



COVID-19 vaccination policies around the world: How democracy influenced prioritisation strategies

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ARTICLE INFO

Keywords:

COVID-19

Vaccination policies

Democracy

State capacity

ABSTRACT

The rapid development of COVID-19 vaccines had a crucial role in facilitating the global recovery from the pandemic. Countries around the world adopted different vaccine prioritisation strategies, but this variation and its underlying causes are poorly understood. Drawing on Oxford COVID-19 Government Response Tracker's data on vaccine prioritisation plans and eligibility, we describe which population groups were prioritised, when, and in which order across countries. We create a new measure of vaccination plan granularity, which captures the degree to which vaccination strategies targeted specific groups. We use correlations and regressions to examine the relationship between granularity and country-level factors—in particular, democracy and state capacity. In simple correlations, more granular vaccination strategies are associated with higher vaccine uptake, and both democracy and state capacity go hand-in-hand with greater granularity. Once potential confounding factors are controlled for, however, of the two, only democracy emerges as a key predictor. We also find that, in line with the World Health Organization's recommendations, older age groups, healthcare workers, and clinically vulnerable people were highly prioritised in vaccination campaigns. The link between granular vaccination plans and democracy highlights the importance of institutional factors in shaping policy design during public health crises like COVID-19.

1. Introduction

Government responses to the COVID-19 pandemic were a matter of life and death for populations around the world, and had enormous consequences for non-health outcomes such as economic growth (e.g. Demirgüç-Kunt et al., 2024; IMF, 2020) and educational attainment (e.g. Engzell et al., 2021; Recch et al., 2022). Understanding why governments adopted different strategies, and with what consequences, is thus critical both for theories that aim to understand how governments respond to emergencies and for practical efforts to prepare for future shocks.

While a large literature has sought to explain why different kinds of governments adopted different non-pharmaceutical interventions (NPIs) (e.g. Cepaluni et al., 2022; Cronert, 2022; Engler et al., 2021; González-Bustamante, 2021; Schmotz and Tansey, 2023), especially in the first year of the pandemic, the rapid development of vaccines shifted the nature of government responses in later years. Building on previous research (Cameron-Blake et al., 2023), we describe and seek to understand a key aspect on which governments' approaches to vaccination

differed: how they prioritised different groups. Because vaccine supplies were limited in availability, countries adopted different vaccine allocation strategies, prioritising the vaccination of some population groups over others. The first key contribution of our study is a descriptive inference of vaccination strategies to better understand their diversity. We focus on which population groups were prioritised, when, and how.

Addressing this question reveals an intriguing puzzle of granularity in vaccine prioritisation plans. Even if most countries followed the World Health Organization's (WHO) advice to start rollout from health workers and the elderly (WHO, 2020), we observe great variation in how granular and fine-tuned vaccine prioritisation plans were across countries. Some countries prioritised only a handful of population groups, while others announced complex vaccination strategies prioritising numerous categories like students, government officials, and refugees and migrants in multiple tiers of priority.

The granularity of vaccination strategies likely matters for a number of reasons. Most significantly, we find that greater granularity is correlated with a higher vaccination rate (Fig. 1), suggesting that more fine-tuned strategies may lead to better outcomes. Understanding how and

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<https://doi.org/10.1016/j.socscimed.2026.119230>

Received 21 May 2025; Received in revised form 27 January 2026; Accepted 22 March 2026

Available online 23 March 2026

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why governments prioritise different groups is therefore crucial.

Following the large literature relating governments' adoption of NPIs to political and institutional factors, we posit that both democracy and state capacity shape the granularity of vaccination strategies. Democratic institutions may affect vaccine strategies in two ways. First, by holding leaders accountable for resource distribution, democracy may increase their concern for more effective use of public resources. Indeed, the literature shows systematic correlations between democracy and public good provision generally. Second, democracy may allow specific subsets of the population to advocate for their interests. For example, marginalised communities who may be vulnerable to a disease can organise and pressure political leaders to address their needs, potentially resulting in vaccination strategies that speak to a specific group's interests.

At the outset of this study, we also hypothesized that a country's capacity to design and implement a complex vaccination programme would affect vaccine plan granularity. Countries with more capacity should be able to direct scarce resources to top priorities, while those with weaker delivery and implementation systems may need to rely on blunter approaches.

We investigated these ideas in a global sample of countries via descriptive analysis and linear regressions. Our descriptive analysis reveals substantial variation in vaccine plan granularity across countries and shows that this granularity is positively correlated with democracy, state capacity, and other relevant country characteristics like national income. Our regressions then isolate democracy as the key predictor of more granular vaccine prioritisation plans. Conversely, even if state capacity is positively associated with granularity in several regression models, it is never statistically significant when democracy is controlled for.

Our results suggest that democracies tend to adopt more fine-tuned vaccination plans, and thus, may be more concerned about using scarce public resources effectively and including diverse population groups in their plans.

Our study has important implications for global guidance on national vaccine allocation priorities in scenarios of limited supply. First, we show that institutional factors, particularly democracy, appear to shape the design of national vaccination strategies by influencing the incentives to adopt more or less granular strategies. The WHO operates in all kinds of institutional contexts, but its prioritisation recommendations for COVID-19 vaccines considered only different epidemiologic

conditions and vaccine supply levels, not institutional differences. Taking institutional differences better into account could enhance the effectiveness of WHO guidance by allowing for a more context-specific approach to vaccine prioritisation and international health emergencies.

Second, relatedly, even though the WHO's recommendations for COVID-19 vaccine prioritisation strategies mentioned multiple population groups, the guidelines showed little granularity, including only three tiers of priority. For instance, in a situation of community transmission, less-at-risk older adults, groups with high-risk comorbidities, high-risk socioeconomic groups, some health workers, and high-priority teachers and school staff were all in the same priority tier. To the extent that more fine-tuned prioritisation strategies are associated with higher vaccine uptake, offering more specific guidance that further prioritises among and within these population categories is likely beneficial. However, certain countries may need additional support (e.g. technical assistance and investments) to adopt more fine-tuned prioritisation strategies, and without it may find that less granular guidance is more practical.

2. Explaining variation in government vaccination strategies: institutional factors

There is wide agreement that targeted vaccination strategies where some population groups are prioritised over others are essential for successful vaccination campaigns when vaccine supply is limited—as was the case with COVID-19. However, there is disagreement on which groups should be prioritised and in which order, as this depends on context, objectives, and ethical considerations (e.g. [Giubilini et al., 2021](#); [Saadi et al., 2021](#)).

While a universally 'best' vaccine prioritisation strategy does not exist, because what is considered to be 'best' varies from one country to another, it can be argued that every society has an ideal sequential order for each individual to get vaccinated in a given situation that optimises resources and leads to desired outcomes, whatever they are. Country-specific factors and objectives result in the ideal sequence to differ among countries. But in all countries, this sequence can be theoretically represented by ranking every individual based on their priority to get vaccinated, considering factors like an individual's risk of getting exposed to the virus, vulnerability to severe health consequences, and role in the society. In reality of course no country has the capability or resources to create such a detailed ranking—it would require an

