

A global database of COVID-19 vaccinations

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Abstract

An effective rollout of vaccinations against COVID-19 offers the most promising prospect of bringing the pandemic to an end. We present the *Our World in Data* COVID-19 vaccination dataset, a global public dataset that tracks the scale and rate of the vaccine rollout across the world. This dataset is updated regularly, and includes data on the total number of vaccinations administered; first and second doses administered; daily vaccination rates; and population-adjusted coverage for all countries for which data is available (169 countries as of 7 April 2021). It will be maintained as the global vaccination campaign continues to progress. This resource aids policymakers and researchers in understanding the rate of current and potential vaccine rollout; the interactions with non-vaccination policy responses; the potential impact of vaccinations on pandemic outcomes such as transmission, morbidity, and mortality; and global inequalities in vaccine access.

26 Main

27 As of 7 April 2021 there have been 2.89 million confirmed deaths and 133 million confirmed
28 cases of SARS-CoV-2 — the virus that causes COVID-19.¹ Since the beginning of the
29 pandemic and up until today, virus transmission and mortality has been reduced through a
30 range of measures: precautionary actions from individuals including social distancing,
31 wearing facemasks, hand hygiene, and restricting interpersonal contact to outdoor settings;
32 widespread testing to identify individuals infected with the virus; and non-pharmaceutical
33 policy responses from governments – including school and workplace closures; bans on
34 public gatherings; travel restrictions; and stay-at-home orders.^{2,3} Now, with the successful
35 development, evaluation and production of multiple vaccines, governments are turning
36 towards vaccination as an essential solution to the pandemic.

37

38 To understand the scale and rate of the vaccine rollout, we need timely, comparable data
39 across countries. The *Our World in Data* COVID-19 vaccination dataset provides a public
40 aggregated global dataset on administered vaccinations. It covers the full period from 13
41 December 2020 – the date of the first publication of vaccination data – and is being updated
42 regularly ever since. The COVID-19 vaccination dataset is continuously expanding as more
43 countries begin releasing official data on their new national vaccination campaigns. As of 7
44 April 2021, the dataset covers 169 countries. Our intention is to maintain this database for
45 the foreseeable future and include additional countries as the vaccination campaign starts in
46 a growing number of countries.

47

48 This dataset tracks the total number of COVID-19 vaccinations administered by country;
49 broken down by first and second doses (where national data is made available); and derived
50 daily vaccination rates and population-adjusted figures. The combination of these metrics
51 allows users to understand the scale and rate of vaccine rollouts relative to population;
52 compare rollout rates between countries; and assess differences in prioritization for
53 countries with one- and two-dose schedules. This data is compiled from official sources,
54 including health ministries, government reports and official social media accounts.

55

56 Our COVID-19 vaccination dataset is used widely by journalists, policymakers, researchers
57 and the public. The World Health Organization (WHO) relies on this dataset for its official
58 COVID-19 dashboard.⁴ Our dataset is also used by policymakers to benchmark the
59 performance of national vaccination programs across countries. The WHO have also relied
60 on this dataset to understand the inequities in global vaccine access, using this evidence to

61 support calls for greater financial support for COVAX, a global initiative supported by the
62 WHO that is aimed at equitable access to COVID-19 vaccines

63

64 Our dataset has been used by leading media outlets, including the New York Times, the
65 BBC, the Financial Times and The Economist.⁵⁻⁸ Global media plays an important role in
66 informing the public during this global pandemic, and it is essential that leading media
67 outlets have timely, transparent and reliable data to present to their audiences. The
68 demonstration of rapid vaccine rollouts across the world, and its potential impacts on
69 transmission and mortality has the potential to shape public attitudes towards vaccinations,
70 reduce vaccine hesitancy, and ultimately lead to an improved response to the pandemic. An
71 effective vaccination response relies on high uptake rates.⁹ As such, our dataset could play
72 a role in building public trust that is essential to an effective global response to the COVID-
73 19 pandemic.

