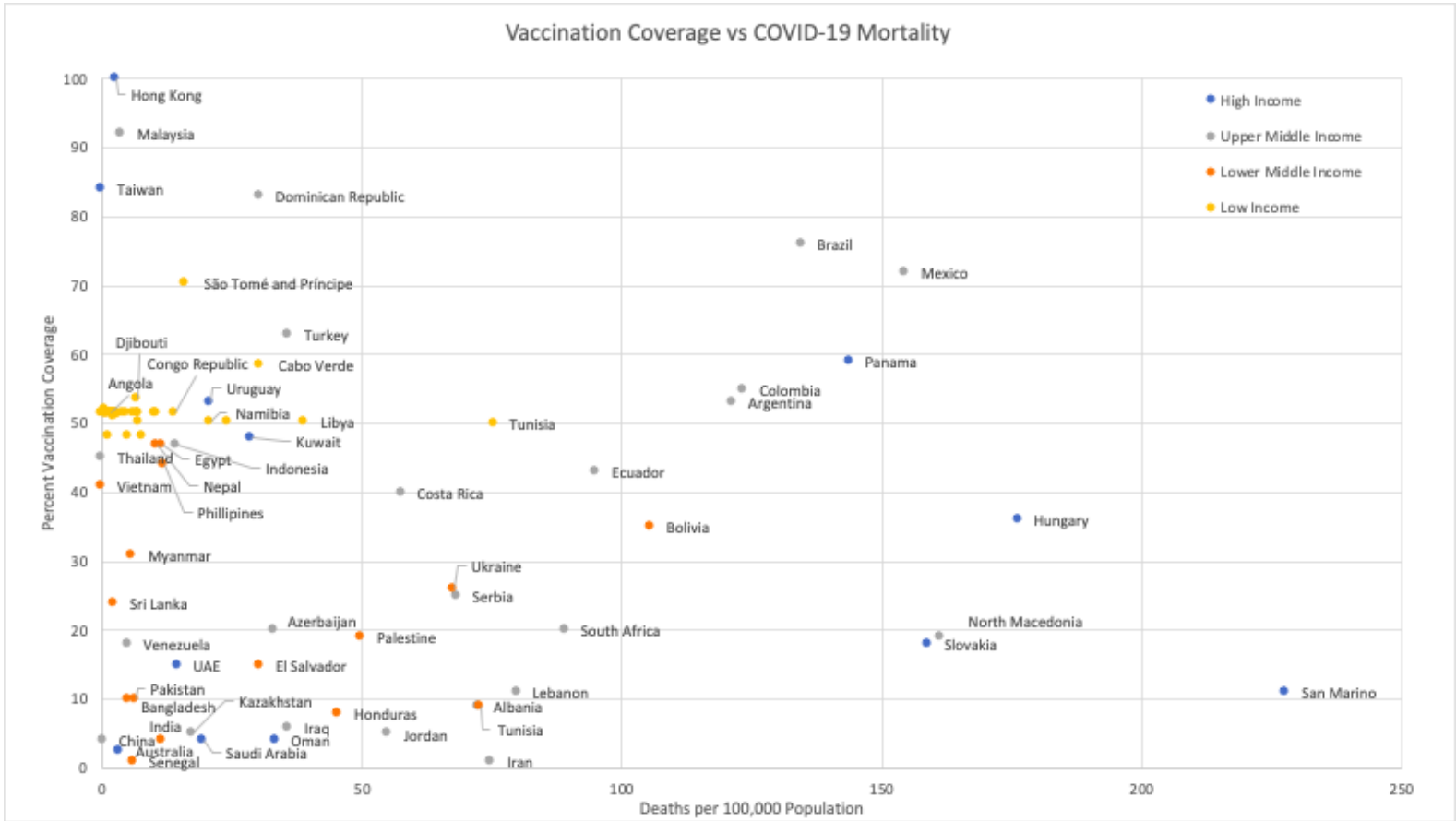


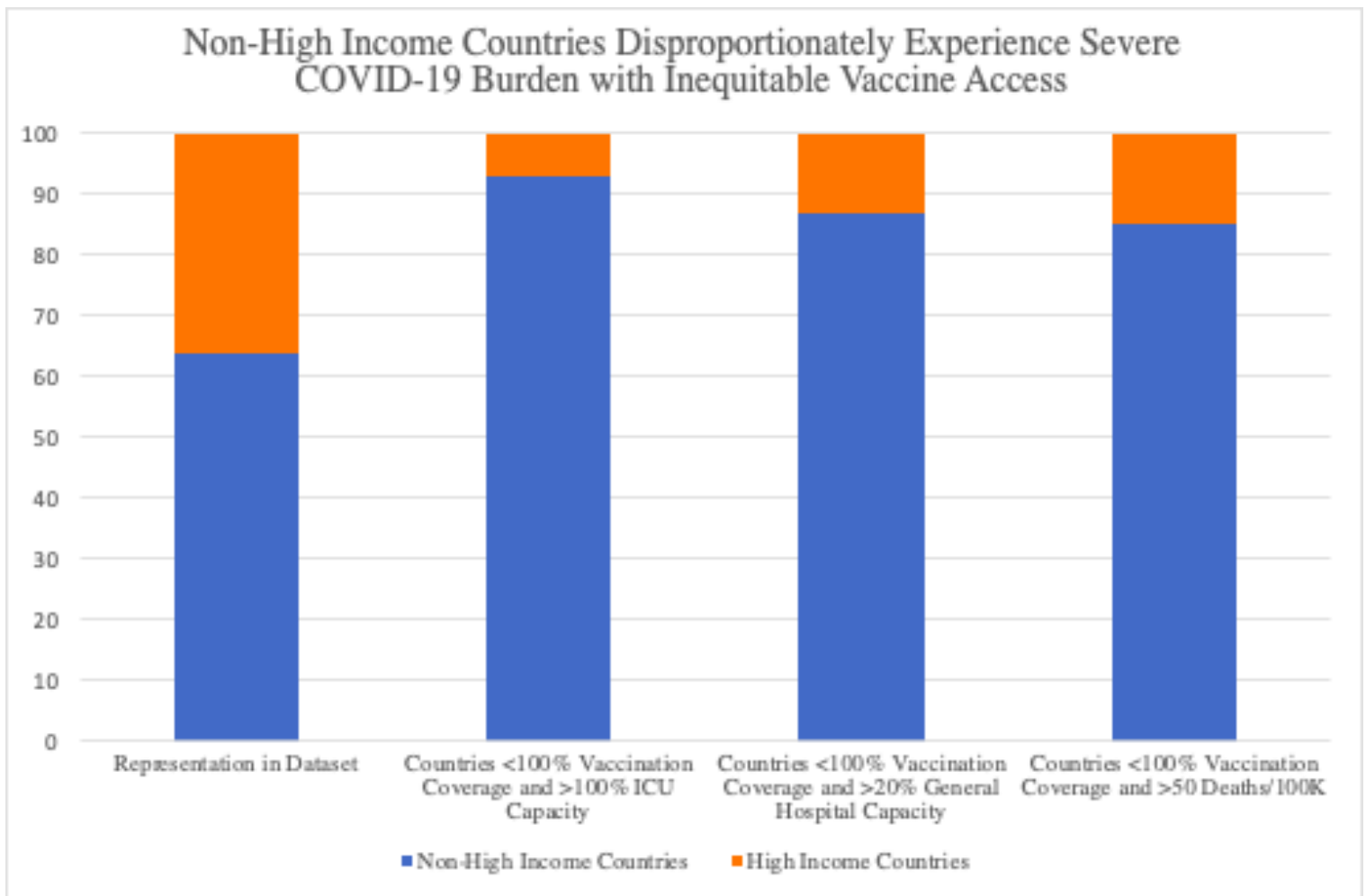
Figure 5B: Under 100% Vaccination Coverage vs COVID-19 Mortality



Summary of Results

Figure 6 presents a summary of the results comparing high income countries to non-high-income countries. Representation of each category in the dataset is compared to the proportion in each analysis component that were clinically overburdened and underrepresented in vaccine purchasing.

