

## Research Article

# COVID-19 Vaccination Policies and Coverage Across 48 OECD-Related Countries at the End of the COVID-19 Emergency

Alejandro Fernandez-Montero<sup>1-3\*</sup>, Anne Katherine Gribble<sup>4,5</sup>, Laura Moreno Garralaga<sup>3,6,7</sup>, Ya Chin Huang<sup>1,4,8</sup>, Karen Fisher<sup>9, 10</sup>, and Stefanos N Kales<sup>1,4</sup>

<sup>1</sup>Department of Environmental Health, Harvard T.H. Chan School of Public Health, USA

<sup>2</sup>Department of Occupational Medicine, University of Navarra, Spain

<sup>3</sup>Instituto de Investigación Sanitaria de Navarra (IdiSNA), Spain

<sup>4</sup>Occupational Medicine, Cambridge Health Alliance, Harvard Medical School, USA

<sup>5</sup>Illawarra Shoalhaven Local Health District, NSW Health, Australia

<sup>6</sup>Boston Children's Hospital, BCH-Harvard Medical School, USA

<sup>7</sup>Department of Paediatrics, University Hospital of Navarra, Spain

<sup>8</sup>Department of Preventive Medicine, Kaohsiung Municipal Ta-Tung Hospital, Kaohsiung Medical University, Taiwan

<sup>9</sup>Nepean Blue Mountain Local Health District, NSW Health, Australia

<sup>10</sup>Faculty of Medicine and Health, The University of Sydney, Camperdown, Australia

**\*Corresponding author**

Alejandro Fernandez-Montero, Department of Occupational Medicine, University of Navarra Clinic. Av. Pio XII, 36. 31008. Pamplona, Navarra, Spain, Tel: +34 948 255400

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**Abstract**

This study analyses COVID-19 vaccination policies across a large sample of countries and international regions at the end of the COVID-19 emergency. We compared levels of vaccination, manufacturers supplying administered doses, recommendations for age of vaccination in the healthy population, and vaccination mandates in 48 countries (OECD members, candidates and key partners). We found that on average in each country, 71.1% of the population had received  $\geq 1$  dose of COVID-19 vaccine, 66.3% had completed a full vaccination schedule and 43.7 booster shots had been administered per 100 people. OECD members generally had higher levels of vaccination than other countries studied, though there were exceptions. All countries continued to recommend primary vaccination of the healthy paediatric population, except for Norway, Sweden and Denmark. 11 of 48 countries had vaccination mandatory for health care workers, whilst only Costa Rica mandated vaccination across the general population. Vaccination policies should adapt to current realities. Recommendations for ongoing booster dosing in the general population, and particularly healthy children, adolescents and young men who have very low risk of severe COVID-19 should reflect updated risk/benefit and cost-effectiveness assessments.

**Key results and their importance**

1. Analysis of post-pandemic COVID-19 vaccine policies
2. Varied vaccination strategies found among related countries.
3. Most still recommend child and teen vaccination (Jan 2023)
4. Reevaluation required for vaccinating low-risk young males.

**INTRODUCTION**

On January 30, 2020, the World Health Organisation (WHO) declared the COVID-19 outbreak a Public Health Emergency of International Concern. [1,2] Now, 3-plus years later, the pandemic threat posed by SARS-CoV-2 has greatly abated, and COVID-19 is now a mild endemic infection. The WHO has officially announced the end of the emergency. At this time, it is crucial to examine the policies currently aimed at disease control and interrogate if they are contemporaneous with the latest evidence and the current situation [3-5].

This article examines the vaccination policies in place in the member countries of the Organisation for Economic Cooperation and Development (OECD), the current candidates for OECD membership and the OECD preferred partners at the time of transition away from emergency. This group of countries share a market economy, a democratic government and are connected by the political and economic cooperation that comes with OECD membership. Due to their economic strength and to direct unilateral arrangements with vaccine manufacturers, all OECD member countries had access to approved COVID-19 vaccinations by early 2021 and have continued to have ongoing

access since that time. OECD countries have highly developed health systems and health infrastructure to enact vaccine roll out and to monitor the prevalence of immunity and incidence of disease within their populations. It would also be expected that these countries, given their democratic systems and their economic development, would adopt vaccination policies that are maximally acceptable to citizens and that are maximally efficient in terms of public health risks and benefits and health economics. For the aforementioned reasons, the policies of this subset of countries are a valuable group to study.

Presently, the major circulating COVID-19 variants are associated with less severe disease, while there is a much higher prevalence of immunity (both natural and vaccine-associated) in the population [1]. At the same time, part way through the third year of mass vaccination, we now have greater knowledge regarding the effectiveness and safety of the available vaccines, to characterise general, as well as population specific side-effects [6,7]. Moreover, we now have immense understanding about population-specific risks of COVID-19 infection, particularly the extremely low risks for children and young adults [8] vaccination of children and adolescents continues to be robustly debated, as the highest burden of COVID-19 morbidity and mortality lies among older adults or high-risk patients and vaccines have a limited role in reducing transmission. [9] Thus, myriad reasons converge to require re-evaluation of Covid-vaccination strategies. In March 2023, the WHO released an updated roadmap for prioritizing uses of COVID-19 vaccines [10]. It presented a major revision of previous recommendations as these had been made to suit previous stages of the pandemic and the current situation presents different challenges.