74

75 Our dataset has been widely-used by the scientific community across multiple disciplines. It
76 has been used to highlight global inequalities in vaccine access, with strong calls to action
77 for the acceleration of financial and policy response efforts to close the existing gaps.¹⁰ It
78 has been used by researchers to identify countries with particularly effective vaccine rollouts,
79 thereby enabling an analysis of how this was achieved.¹¹ These analyses emphasize a
80 range of drivers that explain the large differences across countries that we document:
81 differences in the funding of the development and production of the vaccines; differences in
82 the scheduling and management of vaccinations; differences in public trust and uptake
83 rates; and differentiated responsibilities between national, regional and local level actors.¹²
84 Health policy researchers have used this dataset to assess differences in vaccine
85 prioritization strategies — for example, which groups should be offered the vaccine first.¹³
86 Other research groups have combined it with vaccine development data to provide a
87 complete overview of the global vaccine landscape.¹⁴ It has been used by researchers
88 looking at the role of vaccine hesitancy, and how to design public messaging based on these
89 concerns.¹⁵

90

91 As vaccination campaigns continue to scale, evidence for their effectiveness in reducing
92 transmission, severe disease and death will become increasingly important. Our dataset
93 serves as input for epidemiologists who study these questions. Integrating it with other
94 epidemiological data can help researchers evaluate these outcomes.^{16,17} Evidence of
95 positive impacts of vaccination on transmission and mortality can also in turn help to
96 strengthen public trust.

97

98 The rest of this article is organized as follows: The Results section presents the key metrics
99 used to track vaccine rollout in this dataset, and the headline results so far. The Discussion
100 section outlines the significance and limitations of this work. The Methods section provides
101 detailed descriptions of the underlying methods and sources used to build this global
102 dataset.

103

104 Results

105 **Global coverage of COVID-19 vaccination campaigns**

106 The first published reports of COVID-19 vaccinations (outside clinical trials) occurred on 13
107 December 2020 in the United Kingdom. Our live dataset presents the time-series of
108 vaccinations across the world since then.

109

110 To date, 169 countries reported vaccinations, and are included in this dataset. As of 7 April
111 2021, there have been 710 million doses administered globally. 5% of the world population
112 have received at least one dose of an approved vaccine. This highlights important
113 inequalities in global vaccine access. Figure 1 shows the number of COVID-19 vaccine
114 doses administered by country; these figures are not population-adjusted and should not be
115 used for cross-country comparisons of the scale of the vaccine rollout. It does, however,
116 highlight the countries that have yet to begin vaccinations. At the time of writing most high-
117 and middle-income countries have begun vaccination rollouts, but many low-income
118 countries have not (Figure 2).

119

120 **Large differences in vaccination rates between countries**

121 The data reveals large differences in the scale of the vaccine rollout across countries. As of
122 7 April 2021, we see the cumulative number of doses administered per 100 people range
123 from 118 per 100 in the case of Israel, to less than 0.1 doses per 100 in countries that have
124 just begun their vaccination campaigns, such as Mali, Namibia and Brunei (**Figure 3**). As
125 discussed below, the number of doses can exceed the number of people due to multiple
126 dose vaccination programs.

127

128 These differences in vaccination coverage are dependent on several factors. First, the date
129 when countries started national vaccination campaigns: the United Kingdom, for example,
130 began community vaccination on 8 December 2020 while some countries as of 7 April 2020
131 – as shown in Figure 1 and 3 – have not yet begun vaccine rollouts.

132

133 Second, the rate of vaccinations over time. We see large differences in these rates between
134 countries (**Figure 4a, b**). Israel has received significant attention for the rate of its
135 campaign.¹¹ As well as being one of the first countries to begin vaccinations, it also
136 maintained a consistently high rate of vaccinations over time. This is reflected in its steep
137 linear time-series trend of cumulative doses (**Figure 4a**) and consistently high rate of daily
138 doses (**Figure 4b**). Between the end of December 2020 and mid-March 2021 Israel
139 averaged a rate of approximately one dose per 100 people per day — more than twice the
140 rate of most countries. Rosen et al. (2021) looked at the contributors to Israel's success and
141 identified factors such as the organisational and logistical capacity of its community-based
142 healthcare providers; a clear prioritisation framework; and effective outreach efforts to the
143 public as important.¹¹ Lee al. (2021) also looked at the factors in Israel's success, and
144 emphasized the high level of public trust in particular.¹²