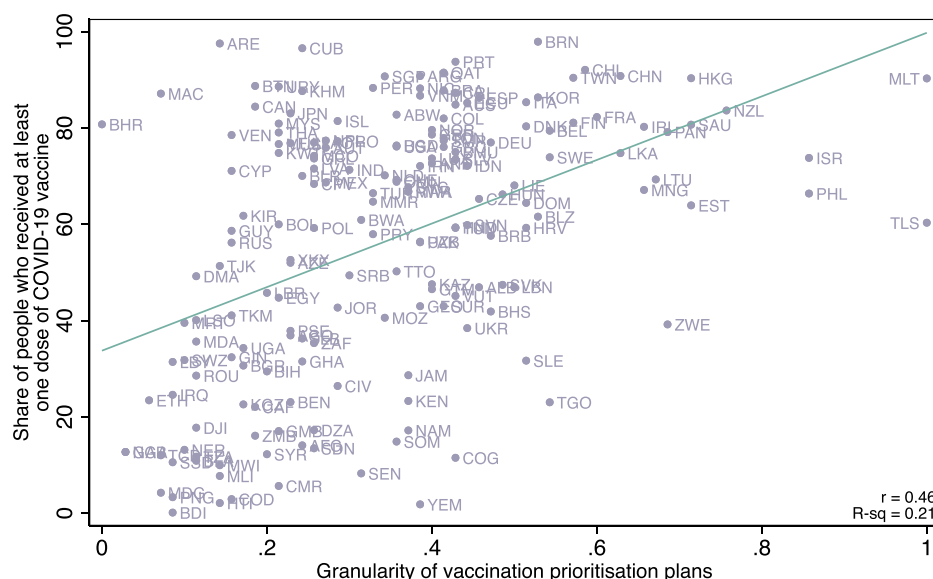


Fig. 1. Granularity of vaccination strategies and share of vaccinated population
Share of vaccinated population as of June 30, 2022. Level of granularity refers to maximum granularity.

enormous amount of precise information about each individual. Moreover, the logistical challenges of implementing such a detailed plan would be unmanageable in practice. So countries typically prioritise broader population groups like the elderly and healthcare workers rather than individuals.

Drawing on this logic, we argue that a more granular vaccination strategy that prioritises more population groups with higher stratification aims at being closer to a country's theoretical ideal—whatever that ideal is—than a strategy without any prioritisation. We systematically compare the widest possible range of vaccination strategies, and investigate the factors that led countries to adopt more granular vaccination strategies. Our analysis therefore does not focus on whether vaccination strategies were implemented well or whether they were successful in getting people vaccinated (although, as previously discussed, simple correlations indicate that more granular strategies were associated with higher uptake). But it focuses on examining what factors best explain some countries' announcements of very detailed vaccine prioritisation plans, and others' lack of detail. As more fine-tuned prioritisation plans arguably reflect higher concern for effective use of public resources and different population groups,¹ and go together with higher vaccination rates, understanding what drives more fine-tuned vaccination strategies can provide insights into the motivations and constraints that affect vaccination policies. It can thus help to improve preparedness to pandemics and other public health emergencies in the future.

In delving into the potential drivers that may shape vaccination strategies, we draw on insights from recent political science research on COVID-19, where two high-level institutional determinants of successful pandemic responses have had particular attention: democracy and state capacity. Theoretical considerations suggest that these two institutional factors may help explain why some countries adopted more granular vaccination strategies targeting specific population groups in a specific, stratified order, instead of more 'indiscriminate' vaccination strategies that do not consider differences in population groups.

We expect more democratic countries to adopt more granular vaccination plans for several reasons. First, electorally accountable politicians have stronger political incentives to provide better public services and improve their citizens' wellbeing (Lake and Baum, 2001). As politicians in democracies will have to deal with the political consequences of their actions, they also tend to adopt more preventative strategies in fighting a pandemic like COVID-19 to "avoid electorally harmful blame for jeopardising public health" (Cronert, 2022: 706). A more granular vaccination strategy reflects higher concern for using effectively public resources and for being closer to a country's theoretical ideal. In a situation of limited vaccine availability, compared to randomly vaccinating people without prioritising anyone, a more granular vaccination strategy represents, all other things equal, a safer preventative choice. Second, citizens in democracies have more political power to determine the content of social policies (Acemoglu and Robinson, 2006), and they might demand more fine-grained and effective vaccination strategies in which their groups are prioritised. Because of the electoral accountability mechanism, governments in democratic countries are more likely to listen to citizens' demands, and thus, adopt such vaccination strategies. Third, political leaders in democracies must please a large winning coalition (Buono De Mesquita et al., 2001), and a more granular vaccination strategy reflects higher concern for a broader number of population groups.

On the other hand, autocracies may take more timely and effective decisions during crises because of their top-down decision-making processes (Gao and Zhang, 2021) and isolation from interest-group pressures (Przeworski and Limongi, 1993). Checks and balances intrinsic to the democratic policy-making process could lead to a

slowdown in selecting among competing vaccine prioritisation strategies. And conflicting demands from different population groups could result in inertia or sub-optimal policies in democracies, if politicians are afraid of prioritising some groups over others due to potentially harmful consequences at the ballot box. Authoritarian leaders are more immune both to checks and balances as well as citizens' demands. Nothing guarantees that they have higher concern for efficiency or more population groups and adopt the optimal policy, but benevolent and wise dictators might be willing and able to choose a fine-tuned vaccination strategy that aligns with citizens' interests. Also, some authoritarian rulers might enact more granular vaccination strategies to increase their legitimacy via better performance or please regime support groups by prioritising them first in vaccination plans. Despite these possibilities, based on theoretical considerations, it seems more likely that more democratic countries develop more granular vaccination plans, due to their greater accountability to citizens and political incentives to enact more inclusive and better public health policies.

Alongside regime type, a competent state apparatus has been seen as a key determinant of successful pandemic responses (Fukuyama, 2020). It is indeed reasonable to assume that developing a more granular vaccine prioritisation plan, along with successfully implementing it, requires a well-functioning and effective state bureaucracy. Such administrative apparatuses are populated by competent public servants who can make better decisions in times of crises (Gisselquist and Vaccaro, 2022). A more fine-tuned strategy regarding which population groups to vaccinate, when, and in which order reflects higher concern for effective use of public resources. Compared to dysfunctional state bureaucracies, well-functioning administrative apparatuses are also better equipped to collect and manage more detailed information on their citizens and the society. Which means they can assist policymakers to make better decisions and translate this information into more fine-tuned vaccine prioritisation strategies that more closely align with societal needs. Countries with well-functioning administrative apparatuses might be thus more inclined to adopt more granular vaccination plans, whereas those with weaker state institutions might avoid targeted and nuanced vaccination strategies, knowing they lack the means to implement them well. However, since vaccine prioritisation tends to be ultimately a political decision, effective state institutions might matter more for implementation than for the degree of granularity itself.

Although past studies have not focused on the granularity of COVID-19 vaccination plans, some have examined the causes of more targeted pandemic policies compared to 'indiscriminate' population-wide responses. Specifically, Chae (2023) analyses whether state capacity—understood as administrative effectiveness—affected the likelihood of adopting more targeted COVID-19 social distancing rules. Arguing that higher state capacity provides better ability to adopt complex restrictions and leads to stronger citizen compliance, he finds that countries with higher state capacity favoured targeted over population-wide restrictions. Although the considerations behind more targeted social distancing rules differ from those driving more granular vaccine prioritisation plans, there are similarities in terms of greater complexity and fine-graininess compared to indiscriminate population-wide approaches. Both targeted social distancing and granular vaccine prioritisation may thus be the preferred type of policy adopted in countries with higher state capacity.

3. Methods

3.1. Empirical strategy

Our empirical analysis proceeds in two steps. First, we investigate descriptively vaccine prioritisation strategies across countries. The objective of this descriptive part is to shed light on COVID-19 vaccination campaigns in terms of timing and prioritised groups. We describe which groups were prioritised, when, and in which order. Second, we focus on the granularity of these strategies. We develop a new index of

¹ To be clear, 'effectiveness' here means being closer to a country's theoretical ideal, not cost-effectiveness or effectiveness in reducing infections.

vaccination plan granularity, examine variation in granularity across countries and its evolution over time, and analyse potential correlates of granularity. Third, we explore the sources of more fine-tuned vaccine prioritisation plans via ordinary least squares regressions. The objective of these regressions is to understand whether democracy and state capacity are associated with the granularity of vaccine prioritisation plans, controlling for other relevant factors.

We use a series of cross-section regression models, from simpler baseline specifications to more elaborate specifications with multiple controls. Our outcome variable is vaccination plan granularity. Our main explanatory variables are democracy and state capacity. In baseline models, we control for GDP/capita, population, and COVID-19 deaths. In more complex models, we first control for elderly population and universal health coverage (UHC), and then for a set of three COVID-19 vaccination variables (delivered doses, rollout date, and early uptake). Last, we run full models containing all these independent variables.

