

## Ethical, public health, and economic dimensions of the inequitable global distribution of COVID-19 vaccines

Pranav Tandon, MSc<sup>1</sup>

<sup>1</sup> Global Health Office, McMaster University, Ontario, Canada

### Introduction

**D**efinitive control of the coronavirus disease 2019 (COVID-19) pandemic has focused on the development of preventive vaccines. Early genomic sequencing of the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) allowed vaccine development to begin soon after SARS-CoV-2 was first isolated in January 2020. With global coordination at the intergovernmental level and massive mobilization of funding towards research and development, COVID-19 vaccines were developed with unprecedented speed within a year while demonstrating safety and efficacy in Phase III clinical trials.<sup>1</sup> As of March 2021, 75 vaccines were being tested in clinical trials and four had been approved for use in Canada – those developed by Moderna, Pfizer-BioNTech, AstraZeneca, and Johnson & Johnson.<sup>2,3</sup> Globally, ten vaccines have seen either emergency or full use approval by national regulators.<sup>2</sup>

While the development of vaccines at an unprecedented speed represented the defining challenge of 2020, success in distributing vaccines effectively and equitably is the challenge before us in 2021 if we are to truly address the ongoing strife caused by the COVID-19 pandemic. Initial international vaccine distribution efforts have delivered good news. On February 5, 2021, Dr. Tedros Adhanom Ghebreyesus, Director-General of the World Health Organization (WHO) announced that the number of vaccinations administered globally had exceeded the number of recorded COVID-19 infections.<sup>4</sup> However, there exists a clear contrast between the level of access to vaccines afforded to rich versus poor countries. As of February 5, 2021, more than 75% of delivered vaccines were limited to ten countries (including the United Kingdom and United States) which collectively account for 60% of the global gross domestic product (GDP), with 130 countries yet to deliver a single vaccination.<sup>4</sup>

### Inequitable distribution of vaccines characterizes the Covid-19 pandemic

The disparity in access to vaccines between rich and poor countries can partly be attributed to bilateral agreements between vaccine manufacturers and individual nation-states. Advance purchase agreements (APAs) allow countries to sign procurement contracts with vaccine developers to secure a pre-arranged supply of vaccines for their national population. By early March 2021, Canada had signed APAs with eight vaccine suppliers for 404 million doses, enough to vaccinate 37 million Canadians 6 times over.<sup>5</sup>

The disproportionate stockpiling of vaccines by select countries – commonly referred to as vaccine nationalism – has been denounced by many, including the WHO Director-General who called it “morally indefensible and clinically counterproductive”.<sup>6</sup> The phenomenon is not entirely unexpected or unprecedented, as countries have long prioritized national self interest in such matters, with inequitable distribution of medicines a broad international norm. During the 2009 H1N1 influenza virus pandemic, self-procurement allowed richer countries to obtain vaccines in advance of all others. 20 of the 53 developed nation-states (Canada, Switzerland, USA, New Zealand, and 16 from the European Union) within the World Trade Organization (WTO) utilized APAs to secure H1N1 vaccines for their respective electorates.<sup>7</sup> This left vaccine manufacturers unable to produce and deliver vaccines for developing countries. These countries then had to rely on WHO’s vaccine deployment initiative which oversaw the global donation of vaccines from developed to developing countries.<sup>7</sup> This system of allocation led to developing countries receiving vaccine doses only once developed countries had supply in excess. Similar patterns of inequity and protectionism were seen in the context of the COVID-19 pandemic with personal protective equipment (PPE) as rich countries were able to procure stocks of supply, leaving poorer countries inadequately armed against the novel coronavirus.<sup>8</sup> Indeed, vaccine nationalism has been a redemonstration of the same behaviour that has fragmented collective responses to past global health threats.