145

146 Most countries which have achieved the fastest vaccine rollouts to date — Israel, United
147 Arab Emirates, United Kingdom, United States, Bahrain, and Chile — are high-income
148 countries. We see from Figure 2 that income matters. But the significant variation at different
149 income levels shows that it's not the only factor. This can be the basis for research into
150 effective strategies at different income levels.

151

152 **Different prioritization strategies between countries**

153 The *Our World in Data* COVID-19 vaccination dataset allows for comparison of cumulative
154 doses administered, and for a subset of countries, disaggregated data on the number of first
155 and second doses is available. This allows for a comparison of prioritization strategies – a
156 central policy and research question.

157

158 Our data highlights large differences in approaches taken by different countries. Some
159 countries — the United Kingdom being the most prominent example — have taken a 'first
160 dose first' approach, delaying the delivery of a second vaccine dose to achieve wider single-
161 dose coverage within the total population. This is reflected in the data which shows the
162 share of the total people that have received at least one dose of a COVID-19 vaccine
163 (**Figure 5a**) and the share that have been fully vaccinated (**Figure 5b**). As of 7 April 2021,
164 46.7% of the total population had received at least one dose, but only 8.4% had received
165 both doses. Other countries have put greater emphasis on giving two doses to a smaller
166 share of the population. In these countries a large share of those who received the first dose
167 have already received the second dose: In Israel, 61.2% had received at least one dose,

168 and 56.5% had been fully vaccinated. In the United States, 32.9% had received one dose
169 and 19% had been fully vaccinated.

170

171 Differences in prioritization have received particular attention in Europe. The ‘first dose first’
172 approach favoured by the United Kingdom has been frequently contrasted with the approach
173 of many countries in the European Union.^{18–20} This is reflected in our dataset: Germany, for
174 example, has a much smaller gap between the share that have received a first dose (12.9%
175 of the total population), and those that have been fully vaccinated (5.5%).

176

177 Discussion

178 The rapid development, testing and manufacturing of multiple effective vaccines against
179 SARS-CoV-2 was a ground-breaking achievement in 2020. Never before in history has a
180 vaccination campaign started so very soon after a new pathogen was identified. In many
181 cases it took many years or decades until a vaccine was developed (Figure 6). In the case of
182 COVID-19 scientists have developed several, highly efficacious vaccines within the same
183 year. The question now is whether the global rollout of the vaccine can match the speed with
184 which the vaccine was developed: whether they can be administered quickly and equitably
185 across the world.

186

187 To do this, governments and public health officials need to understand the most effective
188 approaches to mass vaccination rollouts and prioritize the administration in a way that
189 minimizes morbidity and mortality from the disease. The dataset that we present here could
190 support this. It allows analysts to track vaccinations over time in a specific country, and also
191 to compare vaccination rates and prioritization strategies across countries. Combined with
192 epidemiological data, it serves as input for researchers to understand how vaccination
193 affects the transmission and health outcomes of COVID-19.

194

195 Communicating such research on the efficacy of vaccines is in turn essential for building
196 public trust and reducing vaccine hesitancy.^{21,22} Kreps et al. (2021) found that perceived
197 vaccine efficacy was the strongest predictor of COVID-19 vaccine uptake in the United
198 States.²³ Sherman et al. (2021) studied people’s willingness to be vaccinated against
199 COVID-19 and their attitude towards vaccines.²⁴ The researchers documented that the
200 effectiveness of vaccines in reducing disease is a particularly important argument.

201

202 It is important to highlight what we do not try to achieve with this dataset collection. We only
203 collect data on doses administered — we do not include data on the number of doses
204 manufactured, ordered or delivered. In the collection of data on administered doses we also
205 do not audit official reports beyond technical validation (see Methods section). And we also
206 do not attempt to assess vaccine effectiveness or the impacts of vaccinations on pandemic
207 outcomes. This is beyond the scope of this resource.