We also run additional models to test the robustness of our results and further explore the mechanisms at play. First, since different measures of democracy and state capacity do not always lead to similar results, we examine whether our findings hold when using alternative measures of democracy and state capacity. Second, we create an alternative version of our granularity index using a different aggregation procedure (i.e. by aggregating its component indicators geometrically rather additively), and test the robustness of our findings to this alternative version of the granularity index. Third, we use more specific measures of democracy to try to further shed light on how the association between democracy and granularity exactly works.

3.2. Data

COVID-19 vaccination policy data is taken from the Oxford COVID-19 Government Response Tracker (OxCGRT) dataset (Cameron-Blake et al., 2023; Hale et al., 2021). This data records, amongst other information, which groups were prioritised in vaccine rollout plans and when, as well as which groups de facto became eligible and when, to receive COVID-19 vaccines for 185 countries worldwide (and a number of subnational jurisdictions). In our analysis, we use indicators of vaccine prioritisation ('V1') and vaccine eligibility ('V2'). These indicators provide daily data on 52 population groups—16 general age-based groups, 14 'at-risk' age-based groups, and 22 non-age-based groups (Table A1, Supplementary material)—at the country level from the beginning of the pandemic until December 31, 2022. These groups represent the most common population categories that were included in vaccine prioritisation plans (see Cameron-Blake et al., 2023), and mirror the WHO's Strategic Advisory Group of Experts on Immunization (SAGE) framework on vaccine allocation (Table A2, Supplementary material). V1 reflects the rank order in which a group was prioritised in the plan. V2 captures whether a group was being vaccinated or not on a given date. A more detailed description of this data is available in the OxCGRT repository (Hale et al., 2021).

We draw on V1 to develop a new cross-country index of country-level vaccine prioritisation plan granularity. We conceive such granularity as the combination of two factors: (1) a greater number of prioritised groups in vaccination plans and (2) a higher degree of stratification among the prioritised groups. The first factor provides information on how many groups were included in the prioritisation plans. The second factor reflects the number of prioritisation tiers in a plan. A more fine-tuned plan is thus captured by a greater number of groups and tiers. These two indicators—measured as a share of population groups coded in OxCGRT's dataset—are linearly aggregated by summing the two individual indicators with equal weights and then taking their mean. This procedure can be formally described by Equation (1), where i and t denote, respectively, countries and days, G_{it} is the granularity index, $P_{1,it}$ is the number of prioritised groups in a plan, and $P_{2,it}$ is the number of tiers in a plan. The final index is min-max normalised from 0 to 1, low to

high granularity. As previously discussed, we believe that more granular vaccination plans reflect higher concern for the effective use of public resources and for a broader number of population groups.

$$G_{it} = \frac{1}{2} (P_{1,it} + P_{2,it}) \quad (\text{Equation 1})$$

Vaccination strategies can vary over time, so we first compute granularity at the country-day level and focus on daily values. Nevertheless, in exploring the link between granularity and other relevant factors like democracy or state capacity—which do not vary daily—we opt for an aggregate measure of maximum granularity in each country.

To measure our two institutional factors of interest—democracy and state capacity—we draw on the Varieties of Democracy (V-Dem) dataset (Coppedge et al., 2020). We use V-Dem's *electoral democracy* index to measure democracy and *rigorous and impartial public administration* indicator as a proxy for state capacity.

V-Dem's electoral democracy is a frequently used democracy index. It is theoretically rooted in Dahl's (1971) concept of polyarchy and aggregates observational and expert survey data on elected officials, free and fair elections, suffrage, associational autonomy, and freedom of expression and information. Studies show it performs better than other common democracy indices in various tests (Boese, 2019; Vaccaro, 2021).

State capacity has been operationalised in many different ways. Hanson and Sigman (2021), for instance, identify three dimensions: administrative, extractive, and coercive. We are interested in the administrative dimension of the state, because "in the context of a pandemic, a meritocratic, professional, and competent Weberian bureaucracy is essential to policy making" (Chae, 2023: 892). The selected indicator of rigorous and impartial public administration has been widely used as a proxy for administrative state capacity in the literature (e.g. Gjerlow et al., 2022).

As different indicators of state capacity are not interchangeable among one another (Vaccaro, 2023), it is important to choose a measure with high face validity. The chosen measure of administrative state capacity achieves this goal because impartiality is typically understood as a key characteristic of the Weberian ideal type of bureaucracy. It has been argued that impartial bureaucracy does not always mean higher state capacity (Fukuyama, 2013). But if meritocratic recruitment implies impartiality—and it seems reasonable to assume it does—then, as the mainstream political science literature argues, impartiality is a valid proxy for the administrative dimension of state capacity, because meritocracy increases competence and thus state capacity (Rothstein, 2019).

To ensure our findings are not idiosyncratic to the chosen measures, we also use alternative measures of democracy and state capacity from the Worldwide Governance Indicators (WGI) dataset: we measure democracy with *voice and accountability* and state capacity with *government effectiveness*. Both measures synthesise numerous indicators from different sources, capturing respectively "the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media" and "the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies" (Kaufmann et al., 2011: 223).

WGI's measures conceive democracy and state capacity in broader terms than V-Dem's measures. V-Dem relies mainly on expert assessments, whereas WGI aggregates secondary data from expert assessments and business and citizen surveys. Moreover, WGI's democracy measure includes sub-indicators on human rights and transparency, which are not captured by V-Dem's democracy measure. WGI's state capacity measure also reflects a broader understanding of (administrative) state capacity, which includes features like satisfaction with and the quality of basic public services, while V-Dem's state capacity measure is specifically based on expert responses about whether public officials are rigorous and impartial in performing their duties.

The chosen democracy and state capacity data refer intentionally to 2019—the last year before the COVID-19 pandemic. Using data from this year means that measures are both reasonably up-to-date but also reflect conditions just prior to the pandemic to get closer to our idea of the direction of causality and sequence of events. While our analysis does not aim to prove causality between these institutional factors and COVID-19 vaccination strategies, we nonetheless aim to highlight potential sources of different vaccination strategies. Focusing on pre-pandemic values of democracy and state capacity, as we do, reduces possible concerns of simultaneity and reverse causality.

In the regressions, we control for (1) GDP/capita, as richer countries may have had more resources to adopt more complex vaccination strategies; (2) total population, as more populous countries might have preferred different vaccination strategies; (3) share of elderly population, because higher severity of COVID-19 among older people could have influenced prioritisation choices; (4) cumulative COVID-19 deaths (measured as of December 31, 2020 to capture deaths before the mass rollout of vaccines), because different pandemic health outcomes may have affected concern for resource use and population groups; (5) the number of COVID-19 vaccine doses delivered, as vaccine availability might have shaped vaccination strategies; (6) UHC, as we expect countries where high-quality healthcare is available to most people in an equal manner to use more effectively public health resources and have higher concern for more population groups; (7) the ‘delay’ in vaccine rollout compared to the country that first started vaccinating its citizens (Bahrain, November 3, 2020), as a later rollout meant more information about prioritisation; and (8) initial vaccine uptake, measured as the share of vaccinated population two months (i.e. 60 days) after rollout in each country, as early uptake rates may have led countries to revise their plans.

Finally, we also pick more fine-grained democracy measures to explore the precise mechanisms at play. In doing so, we disaggregate our primary democracy measure into its five sub-indicators—(1) *clean elections*, (2) *freedom of expression and alternative sources of information*, (3) *freedom of association*, (4) *share of population with suffrage*, and (5) *elected officials*. We use V-Dem's *clean elections* to capture the idea that competitive elections push politicians to have higher concern for effective use of resources and more population groups for political reasons, whereas we use the average between V-Dem's *freedom of expression and alternative sources of information* and *freedom of association* to capture the idea that citizens who are able to organise and advocate for their interests can shape the granularity of vaccination strategies by putting pressure on politicians through more vocal demands. By contrast, on theoretical grounds, we expect V-Dem's *share of population with suffrage* and *elected officials* to reflect democratic features are less directly relevant for explaining variation in vaccine prioritisation plan granularity. They serve as falsification tests. The former measures the de jure extent of the franchise, while the latter, according to V-Dem, “is useful primarily for aggregating higher-order indices and should not necessarily be interpreted as an important element of democracy in its own right” (Coppedge et al., 2020: 47).