This study aims to describe the vaccine policies from OECD countries, their future candidates and preferred partners of OECD as of January 2023, with a focus on the guidelines aimed at the healthy population.

## METHODS

The study focused on the 38 members that make up the OECD, the 6 countries that are currently candidates for membership (Argentina, Brazil, Bulgaria, Croatia, Peru, and Romania) and their preferred partners (South Africa, China, India, Indonesia, and the Brazil) [11]. In total, 48 countries were included in the search.

We performed a cross-sectional study of current vaccine policies in these countries at the end of January 2023. All data were collected by four members of the research team using publicly available online resources. Each researcher independently collected data about vaccine coverage, vaccine types and current policies regarding target groups for primary vaccination courses and booster doses. Both the date of data retrieval and the date the online source were last updated and recorded alongside the data collected. Following collection of the full data set, the data were checked for accuracy by another team member who had not been responsible for the initial collection.

Data were collected mainly from two sources of information. Data on vaccination coverage and type of vaccine were extracted from the Coronavirus Pandemic section of Our World in Data [12], and data concerning vaccination policies through national government websites of each country analyzed (This information is shown in a supplementary table). Our World in Data is a non-profit organization collecting and publishing reputable data on Coronavirus sourced from official sources such as national health departments and international organizations like the WHO. The mission of Our World in Data is to make high quality data available to researchers. It has strong internal processes to ensure the most accurate information and a high degree of transparency, publishing the names of their contributors and the links to their sources. It should be noted that our data are focussed on policies aimed at the general healthy population. We did not compare policies specific to immunocompromised individuals and those with significant comorbidities. Further, the data concern national government policies, and do not reflect any mandates enacted at a more local level.

The total population estimates from the United Nations World Population Prospects (UNWPP) were used as the denominator when calculating the percentage of persons who received at least one dose of a COVID-19 vaccine, the percentage of persons who completed the initial vaccination protocol and the number of booster doses administered per 100 persons [12]. The meaning of 'complete initial vaccination protocol' was defined by the manufacturers' vaccination regimen (e.g. 2 doses for Pfizer/BioNTech, Moderna, Oxford/AstraZeneca, and 1 dose for Johnson & Johnson, CanSino, etc) [10]. Booster doses were counted as the doses administered beyond those prescribed by the initial complete vaccination protocol, because initially most countries presented in that way their booster data, so that percentage could exceed 100 if multiple boosters were administered to the same person. For future studies, when possible, each booster dose should be consider separately presenting the coverage in a given year, as done with influenza vaccination. Data from Israel were reported separately from data from Palestine, and the population estimates used for Israel were drawn from the UNWPP. For the percentage of doses administered per each vaccine manufacturer was calculated as the number of vaccine doses from that vaccine manufacturer administered, divided by the total number of doses administered. We also performed additional statistical analyses such as the calculation of the overall averages for OECD members, candidates and preferred partners.

## RESULTS

In January 2023, data were collected from 48 countries, Table 1 summarizes vaccine-coverage within each of the sampled countries. In OECD countries, a mean 77.2% of each's nation's population had received at least one dose of a COVID-19 vaccine. The mean was higher in OECD countries than in OECD candidate countries (mean national coverage of 66.5%) or in OECD preferred partners (69.6%).