208

209 If we want to understand anything about vaccines – effectiveness, policy responses,
210 perceptions – then we need to know how many vaccines have been administered. Our
211 dataset fills this gap.

212 Methods

213 In this section we first provide a description of the metrics made available in this dataset,
214 followed by information on how this data was collected. Finally, we describe how it is
215 published as a complete, open-access dataset and how it can be explored via our online
216 web application.

217

218 **Metrics included in this dataset**

219 The metrics included in this dataset are a combination of original metrics reported by official
220 sources, and derived metrics calculated by *Our World in Data*.

221

222 The nine metrics included in this dataset are the following.

223

- 224 1. **Total doses administered.** This is a count of all doses given. Since several
225 vaccines require multiple doses this count may be higher than the total number of
226 people vaccinated.
- 227 2. **Total doses administered per 100 people.** This is 'Total doses administered' per
228 100 people of the total population.
- 229 3. **Daily vaccinations.** If official sources provide daily updates of vaccinations
230 administered, this is included.
- 231 4. **Rolling average of daily vaccinations over 7 days.** For countries that don't report
232 data on a daily basis, we assume that the number of administered doses was the
233 same on all days over any periods in which no daily data was reported. This
234 produces a complete series of daily figures, which is then averaged over a rolling 7-
235 day window.

- 236 5. **Daily doses administered per million people.** This is the rolling average of daily
237 vaccinations over 7 days, per million people within the total population.
- 238 6. **Number of people that have received at least one vaccine dose.** Depending on
239 the vaccine schedule (a one or two-dose vaccine), this may or may not match the
240 number of people fully vaccinated. If a person receives the first dose of a 2-dose
241 vaccine, this metric goes up by one. If they receive the second dose, the metric stays
242 the same.
- 243 7. **Share of the total population that have received at least one vaccine dose.** This
244 is the number of people that have received at least one vaccine dose per 100 people
245 in the total population.
- 246 8. **Number of people that are fully vaccinated.** This is the total number of people who
247 received all doses prescribed by the vaccination protocol. If a person receives the
248 first dose of a two-dose vaccine, this metric stays the same. If they receive the
249 second dose, the metric goes up by one.
- 250 9. **Share of the total population that are fully vaccinated.** This is the number of
251 people that have received all doses prescribed by the vaccination protocol per 100
252 people in the total population.

253

254 Not all metrics are available for all countries. The availability is dependent on the granularity
255 of reporting provided by the official sources. For example, not all countries provide a
256 breakdown of doses administered by first or second doses. In this case, only the total
257 number of administered doses can be provided for this country.

258

259 One important point to note is how the possibility of ‘booster vaccinations’ – additional doses
260 administered at a later date among individuals that had already been fully vaccinated – may
261 be recorded in our dataset. This has not yet been a concern, but could arise as the dataset
262 evolves and countries begin administering booster vaccinations. To ensure that the
263 comparability of the original metrics between countries was not compromised, additional
264 doses would not be included in the existing metrics listed above. For inclusion in our dataset
265 we would create an additional metric which solely tracks booster vaccinations separately
266 from the initial vaccine rollout.

267

268 **Data collection methods**

269 Raw data on vaccination doses administered is collected through a combination of manual
270 and automated means. This collection process differs by country, but can be broadly defined
271 by three methods.

272

273 Firstly, for a number of countries, figures reported in official sources — including government
274 websites, health ministries, dedicated dashboards, and social media accounts of national
275 authorities — are recorded manually as they are released.

276

277 Secondly, where official sources release vaccination figures in a consistent, machine-
278 readable format, or where structured data is published at a stable location, we have
279 automated the data collection via Python scripts that we execute every day. These
280 automated scripts are made available in our GitHub repository

281 (<https://github.com/owid/covid-19->

282 [data/blob/master/scripts/scripts/vaccinations/automations/](https://github.com/owid/covid-19-data/blob/master/scripts/scripts/vaccinations/automations/)). These are regularly audited for
283 technical bugs to ensure data validity (see ‘Technical Validation’, below).