Additionally, we choose specific elementary indicators from V-Dem to capture even more directly the proposed mechanisms and as further falsification tests. *Free and fair elections* capture the ‘electoral accountability’ mechanism; *CSO consultation* and *CSO participatory environment* capture the ‘citizens’ voice’ mechanism; *disclosure of campaign donations*, *freedom from political killings*, and *high court independence* map onto aspects of democracy that we expect to be theoretically less important for the granularity of vaccination strategies.

This data along with their sources are listed in Table A3 (Supplementary material).

4. Results and discussion

4.1. Variation in vaccination strategies

We begin our empirical analysis by inspecting the timing of vaccination strategies and prioritised population groups across countries. Fig. 2 illustrates the date of announcement of vaccine prioritisation plans (green dot), the start date of vaccine rollout (purple or orange bar), and the number of days that passed between these two (number next to the bar). There was significant variation across countries in terms of the date of announcement of vaccine prioritisation plans. Tajikistan became the first country worldwide to announce a vaccine prioritisation plan (August 14, 2020). It is a clear outlier, as it announced its plan more than two months before Kuwait—the second country to announce a prioritisation plan. Tajikistan's first plan included three priority groups: border guards, clinically vulnerable people, and healthcare workers. The last country to announce a vaccine prioritisation plan instead was Burundi (October 12, 2021).

Most countries announced their prioritisation strategies on the day of rollout or just a few days before. This suggests that most countries were unable or unwilling to prepare their citizens much in advance to the chosen prioritisation strategy. Vaccines became available in late 2020, so Tajikistan is obviously an outlier: it announced its plan 221 days before actual rollout. Guinea, Libya, and United Arab Emirates were the only countries where vaccination began before the announcement of prioritisation plans. While nearly all countries started their vaccination campaigns by targeting specific population groups (purple bars), two countries—Bhutan and United Arab Emirates—started vaccinating right away anyone over the age of 16 (orange bars).

Generally, countries followed the WHO's vaccine prioritisation recommendations (WHO, 2020), as healthcare workers and older adults were the most prioritised population groups both in plans and in practice. Healthcare workers were by far the most highly prioritised non-age-based group (Fig. 3; Table A4, Supplementary material): 96.8% of countries (179 out of 185 in our dataset) included them in prioritisation plans and 89.2% ranked them first. Clinically vulnerable people were the second most highly prioritised non-age-based group: 76.8% of countries included them in prioritisation plans and 34.1% ranked them first. Age-based population groups were prioritised starting from older groups and ending with younger groups (Fig. 4; Table A5, Supplementary material). More than 90% of countries included adults aged 65 years and above in their prioritisation plans, while fewer than 50% included people under 40. Simply put, as recommended by the WHO, many countries started their vaccination campaigns from healthcare workers, older adults, and clinically vulnerable people.

Other population groups were prioritised less frequently. For example: refugees and migrants were included in prioritisation plans by nine countries, being the highest priority only in Rwanda and Yemen; primary and secondary school students by ten countries, being the highest priority only in Myanmar and East Timor; and Australia was the only country that included infants in vaccine prioritisation plans.

4.2. Granularity of vaccination strategies

Fig. 5 shows the evolution of average granularity in vaccine prioritisation strategies in the world from December 2020 to November 2021. The global average remained relatively stable, with the lowest values at the beginning and end of this period. In most regions, granularity increased over time. Countries in Western Europe and North America reached on average the highest levels of granularity, gradually increasing until May 2021. Countries in Eastern Europe and Central Asia also reached a peak in May, but plans were overall less granular. Asia and Pacific followed a similar trend, peaking in July 2021, whereas in MENA countries the increase in granularity was strongest at the end of the prioritisation phase, in August–September 2021. In contrast, other regions ended with less granular plans than they began. Specifically,

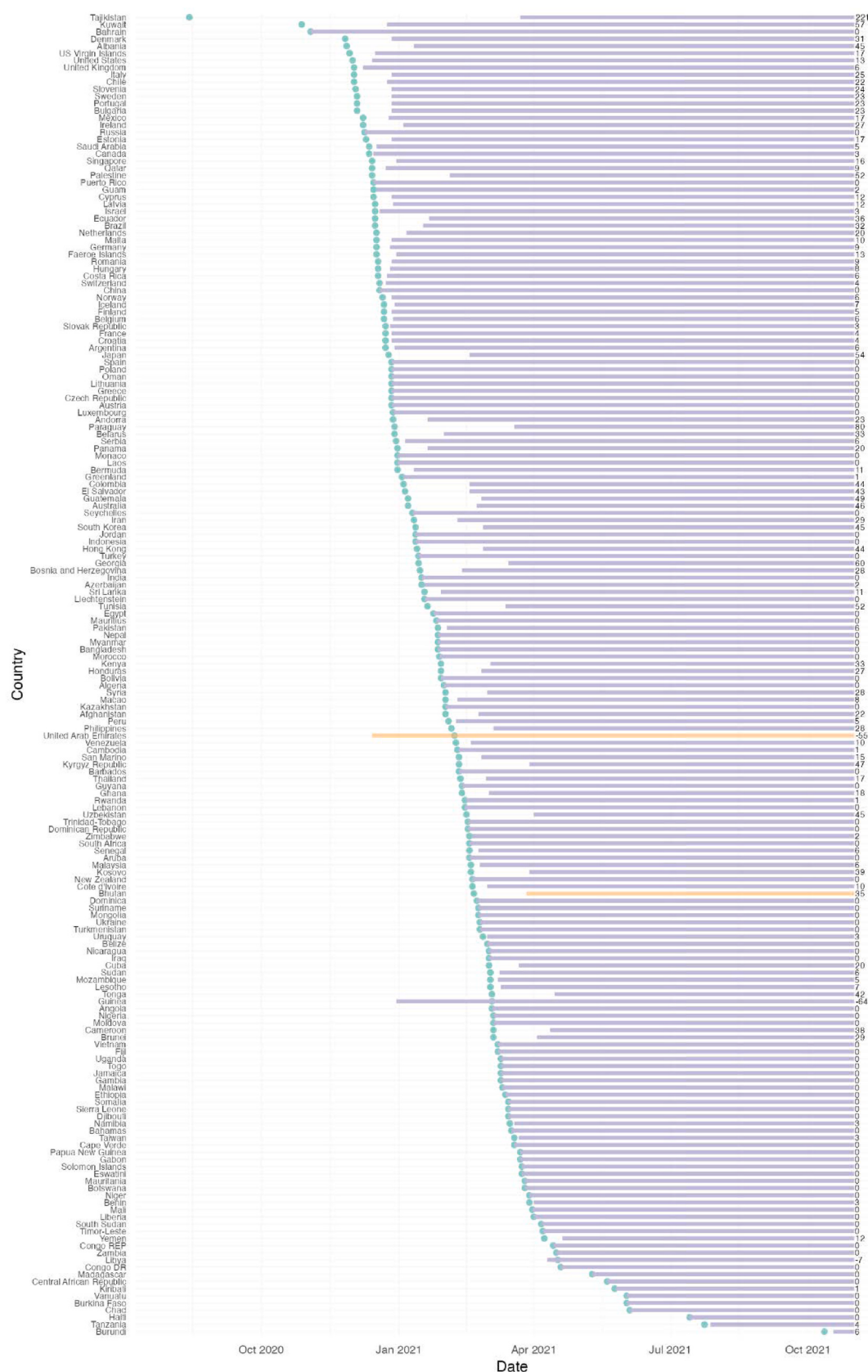


Fig. 2. Prioritisation plan release, start of vaccine rollout, and days between them