The number of booster doses administered per 100 head

## Supplementary table

Country	Search date	Reference of official websites
<b>Members</b>		
Australia*	23 January 2023	<a href="http://www.health.gov.au/our-work/covid-19-vaccines/covid-19-vaccines-translated-information">www.health.gov.au/our-work/covid-19-vaccines/covid-19-vaccines-translated-information</a>
Austria*	26 January 2023	<a href="http://www.sozialministerium.at/Corona/allgemeine-informationen/corona-schutzimpfung.html">www.sozialministerium.at/Corona/allgemeine-informationen/corona-schutzimpfung.html</a>
Belgium*	23 January 2023	<a href="http://www.info-coronavirus.be/en/vaccination/">www.info-coronavirus.be/en/vaccination/</a>
Canada	23 January 2023	<a href="http://www.canada.ca/en/public-health/services/immunization-vaccines.html">www.canada.ca/en/public-health/services/immunization-vaccines.html</a>
Chile*	23 January 2023	<a href="http://www.minsal.cl/vacunate-con-la-dupla/">www.minsal.cl/vacunate-con-la-dupla/</a>
Colombia	31 January 2023	<a href="http://bogota.gov.co/vacunacion-covid-19/">bogota.gov.co/vacunacion-covid-19/</a>
Costa Rica	31 January 2023	<a href="https://n1info.hr/english/news/covid-19-vaccine-for-children-arrives-in-croatia/">https://n1info.hr/english/news/covid-19-vaccine-for-children-arrives-in-croatia/</a>
Czech Republic	25 January 2023	<a href="http://covid.gov.cz/en/situations/vaccination">covid.gov.cz/en/situations/vaccination</a>
Denmark	30 January 2023	<a href="http://en.coronasmitte.dk/general-information/vaccination">en.coronasmitte.dk/general-information/vaccination</a>
Estonia	31 January 2023	<a href="http://vaksineeri.ee/en/covid-19/getting-a-vaccination/">vaksineeri.ee/en/covid-19/getting-a-vaccination/</a>
Finland	31 January 2023	<a href="http://thl.fi/en/web/infectious-diseases-and-vaccinations/what-s-new/coronavirus-covid-19-latest-updates/vaccines-and-coronavirus/getting-vaccinated-against-covid-19-how-why-and-when-">thl.fi/en/web/infectious-diseases-and-vaccinations/what-s-new/coronavirus-covid-19-latest-updates/vaccines-and-coronavirus/getting-vaccinated-against-covid-19-how-why-and-when-</a>
France	23 January 2023	<a href="http://www.gouvernement.fr/info-coronavirus/vaccins">www.gouvernement.fr/info-coronavirus/vaccins</a>
Germany	22 January 2023	<a href="http://www.zusammengegencorona.de/">www.zusammengegencorona.de/</a>
Greece	23 January 2023	<a href="http://www.pio.gov.cy/coronavirus/eng/categories/vaccines-en">www.pio.gov.cy/coronavirus/eng/categories/vaccines-en</a>
Hungary	31 January 2023	<a href="http://vakcinainfo.gov.hu/">vakcinainfo.gov.hu/</a>
Iceland	26 January 2023	<a href="http://www.covid.is/covid-19-vaccine">www.covid.is/covid-19-vaccine</a>
Ireland	20 January 2023	<a href="http://www2.hse.ie/screening-and-vaccinations/covid-19-vaccine/get-the-vaccine/">www2.hse.ie/screening-and-vaccinations/covid-19-vaccine/get-the-vaccine/</a>
Israel	31 January 2023	<a href="http://corona.health.gov.il/en/vaccine-for-covid/over-12/">corona.health.gov.il/en/vaccine-for-covid/over-12/</a>
Italy	23 January 2023	<a href="http://www.salute.gov.it/portale/nuovocoronavirus/homeNuovoCoronavirus.html">www.salute.gov.it/portale/nuovocoronavirus/homeNuovoCoronavirus.html</a>
Japan	23 January 2023	<a href="http://www.mhlw.go.jp/stf/covid-19/qa_vaccine.html">www.mhlw.go.jp/stf/covid-19/qa_vaccine.html</a>
Latvia	31 January 2023	<a href="http://www.vmnvd.gov.lv/lv/balstvakcinacija">www.vmnvd.gov.lv/lv/balstvakcinacija</a>
Lithuania	25 January 2023	<a href="http://koronastop.lrv.lt/en/vaccination">koronastop.lrv.lt/en/vaccination</a>
Luxembourg	25 January 2023	<a href="http://covid19.public.lu/en/vaccination.html">covid19.public.lu/en/vaccination.html</a>
Mexico	23 January 2023	<a href="http://vacunacovid.gob.mx/preguntas-frecuentes/">vacunacovid.gob.mx/preguntas-frecuentes/</a>
Netherlands	26 January 2023	<a href="http://www.rivm.nl/en/covid-19-vaccination">www.rivm.nl/en/covid-19-vaccination</a>
New Zealand*	26 January 2023	<a href="http://www.health.govt.nz/covid-19-novel-coronavirus/covid-19-vaccines">www.health.govt.nz/covid-19-novel-coronavirus/covid-19-vaccines</a>
Norway	30 January 2023	<a href="http://www.fhi.no/en/id/vaccines/coronavirus-immunisation-programme/">www.fhi.no/en/id/vaccines/coronavirus-immunisation-programme/</a>
Poland	31 January 2023	<a href="http://www.gov.pl/web/szczepimysie">www.gov.pl/web/szczepimysie</a>
Portugal	31 January 2023	<a href="http://www.sns24.gov.pt/tema/doencas-infecciosas/covid-19/vacina-covid-19/">www.sns24.gov.pt/tema/doencas-infecciosas/covid-19/vacina-covid-19/</a>
Slovakia	25 January 2023	<a href="http://korona.gov.sk/en/">korona.gov.sk/en/</a>
Slovenia	25 January 2023	<a href="http://www.cepimose.si/cepljenje-proti-covidu-19/pogosta-vprasanja-in-odgovori/">www.cepimose.si/cepljenje-proti-covidu-19/pogosta-vprasanja-in-odgovori/</a>
South Korea	31 January 2023	<a href="http://ncv.kdca.go.kr/menu.es?mid=a10117020000">ncv.kdca.go.kr/menu.es?mid=a10117020000</a>
Spain	22 January 2023	<a href="http://www.sanidad.gob.es/areas/alertasEmergenciasSanitarias/alertasActuales/nCov/vacunaCovid19.htm">www.sanidad.gob.es/areas/alertasEmergenciasSanitarias/alertasActuales/nCov/vacunaCovid19.htm</a>
Sweden	21 January 2023	<a href="http://www.krisinformation.se/en/hazards-and-risks/disasters-and-incidents/2020/official-information-on-the-new-coronavirus/vaccination-against-covid-19/when-is-it-my-turn">www.krisinformation.se/en/hazards-and-risks/disasters-and-incidents/2020/official-information-on-the-new-coronavirus/vaccination-against-covid-19/when-is-it-my-turn</a>
Switzerland	22 January 2023	<a href="http://www.bag.admin.ch/bag/en/home/krankheiten/ausbrueche-epidemien-pandemien/aktuelle-ausbrueche-epidemien/novel-cov.html">www.bag.admin.ch/bag/en/home/krankheiten/ausbrueche-epidemien-pandemien/aktuelle-ausbrueche-epidemien/novel-cov.html</a>
Turkey	31 January 2023	<a href="http://help.unhcr.org/turkiye/coronavirus/covid-19-vaccination/">help.unhcr.org/turkiye/coronavirus/covid-19-vaccination/</a>
United Kingdom	19 January 2023	<a href="http://www.nhs.uk/nhs-services/covid-19-services/covid-19-vaccination-services/">www.nhs.uk/nhs-services/covid-19-services/covid-19-vaccination-services/</a>
United States	31 January 2023	<a href="http://www.cdc.gov/vaccines/covid-19/">www.cdc.gov/vaccines/covid-19/</a>
<b>Candidates for membership</b>		
Argentina	23 January 2023	<a href="http://www.argentina.gob.ar/coronavirus/vacuna">www.argentina.gob.ar/coronavirus/vacuna</a>
Brazil	23 January 2023	<a href="http://www.gov.br/saude/pt-br/centrais-de-conteudo/publicacoes/svsa/coronavirus/plano-nacional-de-operacionalizacao-da-vacinacao-contra-a-covid-19-pno-2a-edicao-com-isbn">www.gov.br/saude/pt-br/centrais-de-conteudo/publicacoes/svsa/coronavirus/plano-nacional-de-operacionalizacao-da-vacinacao-contra-a-covid-19-pno-2a-edicao-com-isbn</a>
Bulgaria	23 January 2023	<a href="http://plusmen.bg/">plusmen.bg/</a>
Croatia	31 January 2023	<a href="http://www.hzjz.hr/en/">www.hzjz.hr/en/</a>
Peru	23 January 2023	<a href="http://www.gob.pe/institucion/minsa/colecciones/3874-protocolos-de-vacunacion-contra-la-covid-19?terms=">www.gob.pe/institucion/minsa/colecciones/3874-protocolos-de-vacunacion-contra-la-covid-19?terms=</a>
Romania	25 January 2023	<a href="https://vaccinare-covid.gov.ro/">https://vaccinare-covid.gov.ro/</a>
<b>Preferred partners</b>		
China	31 January 2023	<a href="http://www.nhc.gov.cn/xcs/s7847/202111/79103c66c2de404b8e50583816f5e31e.shtml">www.nhc.gov.cn/xcs/s7847/202111/79103c66c2de404b8e50583816f5e31e.shtml</a>
Indonesia	28 January 2023	<a href="http://covid19.go.id/id">covid19.go.id/id</a>
India	27 January 2023	<a href="http://cowin.gov.in">cowin.gov.in</a>
South Africa	20 January 2023	<a href="http://www.gov.za/covid-19/vaccine/vaccine">www.gov.za/covid-19/vaccine/vaccine</a>