284

285 Third, in some instances – where national data is not made available in machine-readable
286 format by official sources, but is aggregated by third-party sources – we source data from
287 non-official publishers (e.g. <https://covid19tracker.ca/vaccinationtracker.html> for Canada).

288 These are also regularly audited for accuracy against the original official sources.

289

290 **Calculating derived metrics**

291 Derived metrics are calculated from the raw official counts in two ways.

292

293 1. Population-adjusted metrics. This normalizes total doses, first doses, and second doses
294 to their counts per 100 people within the total population. This allows users to compare the
295 pace and scope of the vaccination rollout across countries. Vaccinations administered per
296 100 people are calculated by dividing administered doses by total population figures,
297 sourced from the latest revision of the United Nations World Population Prospects.²⁵ The
298 exact population values used in these calculations are also provided in our GitHub repository
299 (https://github.com/owid/covid-19-data/blob/master/scripts/input/un/population_2020.csv).

300

301 2. Daily rolling averages. Not all countries report figures at a daily frequency. In order to
302 facilitate cross-country comparisons over time, we therefore derive a ‘smoothed’ daily
303 vaccination series calculated as the seven-day moving average. It is calculated as the right-
304 aligned rolling seven-day average of a complete series of daily changes. For countries for
305 which no complete series of daily changes is available from our source, we derive it by
306 linearly interpolating the cumulative totals. The exact code used to derive the 7-day moving
307 average is available online (see ‘Code Availability’, below).

308

309 **Criteria for inclusion and coverage**

310 To be included in this dataset, countries must provide at least one data point on the number
311 of vaccine doses administered via a trusted country-specific source such as a health
312 ministry, government report or official national account. Reports on the number of vaccine
313 doses ordered or distributed are not included; this dataset only includes doses administered.
314 Vaccinations administered in clinical trials are also not included.

315

316 As of 7 April 2021, the vaccination dataset covers 169 countries. This coverage will continue
317 to expand as more countries begin vaccination campaigns.

318

319 **Technical validation**

320 The *Our World in Data* COVID-19 vaccination database represents a collation of publicly
321 available data published by official sources. The main quality concern for the database itself
322 is whether it represents an accurate record of the official data. We employ several strategies
323 to ensure that this is the case.

324

325 First, all automated collection of data, whether obtained from official channels or non-official
326 publishers, is subject to initial manual verification when it is added to our database for the
327 first time.

328

329 Second, we employ a range of data validation processes, both for our manual and
330 automated time series. We continually check for invalid figures such as negative or illogical
331 values, out-of-sequence dates, implausible changes in time-series data, invalid population-
332 adjusted values, and for each country we test for abrupt changes in vaccination rates.

333

334 Third, our vaccination data is viewed and used by millions of people every day — either
335 through direct usage or third-party usage (such as news reports, social media and other
336 sharing channels). This includes employees of health ministries, researchers, journalists,
337 and policymakers from across the world. We receive large amounts of feedback from this
338 user base. This provides a final 'crowd-sourced' verification method that has been shown to
339 be effective in highlighting any discrepancies to official data sources.

340

341 **Data access and publication**

342 Vaccination data is updated daily and is made available via two channels. Firstly, all data
343 and scripts used for data collection are published and updated in our public GitHub

344 repository (<https://github.com/owid/covid-19-data/tree/master/public/data/vaccinations>). This
345 provides a transparent resource for users to download the data in CSV and JSON formats;
346 replicate the data collection and metric derivation process; and monitor any changes or
347 additions to this process.

348
349 To allow journalists, researchers, policymakers and the public to understand the evolution of
350 the global COVID-19 vaccination rollout, we make all of this data explorable at our online
351 web publication (ourworldindata.org/covid-vaccinations). There we provide interactive
352 visualizations of all available vaccination metrics to allow users to track and compare the
353 vaccination campaigns around the world. These interactive visualizations are built with our
354 custom visualization tool – the *Our World in Data Grapher* – and are made available open-
355 access. They are updated daily in sync with updates in our GitHub repository.