Negative values (on the right) indicate that prioritisation plans were announced after the beginning of rollout; positive values that plans were announced before the beginning of rollout; 0 means that plans were announced on the same day rollout started. Purple bars indicate that rollout started only from some population groups; orange bars that rollout started with anyone over the age of 16. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

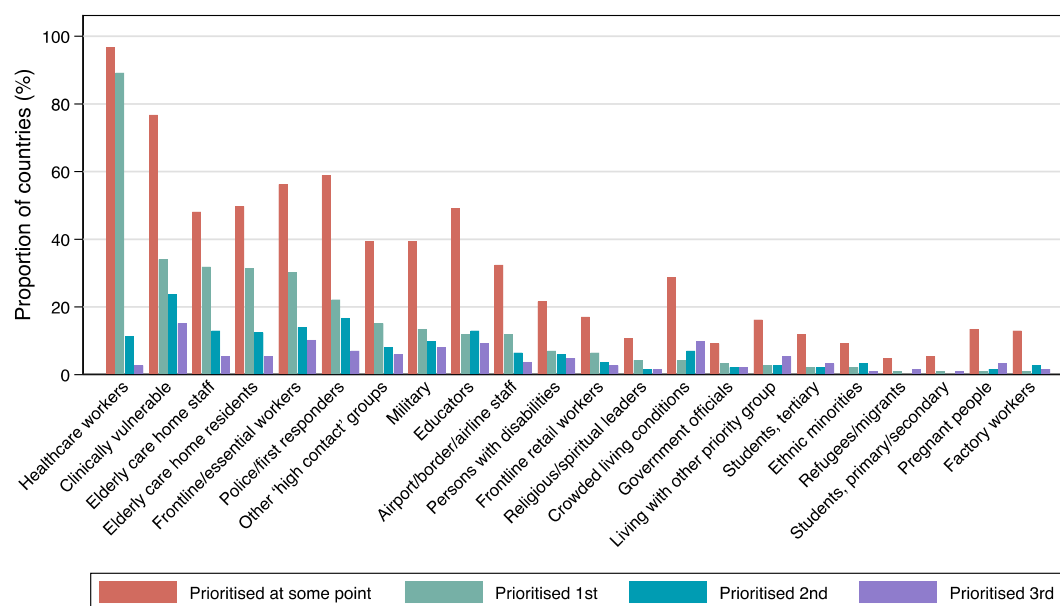


Fig. 3. Proportion of countries that included a given non-age-based group in their vaccine prioritisation plan. Sorted in descending order based on 'prioritised 1st'.

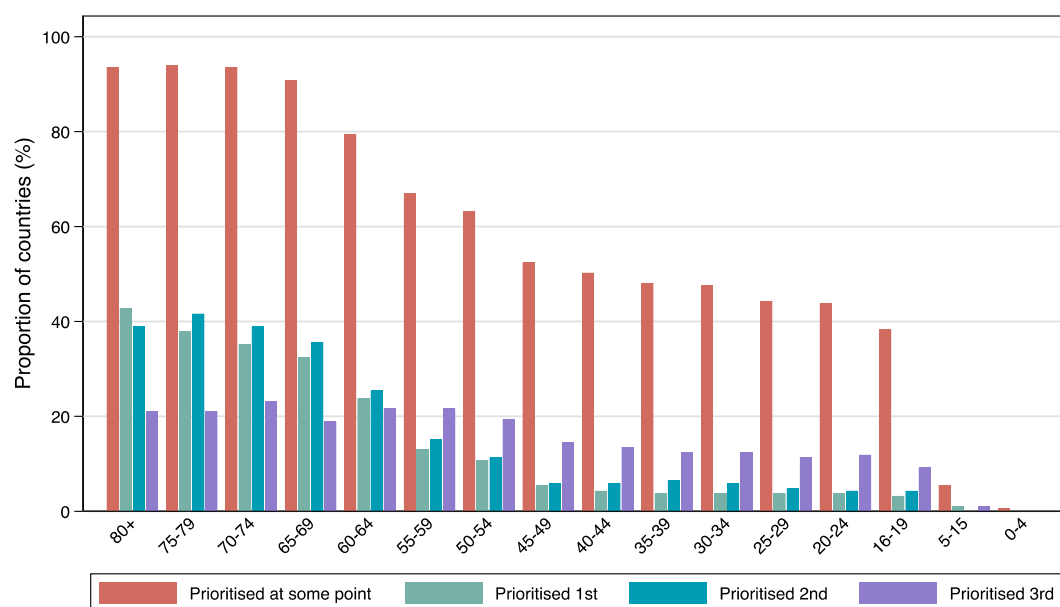


Fig. 4. Proportion of countries that included a given age-based group in their vaccine prioritisation plan. Sorted in descending order based on 'prioritised 1st'. Refers to general population age-based groups, not 'at-risk' age-based groups.

countries in Latin America and the Caribbean had on average the most granular plans globally up to early February 2021, but then ended with lower granularity. In sub-Saharan Africa, after a sharp decline in the first weeks, granularity quickly settled at the lowest levels and remained stable for the rest of the period.

Western Europe and North America and sub-Saharan Africa were thus antipodes in both average levels of vaccine plan granularity and its evolution over time. Countries in the former region gradually increased granularity, reaching higher levels than elsewhere. Countries in the latter more rapidly reduced granularity to comparatively lowest levels. These two regions also stand at opposite ends of several economic, demographic, and social factors, from national income to elderly population and from UHC to COVID-19 deaths. Yet taken together, regional patterns do not clearly point to any single factor as the main driver of

variation in granularity. For example: countries in both sub-Saharan Africa and Latin America and the Caribbean generally ended their prioritisation phases with lower granularity than initially, despite considerable differences in country characteristics. Likewise, the two regions that reached the highest levels of granularity—Western Europe and North America, and Asia and Pacific—differ markedly in many of the factors one might expect to matter.

While there was substantial variation in granularity across countries, changes over time within countries were more limited (Fig. 6). As many as 81 countries did not make any changes to the granularity of their vaccine prioritisation plans once announced. And in the vast majority of those countries that did revise their prioritisation plans after announcement, the degree of granularity was not substantially affected. Average within-country standard deviation is 0.04—a low value

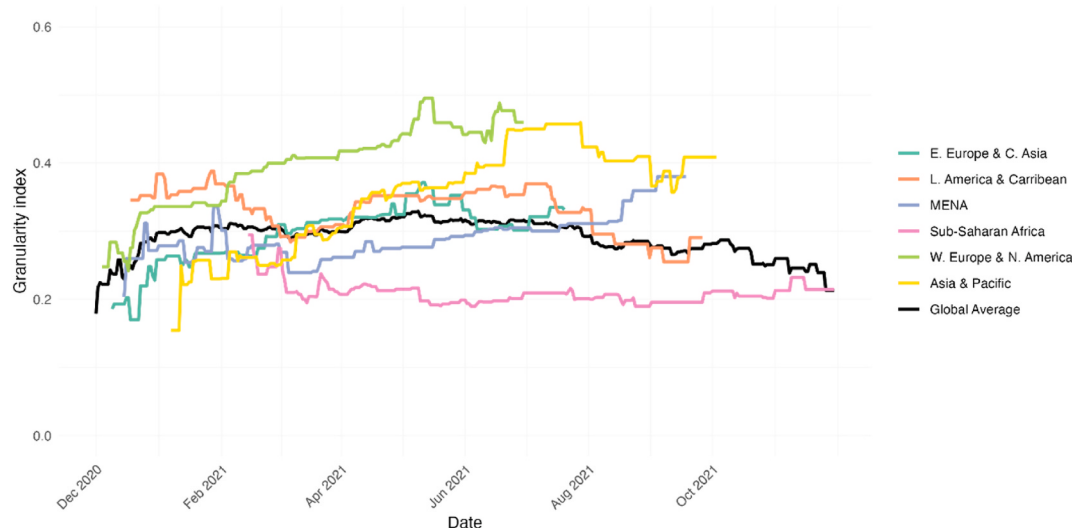


Fig. 5. Average granularity of vaccination plans over time

Daily average in the world and world regions from December 1, 2020 to November 30, 2021. Regional averages shown only when at least five countries in the region had active prioritisation plans.

considering that our granularity index ranges from 0 to 1. But there were some outliers like Malta and New Zealand.