**Table 1:** COVID vaccination coverage in OECD member countries, candidates for OECD membership and OECD preferred partners at the start of 2023

Country		Percentage of population who had received $\geq 1$ dose of a COVID vaccine	Percentage of population who had completed an initial vaccination protocol	Total number of booster doses administered divided by total population
Members/Mean (%)		<b>77.2</b>	<b>73.7</b>	<b>62.9</b>
Portugal (%)		95.2	86.6	68.5
Chile (%)		92.3	90.3	140.0
Canada (%)		90.3	82.6	79.0
Costa Rica (%)		88.9	83.3	54.7
Spain (%)		86.9	85.6	55.6
South Korea (%)		86.6	85.8	79.8
Italy (%)		86.2	81.3	80.2
Australia (%)		85.0	82.7	75.5
Japan (%)		84.4	83.3	136.9
Iceland (%)		83.1	77.8	67.2
New Zealand (%)		82.9	79.8	68.0
Colombia (%)		82.8	71.2	28.3
Ireland (%)		81.8	80.8	63.3
Finland (%)		81.7	78.5	77.6
Denmark (%)		81.5	80.9	61.8
United States (%)		81.0	69.1	40.1
France (%)		80.6	78.5	69.7
Norway (%)		80.0	74.6	68.9
United Kingdom (%)		79.7	75.2	59.8
Belgium (%)		79.5	78.7	99.6
Germany (%)		77.8	76.2	77.5
Mexico (%)		77.7	64.8	44.7
Austria (%)		77.1	76.3	60.4
Greece (%)		76.4	73.6	68.2
Luxembourg (%)		74.4	72.9	70.6
Sweden (%)		74.1	72.4	92.3
Latvia (%)		72.7	70.6	28.6
Netherlands (%)		72.7	68.1	53.6
Lithuania (%)		71.2	68.4	34.3
Israel (%)		71.1	65.2	60.9
Switzerland (%)		69.7	68.8	55.6
Turkey (%)		67.9	62.3	48.5
Czech Republic (%)		66.5	65.7	49.1
Estonia (%)		65.6	64.0	44.9
Hungary (%)		64.4	62.3	43.3
Slovenia (%)		59.7	57.9	31.0
Poland (%)		57.4	56.8	38.2
Slovakia (%)		46.0	45.7	12.1
Candidates for membership/Mean (%)		<b>66.5</b>	<b>61.7</b>	<b>42.0</b>
Argentina (%)		91.0	76.0	76.5
Peru (%)		88.8	83.6	82.8
Brazil (%)		87.8	81.4	57.6
Croatia (%)		57.6	55.9	14.8
Romania (%)		42.6	42.4	9.2
Bulgaria (%)		31.1	30.6	11.3

Preferred partners/Mean (%)	69.6	63.6	26.3
China (%)	91.9	89.5	58.0
Indonesia (%)	73.9	62.7	24.7
India (%)	72.5	67.1	15.8
South Africa (%)	40.0	35.1	6.5

<sup>a</sup> For Australia: the record for a least one dose of COVID vaccine was up to 7 April 2022, for complete protocol was up to 17 June 2022, and for booster doses was up to 19 January 2023.