356

357 **Limitations**

358 Our dataset relies on the publication of vaccination data from national governments and
359 other official sources. This raises several limitations to the completeness of the global
360 vaccination dataset. First, it relies on countries making the latest figures on administered
361 doses available in a timely manner. Being able to understand the rate of national rollouts
362 relies on this data being made available frequently with minimal delay between doses being
363 administered and these being reported. While most countries provide daily to weekly
364 updates, some publish the latest figures with lower frequency. This makes it difficult to get
365 an accurate understanding of the speed of the rollout for these countries.

366

367 Another limitation is the varied completeness of the data provided by official sources. Ideally
368 all countries would publish multiple metrics that are needed to understand the vaccine
369 rollout: cumulative doses administered; daily doses administered; the breakdown of first
370 versus second doses; and the breakdown of vaccinations by type/manufacturer. Some
371 countries do provide this level of disaggregation, and in these cases we make these metrics
372 available in our global dataset, however this completeness varies country by country. Some
373 countries only provide data on cumulative doses administered to date. This limits the cross-
374 country comparability of our dataset. As national vaccination rollouts continue, we hope that
375 this reporting by countries becomes increasingly standardized.

376

377 Finally, we included vaccination figures as they are reported publicly by national
378 governments and official sources. This is sometimes published in different languages, which
379 we overcome with digital translations, and in some cases, input from our global audience.

380 We have yet to encounter a misreporting of the data based on translation issues. The main
381 quality concern for the database itself is whether public announcements represent an
382 accurate record of the official data. We employ several strategies to ensure that this is the
383 case (see 'Technical validation'), however this contingency remains the largest limitation of
384 the dataset.

385 Data availability

386 A live version of the vaccination dataset and documentation are available in a public GitHub
387 repository at <https://github.com/owid/covid-19-data/tree/master/public/data/vaccinations>.
388 This data can be downloaded in CSV and JSON formats.

389 Code availability

390 Our scripts for data collection, processing, and transformation, are available for inspection in
391 the public GitHub repository that hosts our data ([https://github.com/owid/covid-19-](https://github.com/owid/covid-19-data/tree/master/scripts/scripts/vaccinations)
392 [data/tree/master/scripts/scripts/vaccinations](https://github.com/owid/covid-19-data/tree/master/scripts/scripts/vaccinations)). All scripts are also made publicly available on
393 figshare ([https://figshare.com/articles/software/A_global_database_of_COVID-](https://figshare.com/articles/software/A_global_database_of_COVID-19_vaccinations/14387702)
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450

451

452 Figure Captions

453

454 **Figure 1:** Cumulative number of COVID-19 doses administered by country. This represents the
455 current coverage of the global vaccination rollout. Note that these figures are not population-adjusted
456 (see Figure 3) and should not be used for cross-cross comparison of the scale of the vaccine rollout.

457

458 **Figure 2:** Cumulative number of COVID-19 doses administered per 100 people, measured against
459 gross domestic product (GDP) per capita. GDP per capita is PPP-adjusted, and measured in
460 international-dollars.

461

462 **Figure 3: Cumulative vaccine doses administered per 100 people in the total population.**
463 Shown is the global situation as of 7 April 2021.

464

465 **Figure 4: Vaccine doses administered per 100 people: (a)** shown as the cumulative total per 100
466 people; and **(b)** daily doses administered per 100 people (7-day smoothed) for select countries.

467

468 **Figure 5: Share of the total population that have: (a)** received at least one dose of the COVID-19
469 vaccine; and **(b)** been fully vaccinated against COVID-19, for select countries.

470

471 **Figure 6: Timeline of innovation in the development of vaccines.** Each bar begins in the year in
472 which the pathogenic agent was first linked to the disease and the bar ends in the year in which a
473 vaccination against that pathogen was licensed in the US.

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495 **Author contributions**

496 Edouard Mathieu led the study and collected vaccination data with input from Cameron
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501 **Competing interests**

502 The authors declare no competing interests.

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