Malta released its first prioritisation plan on December 17, 2020. This plan included five population categories in five priority levels in the following order: (1) at-risk population aged over 80, (2) general population aged over 80, (3) elderly care home staff, (4) elderly care home residents, and (5) healthcare workers. On February 4, 2021, Malta adjusted its plan to include 21 categories in 21 different tiers. And after regularly increasing the granularity of its plan by including further groups and tiers, its prioritisation policy ended on May 17, 2021 with 36 groups vaccinated in 36 tiers, when all individuals aged over 16 became eligible for vaccination.

In New Zealand instead the increase in granularity was more immediate and sharper. The country released its first vaccine prioritisation plan on February 19, 2021. This plan included only three groups—frontline, airport, and healthcare workers—and did not distinguish between them by priority. However, after less than three weeks, on March 10, 2021, New Zealand announced a new prioritisation plan that included as many as 42 groups stratified by 13 tiers. Its new vaccination strategy was not further revised until September 1, 2021, when the country shifted to universal vaccination for everyone aged over 12.

When vaccination plans were transformed, changes were typically towards higher granularity. This is likely because countries had the opportunity to gain insights into more effective vaccination strategies, and thus, provide more detailed guidance over time.

Scatterplots between maximum granularity and selected factors of interest (Fig. 7) show that granularity is positively correlated with many relevant country characteristics: democracy ($r = 0.37$), state capacity ($r = 0.33$), GDP/capita ($r = 0.34$), UHC ($r = 0.41$), an older population structure ($r = 0.32$), and more cumulative (population-adjusted) COVID-19 deaths ($r = 0.20$) during the first year of the pandemic (as of December 31, 2020). Albeit statistically significant at conventional levels, these correlations are not particularly strong, and leave doubts on which of these factors might ultimately predict granularity, if any.

4.3. Determinants of more granular vaccination strategies

To analyse more thoroughly the potential sources of more granular vaccine prioritisation plans, we carry out a series of multivariate cross-section regressions. First, we run models where democracy is the key explanatory variable (Table 1). Then, we run models where state capacity is the key explanatory variable (Table 2). As previously discussed,

we estimate basic models with standard controls and more complex models with other potential confounding factors. Full models further include both democracy and state capacity, allowing us to assess whether the validity of one of our two main theoretical arguments is stronger than the other, isolating for the association with democracy while accounting for state capacity, and vice versa.

The regression results provide partial support to our arguments. On the one hand, they demonstrate that democracy is a key predictor of more granular vaccine prioritisation plans. The estimates reported in Table 1 show that higher democracy is associated with greater granularity, and that democracy's coefficient is statistically significant across models (in the full model: $\beta = 0.303$, $p = 0.002$, 95% CI = 0.114 to 0.491). On the other hand, these models do not suggest that state capacity affects vaccination plan granularity (Table 2), as its coefficient never reaches conventional levels of statistical significance.

We run a series of robustness tests to check the validity of these results. First, we use broader democracy and state capacity indicators from WGI. The regression results corroborate our interpretations. Democracy is significantly and positively associated with granularity across models (Table A6, Supplementary material). State capacity is not (Table A7, Supplementary material); its coefficient is positive and significant only in the baseline model. Thus, regardless of whether democracy and state capacity are conceived and measured more narrowly (V-Dem) or broadly (WGI), our results show that more democratic countries adopted more granular vaccination strategies, whereas we find no evidence that state capacity predicts granularity once the level of democracy is accounted for.

Second, we re-run our main models and these robustness tests with an alternative index of granularity, where its two component indicators are aggregated multiplicatively rather than additively. Using the multiplicative index of granularity provides further support to the democracy argument (Table A8, Supplementary material). Consistent with our main models, state capacity does not reach statistical significance (Table A9, Supplementary material). These results also hold in models that use democracy and state capacity data from WGI (Table A10–A11, Supplementary material).²

² We also check whether controlling for government trust affects the relationship between democracy and vaccine prioritisation plan granularity. Due to a substantial reduction in the number of observations we do not report these results, but they confirm democracy is a significant positive predictor.

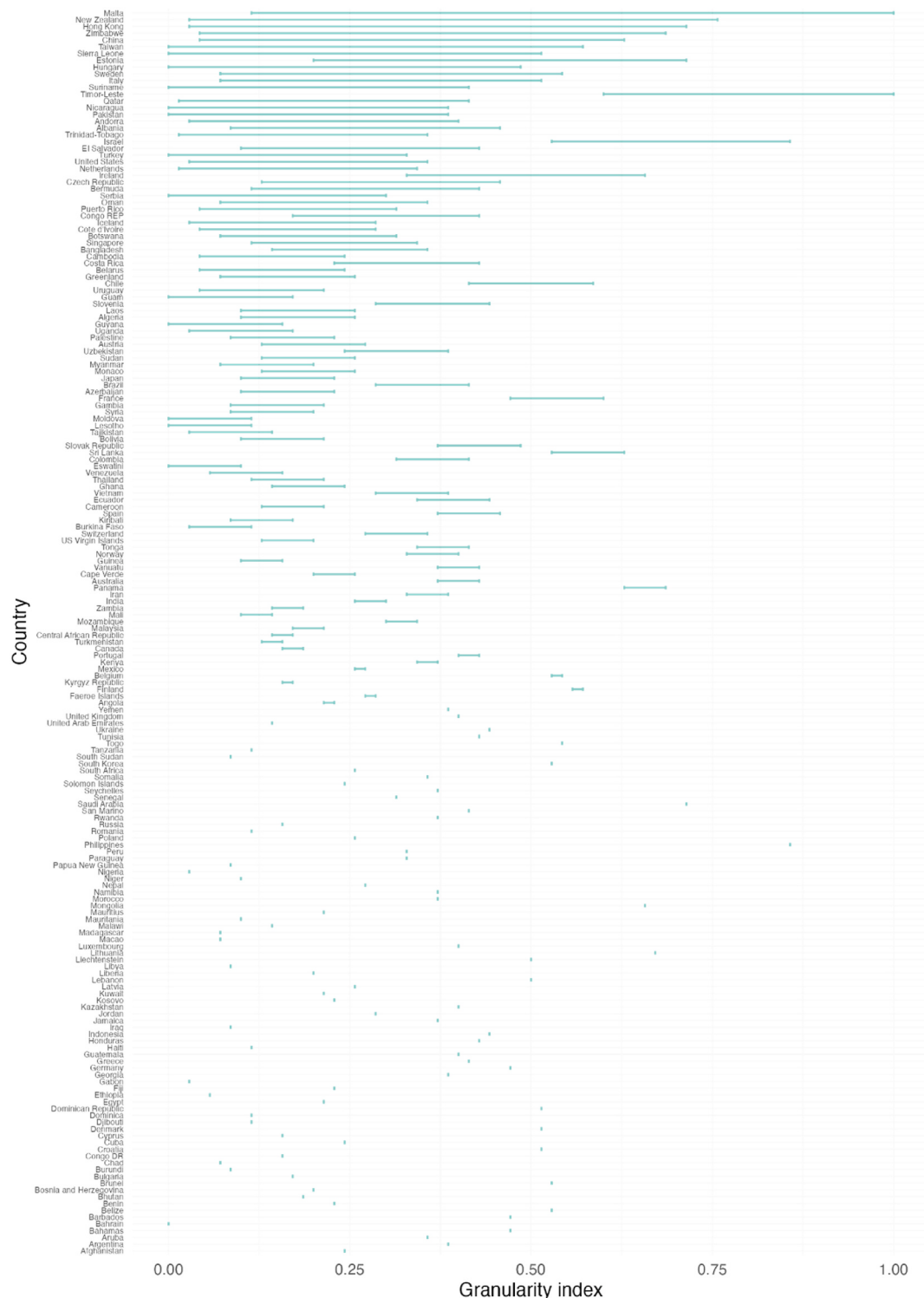


Fig. 6. Range of granularity index in countries around the world.