<sup>b</sup> For Austria: the record for a least one dose of COVID vaccine and complete protocol were up to 13 December 2022, and for booster doses was up to 20 January 2023.

<sup>c</sup> For Mexico: the record for a least one dose of COVID vaccine and complete protocol were up to 7 October 2022, and for booster doses was up to 18 November 2022.

<sup>d</sup> For Croatia: the record for a least one dose of COVID vaccine and complete protocol were up to 29 January 2023, and for booster doses was up to 9 January 2023.

<sup>e</sup> For Romania: the data was collected from European Centre for Disease Prevention and Control because no data was available in our World in data.

of population was lower than the percentage of people with a completed vaccination course, except in six countries: Japan, Chile, Belgium, Sweden, Germany and Argentina. Across the other countries in our study sample, the mean difference between rates of complete vaccination and booster doses was 19.4 percentage points. In OECD countries, the mean number of booster doses administered was 62.9 per 100 population and the median was 61.4%. In OECD candidates, the mean was lower (42.0%), as was the median (36.2%) and results ranged from 9.2% (Romania) to 82.8% (Peru). In OECD preferred partners, the number of boosters administered per 100 people ranged from 6.5% (South Africa) to 58.0% (China), with a mean of 26.3% and median of 20.3%.

Table 2 shows that in the majority of countries, the predominant vaccine administered was Pfizer/BioNTech, accounting for a mean 67.8% of doses administered. No data were available/found for the breakdown of vaccine manufacturers in the following countries: United Kingdom, Greece, Australia, Turkey, Israel, New Zealand, Colombia, Costa Rica, Brazil, China, India, and Indonesia.

Table 3 presents national vaccination policies regarding the ages at which primary vaccination and booster doses were recommended in the general healthy population as well as whether vaccination was mandatory for health care workers (HCWs). In January 2023, 14 out of the 48 countries recommended paediatric vaccination from 6 months of age even in the absence of specific risk factors. Another 4 countries recommended vaccination from 3 years of age, and 20 countries recommended starting at 5 years of age. Only 6 countries limited their recommendation to older children: Finland, Turkey, the United Kingdom, India and South Africa recommended vaccination of adolescents from the age of 12 and Switzerland recommended starting at the age of 16. Only Norway, Sweden and Denmark restricted their recommendations to adults.

Regarding the recommendations for booster dosing in the healthy population, there is even larger variation between countries. The United States, Argentina, and Poland recommended booster doses for healthy infants from 6 months of age. 43 of the 48 countries studied recommended at least one booster dose for healthy young people aged 18 or younger, whereas 5 countries

**Table 2:** Brand of COVID vaccine administered as percentage of total doses administered in OECD member countries, candidates for OECD membership and OECD preferred partners. Data from January 2023.

Country	Data up to	Pfizer/ BioNTech	Moderna	Oxford/ AstraZeneca	Sinovac	Sinopharm/ Beijing	Johnson & Johnson	Sputnik	Other vaccines
<b>Members</b>									
Australia	Not available*	-	-	-	-	-	-	-	-
Austria	13 December 2022	82.2	8.2	7.8	-	-	1.8	-	0.1
Belgium	23 January 2023	74.1	14.8	9.6	-	-	1.5	-	0.0
Canada	22 January 2023	66.7	30.3	3.0	-	-	-	-	0.0
Chile	30 August 2022	23.3	-	1.6	75.1	-	-	-	0.0
Colombia	Not available*	-	-	-	-	-	-	-	-
Costa Rica	Not available*	-	-	-	-	-	-	-	-
Czech Republic	17 January 2023	84.1	8.8	4.8	<0.01	<0.01	2.2	-	0.1
Denmark	13 January 2023	86.0	12.6	1.1	-	-	0.3	-	-
Estonia	23 January 2023	74.3	11.1	10.9	-	-	3.6	-	0.1
Finland	13 January 2023	79.7	16.0	4.3	-	-	-	-	-
France	19 January 2023	78.5	15.7	5.1	-	-	0.7	-	0.0
Germany	20 January 2023	74.1	16.9	6.9	-	-	2.0	-	0.1
Greece	Not available*	-	-	-	-	-	-	-	-
Hungary	6 January 2023	59.0	6.5	7.6	-	14.0	2.1	10.9	-
Iceland	29 March 2022	92.1	7.8	<0.01	-	-	0.1	-	-
Ireland	19 January 2023	75.3	13.2	9.6	-	-	1.9	-	0.0
Israel	Not available*	-	-	-	-	-	-	-	-
Italy	19 January 2023	66.6	23.9	8.5	-	-	1.1	-	0.0
Japan	23 January 2023	78.0	21.9	0.0	-	-	-	-	0.1