Despite protectionist approaches appearing to be the norm, the international response to COVID-19 has demonstrated remarkable levels of global cooperation as well. Noting the siloed and disaggregated nature of self-procurement through APAs, the COVID-19 Vaccine Global Access (COVAX) facility was developed by WHO, the Centre for Epidemic Preparedness and Innovations (CEPI), and GAVI (Global Alliance for Vaccines and Immunization), to coordinate a global solution for financing and procuring vaccines from manufacturers around the world. In effect, the COVAX facility acts as an insurance scheme that reduces risk of going unvaccinated for countries that would otherwise be unable to secure access to vaccines from pharmaceutical companies while reassuring manufacturers of the global demand for their candidate vaccines. Collectively, COVAX aims to secure and distribute 2 billion vaccine doses by the end of 2021.<sup>9</sup> COVAX is promising as a novel procurement mechanism since it demonstrates a recognition at the international level that the vaccination crusade must be more equitable. However, despite these efforts, poorer countries have not received vaccines at the scale or speed as rich countries thus far, likely attributable to continuing bilateral agreements between countries and manufacturing companies.

Corresponding Author:  
Pranav Tandon  
tandop1@mcmaster.ca

Vaccine nationalism therefore represents a significant roadblock on the path to alleviating the global population of COVID-19 stress. Paradoxically, the hoarding of vaccines within in few countries threatens the benefit that can be derived from those very vaccines. This commentary examines the dangers of global inequities in vaccine distribution from ethics, public health, and economic perspectives.

### **Ethical argument against inequitable global vaccine distribution**

While everyone is at risk of acquiring COVID-19, this risk is not equally distributed. The Government of Canada and WHO have both stated that vaccines ought to first be distributed among health care workers and adults of advanced age.<sup>10,11</sup> Health care workers are vulnerable to COVID-19 by nature of their professions as they provide frontline care to patients – some of whom may have COVID-19. Meanwhile, the elderly (particularly those over 70 years of age) face greatest epidemiologic risk as they are most vulnerable to hospitalization and mortality.<sup>12</sup> Although the magnitude of COVID-19 risk fluctuates depending on socio-economic status and geopolitical context (including health system strength and capacity, national availability of PPE, shifting community spread, etc.), health care workers and the elderly ought to have access to COVID-19 vaccines regardless of national identity or ability to finance vaccines. To deny an available vaccine to either of these vulnerable populations at an international level in favour of lower priority populations in richer countries, despite access to developed safe and effective vaccines, would be ethically harmful.

Some have conceptualized this as an ethical dilemma between vaccine nationalism and vaccine cosmopolitanism.<sup>13</sup> Vaccine nationalism behaviours subscribe to ethics of communitarianism – the idea that identities and values are shaped by our different community belongings which inform our moral obligations.<sup>14</sup> In this view, obligations to the political, more proximal, community can be seen as most valuable. In contrast, vaccine cosmopolitan approaches purport that vaccines should be made available to the global community in an equitable manner. This approach is rooted in utilitarianism which measures the value of an act by measuring its impact on overall wellbeing.<sup>15</sup> In this case, overall wellbeing is measured by the number of countries being able to protect their most vulnerable from COVID-19.

Ferguson and Caplan (2020) have argued that instead of viewing vaccine nationalism as inherently bad and vaccine cosmopolitanism as inherently good, they must be viewed as two competing obligations – one to immediate, geo-politically defined community members, and another to the community of humanity.<sup>16</sup> Following from this view, the ethics of prioritizing the vaccination of citizens within political boundaries have to be compared with the ethics of averting severe disease and death at the international stage.

As an analogy, if both a friend and stranger had requested assistance with an errand at the same time (limited resource analogous to limited vaccine availability), our obligations to our friend would hold greater importance and we would be likely to choose to assist them. It likely would not be immoral to choose to assist our friend by nature of the stronger relationship. However, in the same situation, if our friend needed assistance with an errand while a stranger was in a life-threatening situation, it would certainly be immoral to refuse assistance to the stranger if there was capacity to provide support.

Similarly, given the current epidemiological evidence, morality would dictate that we ought to navigate our obligations to proximal and/or generalized others based on where our assistance can be most beneficial in averting severe suffering and death. Given the impact that COVID-19 has had on health care workers and those of advanced age, countries that have already vaccinated their health care staff and elderly populations and also find themselves situated more comfortably on the epidemiologic curve should share vaccines with neighbouring countries to avoid moral injury and mitigate greater loss of life in the global community as a whole.