In short, higher levels of democracy before the pandemic are associated with the adoption of more granular vaccine prioritisation plans during the pandemic. Across full models, a one standard deviation increase in democracy is associated with a 0.294–0.393 standard deviation increase in vaccine plan granularity, depending on the measures of democracy and granularity used. Conversely, we find no clear empirical evidence that state capacity is related to the granularity of COVID-19 vaccine prioritisation plans.

Previous studies have suggested that both democracy and state

capacity played a significant role for explaining variation in COVID-19 responses (e.g. Cronert, 2022). Some scholars have argued that state capacity matters more than political regime in explaining why some countries handled the pandemic crisis better than others (Fukuyama, 2020). Our analysis, however, indicates that democracy was a more decisive institutional factor in predicting the granularity of vaccine prioritisation plans. As previously discussed, more granular plans that prioritise more population groups with higher stratification reflect higher concern for effective use of public resources and for more

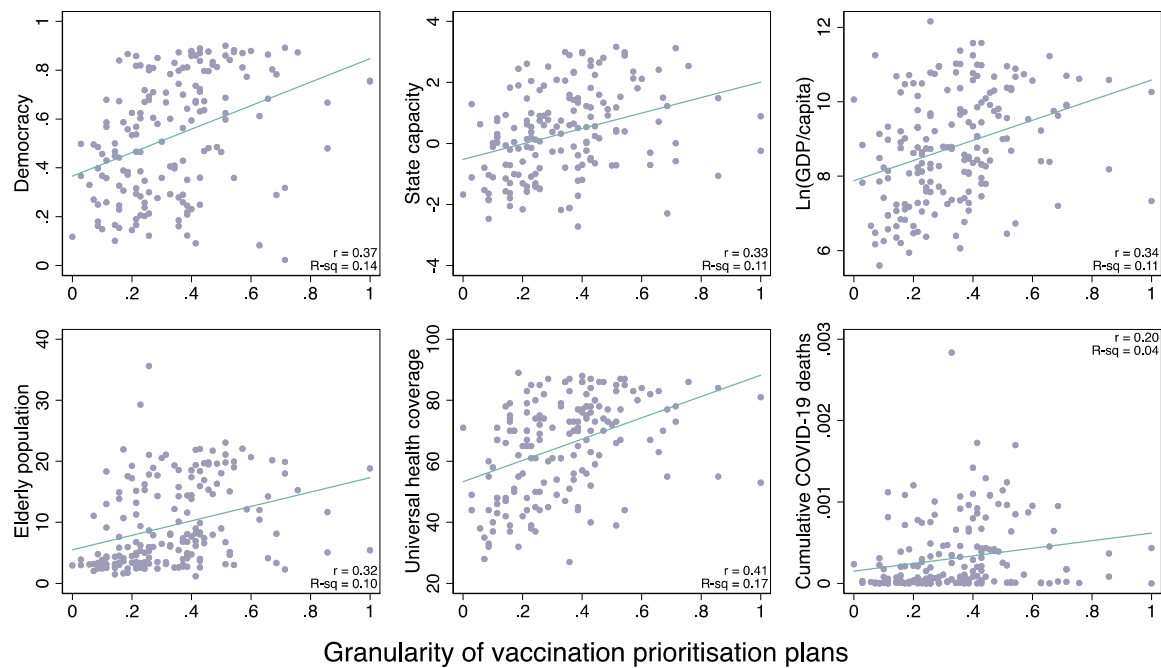


Fig. 7. Relationship between granularity of COVID-19 vaccination plans and selected factors of interest in countries worldwide.

Table 1

Regressions of vaccine prioritisation plan granularity on democracy.

	y = granularity of vaccine prioritisation plans				
	(1)	(2)	(3)	(4)	(5)
Democracy	0.172** (0.078)	0.195** (0.079)	0.241*** (0.069)	0.204** (0.099)	0.303*** (0.096)
Ln(GDP/capita)	0.042*** (0.013)	−0.002 (0.021)	−0.003 (0.016)	0.045*** (0.015)	−0.025 (0.022)
Ln(population)	0.007 (0.010)	0.004 (0.010)	0.001 (0.010)	0.007 (0.010)	−0.002 (0.011)
Deaths	−27.410 (30.138)	−35.438 (31.823)	−21.007 (29.639)	−29.734 (30.763)	−37.976 (31.186)
Elderly pop.		−0.001 (0.003)			−0.000 (0.003)
UHC		0.004*** (0.002)			0.003** (0.002)
Delivered vaccines			0.000 (0.000)		0.000 (0.000)
Timing of rollout			−0.001** (0.000)		−0.001** (0.000)
Initial uptake			0.002 (0.003)		0.002 (0.003)
State capacity				−0.009 (0.019)	−0.016 (0.018)
R ²	0.19	0.21	0.23	0.19	0.25
N	162	159	155	162	154

Robust standard errors in parentheses. Constant coefficient measured but not reported. *p < 0.1, **p < 0.05, ***p < 0.01.

population groups. There are a number of potential reasons that might explain why democracy emerges as a stronger predictor than state capacity.

Enacting more granular prioritisation plans does not necessarily translate into effective implementation of the plans. While countries need state capacity to implement their plans in practice, it may be that the content of national vaccination strategies was more affected by political will rather than the effectiveness of a state administration. Democratic leaders must listen to more population groups and their demands compared to dictators. Because of stronger vertical and diagonal accountability mechanisms, politicians in democratic countries have more incentives to accommodate these pressures, show they are

Table 2

Regressions of vaccine prioritisation plan granularity on state capacity.

	y = granularity of vaccine prioritisation plans				
	(1)	(2)	(3)	(4)	(5)
State capacity	0.014 (0.015)	0.014 (0.015)	0.014 (0.015)	−0.009 (0.019)	−0.016 (0.018)
Ln(GDP/capita)	0.044*** (0.016)	−0.001 (0.023)	0.004 (0.017)	0.045*** (0.015)	−0.025 (0.022)
Ln(population)	0.004 (0.010)	−0.000 (0.011)	−0.002 (0.011)	0.007 (0.010)	−0.002 (0.011)
Deaths	−2.330 (28.505)	−16.011 (30.397)	11.845 (28.934)	−29.734 (30.763)	−37.976 (31.186)
Elderly pop.		0.002 (0.004)			−0.000 (0.003)
UHC		0.004** (0.002)			0.003** (0.002)
Delivered vaccines			0.000 (0.000)		0.000 (0.000)
Timing of rollout			−0.001 (0.000)		−0.001** (0.000)
Initial uptake			0.002 (0.003)		0.002 (0.003)
Democracy				0.204** (0.099)	0.303*** (0.096)
R ²	0.16	0.18	0.18	0.19	0.25
N	162	159	155	162	154

Robust standard errors in parentheses. Constant coefficient measured but not reported. *p < 0.1, **p < 0.05, ***p < 0.01.

concerned about addressing citizens' needs, and make sure their public support remains high. The next elections are always behind the corner, and regardless of whether a country was able to successfully implement a highly granular prioritisation plan in practice, one interpretation is that leaders in democratic countries preferred to choose vaccination strategies that expressed higher concern for efficiency and a multitude of constituencies.

We run additional regressions to further explore the precise mechanisms linking democracy to greater granularity using a number of more specific measures of democracy. First, we estimate models for each specific measure sequentially without including our main democracy measure—V-Dem's electoral democracy index. Then, we re-run these

models also including it. Finally, we estimate a ‘horse-race’ model that includes simultaneously each specific measure. We conduct this exercise twice: first, with the constituent indicators of the overall democracy index (Table A12, Supplementary material); second, with six elementary indicators from V-Dem (Table A13, Supplementary material). The findings lend support to both mechanisms. Evidence for the ‘electoral accountability’ mechanism is stronger than for ‘citizens’ voice’.