Latvia	11 July 2022	56.1	24.7	9.1	<0.01	0.0	10.2	-	0.0
Lithuania	17 January 2023	74.3	7.3	11.9	-	-	6.5	-	-
Luxembourg	17 January 2023	62.4	28.7	8.8	-	-	3.5	-	0.0
Mexico <sup>§</sup>	12 January 2023	28.5	2.4	44.0	7.8	-	0.5	7.8	9.1
Netherlands	2 September 2022	66.0	24.6	7.2	-	-	2.2	-	0.0
New Zealand	Not available*	-	-	-	-	-	-	-	-
Norway	6 January 2023	79.3	19.4	1.2	-	-	0.1	-	-
Poland	13 January 2023	77.9	7.1	9.9	-	-	5.1	-	0.0
Portugal	27 January 2023	72.0	14.9	8.7	0.04	0.02	4.3	-	0.0
Slovakia	17 January 2023	74.8	9.8	12.2	-	-	2.7	0.6	0.1
Slovenia	17 January 2023	83.4	0.06	11.6	-	<0.01	4.9	-	0.0
South Korea	12 December 2022	59.7	15.3	22.9	-	-	-	-	0.3
Spain	6 January 2023	67.6	21.8	8.8	-	-	1.8	-	-
Sweden	6 January 2023	75.8	18.4	5.8	-	-	-	-	0.0
Switzerland	22 January 2023	36.7	62.9	-	-	-	0.4	-	0.0
Turkey	Not available*	-	-	-	-	-	-	-	-
United Kingdom	Not available*	-	-	-	-	-	-	-	-
United States	17 January 2023	59.7	37.5	-	-	-	2.8	-	0.0
<b>Candidates for membership</b>									
Argentina	20 January 2023	17.1	15.0	23.5	-	25.4	-	18.2	0.9
Brazil	Not available*	-	-	-	-	-	-	-	-
Bulgaria	21 January 2023	67.0	11.1	10.4	-	-	11.5	-	-
Croatia	29 January 2023	75.8	9.8	10.7	-	-	3.8	-	0.0
Peru	19 January 2023	59.0	7.2	9.4	-	24.5	-	-	-
Romania	17 January 2023	76.7	6.0	5.0	-	-	12.2	-	-
<b>Preferred partners</b>									
China	Not available*	-	-	-	-	-	-	-	-
India	Not available*	-	-	-	-	-	-	-	-
Indonesia	Not available*	-	-	-	-	-	-	-	-
South Africa	26 December 2022	75.4	-	-	-	-	24.6	-	-

\*No data able to be identified about the manufacturer of vaccines administered in Australia, Brazil, China, Colombia, Costa Rica, Greece, India, Indonesia Israel, New Zealand, Turkey, or the United Kingdom from our World in data.

<sup>§</sup>The data for Mexico was retrieved directly from their governmental website, not from My World in Data

**Table 3:** Comparison of COVID vaccination policies across OECD member countries, candidates for OECD membership and OECD preferred partners, with a specific focus on age from which vaccination is recommended, age form which booster doses are recommended and whether vaccination is mandated for health care workers.

Country	Search date	Age (years) from which COVID vaccination is recommended	Age (years) from which ongoing booster vaccinations are recommended	Mandatory vaccination of healthcare workers
<b>Members</b>				
Poland	31 January 2023	0.5	0.5	Yes
United States	31 January 2023	0.5	0.5	No
Austria	26 January 2023	0.5	5	No
Canada	23 January 2023	0.5	5	Yes
Colombia	31 January 2023	0.5	5	No
Czech Republic	25 January 2023	0.5	5	No
Japan	23 January 2023	0.5	5	No
Greece	23 January 2023	0.5	12	Yes
Luxembourg	25 January 2023	0.5	12	No
Netherlands	26 January 2023	0.5	12	No
Slovenia	25 January 2023	0.5	18	No
Chile	23 January 2023	3	3	No
New Zealand	26 January 2023	3	18	Yes
Estonia	31 January 2023	5	12	No
France	23 January 2023	5	12	Yes
Germany	22 January 2023	5	12	No
Hungary	31 January 2023	5	12	Yes
Iceland	26 January 2023	5	12	No
Ireland	20 January 2023	5	12	No
Israel	31 January 2023	5	12	No
Lithuania	25 January 2023	5	12	No

Slovakia	25 January 2023	5	12	No
Belgium	23 January 2023	5	16	Yes
Latvia	31 January 2023	5	16	Yes
Costa Rica	31 January 2023	5	18	Yes <sup>‡</sup>
Portugal	31 January 2023	5	18	No
South Korea	31 January 2023	5	18	No
Mexico	23 January 2023	5	40	No
Australia	23 January 2023	5	50*	Yes
Spain	22 January 2023	5	60	No
Italy	23 January 2023	5	80*	No
Turkey	31 January 2023	12	12	No
Finland	31 January 2023	12	18	No
United Kingdom	19 January 2023	12	50	No
Switzerland	22 January 2023	16	16	No
Sweden	21 January 2023	18	18	No
Norway	30 January 2023	18	65	No
Denmark	30 January 2023	50	50	No
Candidates for membership				
Argentina	23 January 2023	0.5	0.5	No
Bulgaria	23 January 2023	0.5 <sup>§</sup>	5 <sup>§</sup>	No
Peru	23 January 2023	0.5	18	No
Brazil	23 January 2023	3	40*	No
Croatia	31 January 2023	5	18	Yes
Romania	25 January 2023	5	12	No
Preferred partners				
China	31 January 2023	3	18	No
Indonesia	28 January 2023	6	18	No
India	27 January 2023	12	18	No
South Africa	20 January 2023	12	12	No

\* Some countries have more detailed age-based specifications for booster doses:

- In Italy, a single booster dose is recommended for all people >12 years. Two booster doses are recommended for people >60 years. Subsequent ongoing booster vaccination is only recommended over 80 years.
- In Australia, a single booster dose is recommended for all people >16 years. Subsequent ongoing booster vaccination is only recommended >50 years.
- In Brazil, a single booster dose is recommended for all people >17 years. Subsequent ongoing booster vaccination is only recommended >50 years.