Currently, the vaccine distribution patterns are not commensurate with the impact of COVID-19 on national populations. By February 16, 2021, no country in Sub-Saharan Africa had started vaccinating its healthcare workers while 55.2 million people had been vaccinated in the United States of America alone.<sup>17</sup> Although vaccine doses procured through the COVAX facility began being delivered to Sub-Saharan African countries on March 1, there remains a stark difference in the vaccination coverage between COVAX-supported countries and those with independent procurement deals. In fact, as of March 15, only 23.6 million doses had been distributed in Africa (corresponding to a continental coverage of 1.7%), far shy of the goal of vaccinating 60% of the continent's population.<sup>18</sup> This trend is fundamentally inequitable, ethically unjustifiable, and must be addressed through stricter global governance and stronger collective action.

### **Public health implications of inequitable global vaccine distribution**

In addition to the moral argument against keeping vaccines from countries based on their ability to secure independent APAs with vaccine manufacturers, there is epidemiological rationale for sharing vaccines globally. If current trends continue and rich countries continue to vaccinate their citizens, viral transmission, and subsequent death will occur disproportionately in unvaccinated regions. In a preliminary modelling study, Chinazzi et al. (2020) indicate that if the first 2 billion doses of COVID-19 vaccines were allocated to each country proportional to its population, worldwide deaths would reduce by 61%. Conversely, in a scenario more akin to common practice today, doses distributed to the world's 50 richest countries would only reduce global mortality by 33%.<sup>19</sup>

Where transmission of SARS-CoV-2 remains unabated, further mutations within the viral genome will continue to accumulate, leading to variants with potentially increased pathogenicity. Although evidence on the ability of preventive vaccines to mitigate transmission of SARS-CoV-2 between people is currently insufficient and robust data collection on this dimension is crucial, it has been suggested that the immunity imparted by vaccines plays a key role in reducing cases of COVID-19. This will be an important target to achieve in all countries to reduce the chances of novel variants arising.

Several variants of concern that illustrate the danger of unchecked community transmission have been circulating since December 2020 and continue to place added stress on health systems internationally. There are three SARS-CoV-2 variants of note. The B.1.1.7 variant, originally discovered in the United Kingdom in December 2020, has been detected in 94 countries.<sup>20</sup> Early data estimate the variant to be up to 70% more transmissible than wild-type, spurring concerns that it will lend to increased hospitalization rates and worsened

strain on health care systems.<sup>21</sup> The B.1.351 variant, originally discovered in South Africa in December 2020, has been detected in 46 countries and is now the dominant strain circulating in South Africa.<sup>20</sup> Early (preprint) data have shown that the B.1.351 variant shows substantial escape from neutralizing antibodies in COVID-19 convalescent plasma, raising concerns about the potential of resurgence of COVID-19 cases even among vaccinated regions should variants with “escape mutations” be introduced.<sup>22</sup> The P.1 variant has become the dominant strain circulating in Brazil and shares several independently acquired mutations with the B.1.1.7 and B.1.351 variants.<sup>23</sup> These variants highlight the threat of society’s failing to vaccinate rapidly and equitably and are forewarnings of the wide array of SARS-CoV-2 strains that may begin to circulate. The threat posed by these variants should be heeded as a lesson as the resurfacing of novel strains may prolong the global pandemic.

Seeing as SARS-CoV-2 variants represent a significant barrier to the arrival of a post-pandemic era, vaccine manufacturers have turned their attention to developing variant-specific vaccines. That is, if vaccines are ineffective at raising a sufficient immune response, they can be adjusted (especially those using the novel mRNA vaccine platforms) based on characteristics of new strains. In fact, Moderna recently submitted a variant-specific vaccine candidate against the B.1.351 variant to the National Institutes of Health for phase I clinical trial testing.<sup>24</sup> As well, Pfizer/BioNTech began evaluation of the safety and immunogenicity of a third dose of the BNT162b2 vaccine (against the B.1.351 variant) on February 25.<sup>25</sup> However, this strategy is costly and leaves medical science “catching up” to a virus that is constantly evolving. More importantly, this effort takes time, which is equivalent to higher infected cases, deaths, morbidity, and struggle for those within disadvantaged socioeconomic groups. This scenario is unacceptable and demands urgent, tactful, and globally coordinated action.