When the constituent indicators of the overall democracy index are introduced separately, both clean elections and citizens’ voice are positively and significantly associated with granularity (Table A12, models 1–2). Clean elections reduces the magnitude of democracy’s overall ‘effect’ more than citizens’ voice (models 5–6), suggesting it is a stronger mediating factor. When constituent indicators are included simultaneously, the point estimate of clean elections is stronger than citizens’ voice (model 9), even if neither is statistically significant. The theoretically less relevant elected officials and suffrage components are never statistically significant, have little impact on the magnitude of democracy’s overall effect, and have smaller point estimates, indicating that the association between democracy and granularity is, expectedly, not driven by these aspects.

Estimating the models with six elementary indicators from V-Dem largely corroborates these views. Free and fair elections and CSO participatory environment are the only aspects of democracy that are positively and significantly associated with granularity when introduced separately (Table A13, models 1–6) and in a horse-race approach (model 13). They also reduce the magnitude of democracy’s overall effect more than other elementary indicators (models 7–12). Point estimates suggest that electoral accountability contributes more strongly than citizens’ voice to explaining variation in granularity. Theoretically less relevant aspects of democracy—campaign donation disclosure, freedom from political killings, and high court independence—have little effect on granularity, providing additional support to our theoretical arguments.

CSO consultation—an indicator capturing the extent to which policymakers consult civil society organisations (CSOs)—is not associated with granularity. However, as other measures of citizens’ voice significantly predict granularity, we do not interpret this null result as evidence against the entire mechanism. Rather it suggests that consultations between policymakers and civil society were generally not a relevant channel. Policymakers had to make quick decisions during the pandemic, so it was not a time for consultations with CSOs. Since a more vital civil society is anyhow associated with more granular vaccination strategies, citizens’ demands likely reached policymakers in other ways. Overall, these results suggest that both ‘electoral accountability’ and ‘citizens’ voice’ mechanisms contributed to more granular vaccination strategies, with the former likely playing a more significant role.

5. Conclusions

This article has examined differences in the granularity of COVID-19 vaccination strategies across countries, analysing which population groups were prioritised, when, and how, as well as why some countries adopted more granular vaccine prioritisation strategies than others. A more granular vaccination strategy may reflect a stronger intent by authorities to use scarce public resources effectively and address the needs of various population groups. Indeed, we find it is correlated with higher vaccine uptake.

Despite significant variation in vaccination policies, most countries followed the WHO’s recommendations, prioritising first health workers and the elderly. Some countries prioritised only these groups. Others adopted highly granular plans with dozens of groups ranked in different priority tiers. Our findings reveal that democracy is a key predictor of this variation: more democratic countries adopted more fine-tuned vaccine prioritisation plans.

These results contribute to a large body of literature investigating whether and how institutional factors were important in explaining differences in COVID-19 policy responses. Echoing some of these

studies, our results emphasise the relevance of democratic institutions for better understanding variation in public health policies. Some have suggested that non-democratic regimes might have an advantage to adopt more effective and stronger responses in times of crisis (e.g. Cepaluni et al., 2022; Kavanagh and Singh, 2020), yet these studies have not focused on vaccination policies. Our findings suggest the opposite is true: democracies not only often started rollout earlier but also had more fine-tuned vaccine prioritisation strategies that were linked to higher uptake.

Our analysis underscores the WHO’s key role in coordinating global health policy: most countries followed closely its vaccine prioritisation recommendations. Yet many countries also adopted more granular vaccination strategies than those outlined by the WHO. It is widely accepted that in a scenario of limited vaccine supply, prioritising some population groups over others is useful and necessary. To enhance preparedness for future pandemics, the global health community could improve its recommendations by offering more detailed and context-specific guidance, particularly in relation to different institutional settings. Determining exactly which groups should be prioritised and in which order in a given situation remains an important question for future research.

Since the end of the COVID-19 pandemic, academic and policy attention has shifted to new global security threats. Many experts however have warned that we will have to deal with a new pandemic sooner or later, making it crucial to be better prepared. Given that more democratic countries seem to be more attentive to the effective use of public health resources, our findings raise the question of whether strengthening democratic institutions may enhance pandemic preparedness more broadly. Citizens in democracies tend to have more opportunities to shape policy, so current trends of democratic backsliding might undermine global pandemic preparedness. We call for further research on the effects of democratic erosion on pandemic preparedness.

We found no evidence that state capacity—understood as administrative state capacity—affected the granularity of vaccine prioritisation plans. We expected more competent and professional bureaucracies to be better prepared to develop more fine-tuned vaccination policies. Yet the content of vaccination policies ultimately depends on political decisions. Politicians were heavily involved in pandemic policymaking during COVID-19, so public officials—no matter how competent and impartial—may have had limited influence over vaccine prioritisation plans. Public health officials likely had greater influence, but our data refer to public officials in general. Despite this lack of evidence, state capacity might still matter indirectly—for instance, by helping to ensure everyone can access well-functioning health services (UHC was positively and significantly associated with granularity in many regression models). Also, other dimensions of state capacity might influence vaccination strategies through alternative mechanisms: coercive capacity could affect their enforcement and extractive capacity could affect resources at disposal. If state capacity is defined as the state’s ability to implement policies, then it definitionally affects their implementation.

Although we find that more granular COVID-19 vaccination strategies are associated with higher uptake, our analysis of this relationship is illustrative rather than exhaustive. Establishing a causal link between the two requires a more complex research design beyond the scope of our study. We acknowledge that, despite the general positive association with vaccine uptake, greater granularity may reflect in some cases questionable priorities or create practical challenges. First, if individuals are stratified in a sub-optimal order—say, prioritising friends of political elites over the most vulnerable—then a highly granular strategy reflects inequitable use of resources and unlikely leads to better health outcomes. Second, overly granular strategies can be difficult to implement, potentially slowing down vaccine rollout by creating logistical bottlenecks and confusion. Due to stronger political incentives to ‘play it safe’ and show responsiveness to diverse constituencies, democracies may be

particularly prone to adopting highly granular plans that appear effective but are challenging to implement in practice.

Greater granularity thus is unlikely to automatically imply better policy design or outcomes. If a vaccine prioritisation plan is misaligned with policy goals, greater granularity cannot transform it into an effective one. And if a vaccine prioritisation plan is operationally infeasible, few would argue it reflects good policy design, regardless of how fine-tuned it is. The inclusion of numerous population groups in different tiers inevitably increases complexity in both design and implementation. But if the prioritisation strategy is aligned with desired objectives and can be delivered, then, all else equal, more granular prioritisation plans should reflect stronger concern for effective use of resources and for addressing the needs of various population groups. As greater granularity also meant higher COVID-19 vaccine uptake, it appears to be generally associated with better results. Further research is needed to better understand the interplay between granularity, implementation, and uptake, as well as to identify any potential factors that might condition these relationships. Should future studies confirm that indeed more granular strategies led to higher uptake, this would further strengthen the case for more fine-tuned vaccine prioritisation and guidance in the future.

Finally, it is important to note that our analysis is affected by the number and classification of population groups considered. Reflecting the WHO SAGE framework, the groups coded by OxCGRT include the ones that were most commonly prioritised in vaccination plans. Some countries might have prioritised minor groups that were not considered in this classification, with potential implications on our results. Nevertheless, our empirical focus on the most common population groups means that empirically greater granularity can be interpreted as high granularity within realistic policy boundaries, rather than as a theoretical ideal that cannot be effectively delivered.

Statement EA not required

No human participants were involved in this study. As such, no ethics approval was required.

CRedit authorship contribution statement

Andrea Vaccaro: Conceptualization, Formal analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Thomas Hale:** Conceptualization, Methodology, Supervision, Writing – original draft, Writing – review & editing. **Anna Petherick:** Conceptualization, Methodology, Supervision, Writing – original draft, Writing – review & editing.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.socscimed.2026.119230>.

Data availability

Data will be made available on request.

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