<sup>§</sup>In Bulgaria, the COVID vaccination is available from 0.5 years of age and booster is available from the age of 5, however official sources recommended that vaccination for children 0.5-12 years be discussed with the child's pediatrician. As such, it is possible that vaccination and boosters will not be recommended to all children <12.

<sup>‡</sup>In Costa Rica, COVID vaccination was mandatory in general population at the time of data collection. This policy was in effect until 27 March 2023.

recommended boosters only for older adults: Denmark (from 50), Mexico (from 40), Norway (from 65), Spain (from 60) and the UK (from 50).

At the time of data collection, 11 countries had mandatory COVID-19 vaccination for HCW: Australia, Belgium, Canada, France, Greece, Hungary, Latvia, New Zealand, Poland, Croatia and Costa Rica, and only one country, Costa Rica, had compulsory vaccination for the general population.

## DISCUSSION

Our data from January 2023 indicates a large degree of variation in vaccination policies and vaccination coverage amongst the sample of 48 economically related countries. Different countries targeted different populations for vaccination. Primary vaccination as well as ongoing booster dosing was recommended from a very young age in the general healthy population in most countries despite a lack of risk among young persons. Meanwhile, only a handful of countries had policies mandating vaccination for HCWs, despite the lack of evidence that vaccines block covid transmission.

The primary aim of most vaccination programs is to protect individual recipients against the symptoms and complications of infection, while the secondary aim is to prevent subsequent transmission to other members of the population. To do so, a vaccination program requires an effective vaccine. Vaccines against COVID-19 have proven effective in reducing deaths and hospitalization from severe disease among older and vulnerable persons [13,14]. However, they are not effective in preventing transmission with current variants. Significant differences in efficacy, both in preventing severe infection and transmission, are evident across various COVID-19 vaccine types. Recent studies emphasize for example distinct responses to the Omicron variant among Pfizer-BioNTech, Moderna, and AstraZeneca-Oxford vaccines. Pfizer-BioNTech (BNT162b2) sees a decline in efficacy to 70% during Omicron predominance from the earlier 93% during the Delta outbreak. A booster significantly raises neutralizing antibodies, especially in those 65 and older. Moderna (mRNA-1273), initially 85% effective against Omicron, decreases to 55% after 7 months. Moderna booster, especially the 100 µg-dose, notably boosts neutralizing antibodies. AstraZeneca-Oxford (ChAdOx1 nCoV-19), about 5 months post-second dose, shows 90% lacking Omicron-specific neutralizing antibodies.

Neutralization effectiveness drops 6 to 23 times, emphasizing the need for boosters. These findings underscore varying responses across different COVID-19 vaccines [15].

Similarly, all countries in our study recommended booster doses to the older elderly within their recommendations to wider target groups. However, our findings indicated a highly variable rate of booster dose administration, suggesting the failure of booster campaigns to sufficiently cover high priority groups. In the United States, for example, one would have expected higher rates of booster dosing given the demographics of the population (over 50% have important comorbidities [16-18] and 16.8% aged over 65 [19]) and the time since initial vaccine roll out. Our data suggests that as they emerge from the state of emergency, rather than stepping down the response to COVID-19, many of the countries sampled need to step up to improve their booster vaccination programs in high-risk populations.

A second fundamental pillar of the use of vaccination involves the safety and cost-effectiveness of the vaccine. Safety and cost-effectiveness are properties that are not inherent to any given product, but instead emerge only in relation to the risks, harms and benefits associated with alternative options. As such, the safety and cost effectiveness of vaccination requires careful re-interrogation. Safety is a balance, not an absolute – it requires that there is less risk associated with vaccination than that posed by the disease, considering both the severity of possible outcomes and the likelihood of them occurring. Cost effectiveness is also essential since funding and human resources are limited and any money or time spent in one effort has an opportunity cost associated. Our analysis leads us to urge careful interrogation of vaccine recommendations for healthy children, adolescents and young adults. New studies should be performed taking into account the risk/benefit balance and the cost-effectiveness of currently vaccinating low risk populations, such as healthy children.

In January 2023, most countries surveyed in our study recommended primary series vaccination and booster doses for healthy infants, children, and adolescents 6 months of age and older. These policies contrast with the WHO roadmap released in March 2023 which recommends against COVID-19 vaccination in healthy children, citing safety concerns and poor cost-effectiveness [10]. On the other hand, the Centre for Disease Control (CDC) recommends (current as of 7 June 2023) that all individuals over 6 months of age receive an updated bivalent mRNA vaccine [20], regardless of complete vaccination status prior to April 2023 when the FDA approved the use of these updated vaccines in children [21]. The differences in COVID-19 vaccination strategies for children across similar countries can be attributed to multiple factors. Regulatory distinctions and varying approval processes, influence the timing and authorization of vaccines for pediatric use. Disparities in the prevalence and impact of COVID-19 among children, along with differences in vaccine availability and distribution, might also contribute to these differences. Finally, the prioritization of public health objectives, influenced by local scientific opinions, citizens

sentiment and risk-benefit assessments, and the variations in each country healthcare infrastructure further contribute to the decision-making processes, resulting in tailored strategies aligned with each nation's specific circumstances and priorities.