Figure 6: Results Summary



Discussion

Non-high-income countries are shown to disproportionately experience severe clinical need in the overburdening of their general and ICU hospital capacities as well as significant mortality from COVID-19, all while unable to secure vaccination coverage for their populations. The visualizations produced by this analysis enable the creation of a vaccine priority list for countries in the aforementioned “crisis zones”. Consistently, countries in Latin America and member states of the African Union appeared in the visualizations as overburdened and under-vaccinated and would serve as ideal candidates for a targeted redistribution scheme. This analysis provides evidence that warrants a global focus on equity in vaccine purchasing and highlights the need to incentivize high income countries to redistribute their excess advance-purchase stock if equitable global allocation of vaccines is to be achieved.

Policy Implications

The prioritization of LMICs in vaccine purchasing requires the mobilization of stakeholders from high income countries to participate in a redistribution mechanism. Some nations have started to cautiously negotiate their excess supply once confident of their own population’s coverage. The United States has tentatively agreed to share AstraZeneca doses from their advance purchase supply and will provide 4 million doses to Mexico and Canada.^{16,17} Brazil is in current talks with the US government to import excess vaccines, and Norway has pledged to donate vaccine doses to low-income countries.^{18,19} As such, participation in vaccine diplomacy is emerging as a mechanism to incentivize high income countries to redistribute their excess supply.

Recommendations for global strategies in moving towards equitable vaccine allocation lie in reframing measures of progress in the pandemic away from nationalistic targets. In order to successfully create a priority list for global vaccine allocation and incentivize participation in a redistribution mechanism, high income countries must understand that national coverage of their own populations is not sufficient to end a global pandemic. Three arguments can be made to convince high-income stakeholders of the urgency of redistributing excess vaccine supplies:

Epidemiological

If high income countries continue to hold on to their advance purchase stock, the pandemic could last as long as seven more years.⁴ Even if a given country were to fully vaccinate its own population, unchecked spread of COVID-19 in LMICs could produce dangerous new variants that threaten a globalized community.

Economic

Studies on the global consequences of inequities in vaccine access found that allowing the pandemic to continue in LMICs will damage the economies of high-income countries that depend on global supply chains. The global economy is expected to lose USD 9 trillion if poorer nations are left behind in vaccination, with high income countries bearing 49% of this cost.²⁰

Foreign Policy

This analysis identified LMICs that are disproportionately in severe crisis as a result of the COVID-19 pandemic - both clinically overburdened and shut out of vaccine purchasing. Donations of excess vaccine supply could be reframed as a method of global disaster relief instead of viewed in direct conflict with national priorities and would serve to boost the global standings of high-income countries. While governments have focused on national success in

vaccinations as a measure of progress, exportation and donations of vaccines as global aid could similarly be framed as a source of national pride.

Analysis Limitations

Measures of COVID-19 burden discussed in this thesis are subject to inconsistencies in national reporting. COVID-19 mortality rates may be deflated as fatalities are misattributed to other causes of death. Errors in reporting of hospital demand and capacity status for COVID-19 patients are possible and depend largely on the transparency of national governments and healthcare systems.

This analysis provided vaccination coverage and COVID burden data using a snapshot of the current global situation and does not reflect earlier periods of crisis or changes in the pandemic experienced over time. Furthermore, national statistics of COVID mortality and overburdening of hospitals do not reflect regional conditions. For the US in particular, varying state level regulations resulted in differing COVID-19 burden and hospital capacity outcomes.

Finally, the percentage of national populations that could become vaccinated based on purchases is an ideal number and does not reflect the reality of who can access vaccinations. Within each country, national vaccine distribution and delivery processes can prevent equitable rollout if disadvantaged populations are not afforded access. Equitable vaccine purchasing is one small component of the global health equity considerations relevant to the COVID-19 pandemic, which include sustainable access to personal protective equipment, availability of diagnostic testing, and access to quality healthcare services among many others.

Conclusion & Future Directions

As high-income countries continue to hoard an excess stock of purchased vaccines, LMICs are prevented from securing enough COVID-19 vaccine doses to cover their populations while facing severe clinical need. This analysis visualized COVID-19 burden with respect to vaccination coverage to identify the countries that must receive priority if equitable global allocation is to be achieved and found that the LMICs are disproportionately the countries in crisis - overburdened and underrepresented in vaccine purchasing. Leaders in global health policy must continue to support the work of COVAX and propose a mechanism for the redistribution of excess vaccines that convinces high income countries of the need for global health equity in ending the COVID-19 pandemic.

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