At the current time, death, and severe disease due to COVID-19 is very rare in healthy children. In addition, previously uncommon clinical presentations of concern, such as multisystemic inflammatory syndrome (MIS-C) or long COVID, appear to occur less often in Omicron era [11,22,23]. Most children have asymptomatic infection with Omicron. With regards community transmission, vaccination of children may not greatly reduce risk of infection in others as children appear to be less infectious than adults at baseline and thus vaccines do not meaningfully reduce that baseline low risk. The most effective way to protect vulnerable people is directly.

Given the vaccination of healthy children offers very minor benefit against COVID-19, it becomes hard to justify either the small risk of serious side effects like anaphylaxis (5 in 1 000 000 [24]) or the transient pain and reactogenicity following vaccination. Further, given minimal cost - human or otherwise - associated with COVID-19 infection in children, there is no cost to be mitigated and the cost-effectiveness of vaccinating this group is unfavourable. In addition, the WHO also warns of the significant opportunity cost associated with COVID-19 vaccination and urges the prioritisation of vaccines against severe childhood illnesses [11] - even in OECD countries, public perception of their importance has suffered since the pandemic[25] and their uptake has dwindled [26].

In addition, evidence has emerged that COVID-19 vaccination increases the risk of myocarditis and pericarditis in males aged 12-29[24,27,28]. The increase in baseline risk of myocarditis is highest in males aged 16-17 [24,28], and seems higher following the second dose of the primary vaccination schedule and in association with mRNA vaccines (PfizerNBioTech and Moderna). Incidence estimates range from 7 to 300 in 1 000 000 based on studies in OECD countries [24,29,30]. Meanwhile, the risk of pericarditis appears to be highest in males aged 18-39 following any dose of an mRNA vaccine [30]. Post-vaccination myocarditis is unlikely to be fatal, however it will usually require a short hospital admission (median 2-3 days) for supportive care and monitoring until biomarkers resolve and cardiology follow up in the 12 months following acute resolution [27]. This safety risk must be evaluated in the context of the low risks of death or complicated COVID-19 infection in males in the affected age range. One study into the safety of mRNA booster dose administration in young adults estimates that, per COVID-19 hospitalisation prevented, there would be at least 18.5 serious adverse events, including 1.5-4.6 booster-associated myopericarditis cases [29]. In addition to the risk of myopericarditis, the paper also states that young adult men are affected by high rates of reactogenicity following vaccination which may interfere with daily activities for 1-2 days following vaccination [29]. Given there is presently low risk associated with COVID-19 infection in healthy males aged 12-29, the safety and cost effectiveness of vaccinating this group



may be unfavourable. In January 2023, the UK, Norway, Taiwan and Hong Kong had a one dose policy for complete primary vaccination in males under the age of 18 [29], and Finland did not offer Moderna vaccine to males under 30 [31]. However, none of the countries studied singled out healthy males aged 12-29 for vaccination exemption - Norway and Sweden did not recommend COVID-19 vaccination in children and adolescents under 18, but recommended it in healthy adults [32].

Disparities in childhood vaccination policies stem from a myriad of factors. Long-term studies will be essential to better understand how these differences in vaccination campaigns manifest in tangible outcomes. Time will reveal which strategies have proven most effective, offering valuable insights for future public health decisions.

The final concept to consider is the use of vaccines to prepare for future disease outbreaks. Our evidence suggests possible deficits in the preparedness of our sample group. Inadequate booster dosing in vulnerable groups, as already discussed above, may place unnecessary pressure on the health care system. Furthermore, health care systems rely on HCWs, and effective use of vaccination for public health should include the specific vaccination of this group [33]. COVID-19 infections in HCWs feed a cycle of increasing health care system distress and overwhelm reduced staffing increases the workload on the remaining staff, worsening levels of stress and fatigue, in turn contributing to medical error, lower immunity and lower HCW retention. The WHO recommends periodical vaccination of health workers every 12 months even in the absence of other risk factors. In the countries we surveyed, few countries had compulsory vaccination for HCW, although it is noted that our data only reflects policy mandates at a national level but not mandates set by individual employers.

The strengths of our study lie in the comprehensive compilation of detailed data from reputable sources, ensuring a substantial scale of representation. However, it's important to acknowledge several limitations. Our data, while extensive, captures a singular moment in an ever-evolving landscape. It's crucial to note that our primary objective was not to provide a real-time snapshot but rather to underscore the significant differences across similar countries. In this regard, we have successfully achieved our goal. Long-term studies are currently essential to discern how these variations detected in vaccination policies across countries correlate with real differences in the years to come. Multidisciplinary engagement is needed to examine the national and international responses to the pandemic and to identify the lessons to be learned.

## CONCLUSION

COVID-19 policies must remain responsive to the changing situation during the transition away from emergency. Having successfully curbed the existential threat posed by COVID-19, vaccination must be deployed now to minimise the burden of the disease, to allow our health systems to recover and to optimise our preparedness for future challenges. As the impact

of COVID-19 on healthy children and adolescents seems low, special recommendations should be made regarding the use of vaccines in this low-risk population and policymakers will need to correctly balance the risk benefits of mass vaccination across specific age groups.

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