### Economic case for promoting vaccine equity

COVID-19 has exacted a toll not only on human lives, but also on livelihoods. According to projections by the International Monetary Fund (IMF), 2020 saw the global economy plunge by 4.4% – the deepest recession since the Second World War.<sup>26</sup> Vaccines represent a solution to alleviating not only the health, but also the economic consequences of COVID-19. If the economic benefit is to be reaped broadly and to its fullest extent, however, it is in the best interest of countries to distribute vaccines equitably. The World Economic Forum (WEF) and International Chamber of Commerce (ICC) have both stated that steady global economic recovery demands that developing nations be given access to COVID-19 vaccines.<sup>27,28</sup> The International Chamber of Commerce has released modelling that predicts that delays to vaccine access in poorer countries will cost the whole global economy as much as \$9.2 trillion USD.<sup>28</sup> ICC modelling also suggests that rich countries may bear a cost between \$203 billion USD - \$4.95 trillion USD (a range representative of variables associated with trade and international production network relations).<sup>28</sup> Meanwhile, the COVAX Facility currently has an outstanding funding gap of \$7.8 billion to achieve the initial procurement target of 2 billion vaccines.<sup>29</sup> A comparison of economic losses in an arena with vaccine nationalism versus the cost needed to procure 2 billion vaccines for developing economies via COVAX makes a clear case for investment from high income countries. Even

with a strong case for investing in the COVAX facility to improve vaccine access for developing countries, reasoning that appeals to the self-interests of advanced economies should not be the primary deterrent for vaccine nationalism. Equitable distribution of vaccines will protect developing countries from ongoing and exacerbated harm and prevents downstream developmental challenges which could further displace us from global targets for sustainable development and international prosperity.

### The path forward

With limited global supply, fair allocation of approved COVID-19 vaccines is indeed a challenging task. It was predicted well before vaccines were distributed that initial public demand would far exceed vaccine supply. Ethical, public health, and economic reasoning make it evident that the world must first vaccinate some people in all countries rather than all people in some countries.

The current situation surrounding global vaccine distribution currently paints a grim picture, however, as variants of concern begin to circulate unabated within communities and high priority populations remain unvaccinated in poorer countries. With rich countries around the globe securing APAs with pharmaceutical manufacturers, even countries whose leaders have publicly endorsed vaccine cosmopolitanism (such as Canada) have displayed national partiality.<sup>30,31</sup> This scenario is akin to the “Prisoner’s Dilemma” and the world finds itself imprisoned in a vaccine deadlock. Although cooperation from all countries – in the form of equitable distribution of COVID-19 therapeutics and vaccines – would yield better outcomes in nearly all dimensions (including morally, viral transmission, global trade, post-pandemic economic recovery, etc.), nationalistic approaches to vaccine procurement have kept sufficient doses from reaching the poorest settings with some of the most significantly impacted communities.

Ongoing clashes between the United Kingdom and the European Union over AstraZeneca’s inability to fulfill its vaccine deliveries to the EU demonstrate that it is not only rich countries keeping vaccines away from poor – the rich are sparring amongst themselves as well.<sup>32</sup> This level of global conflict beckons inquiry into whether the current system of vaccine development and distribution are capable of addressing a global pandemic.

The existing fragmented responses towards global vaccine distribution clearly show striking inefficiencies in the ability of current global governance systems to mitigating COVID-19 spread. As it exists, the current system of securing APAs with manufacturers, leaving countries to race against one another to procure and vaccinate, and demonstrating practical disregard for equity is not a system that will be capable of effectively mitigating a pandemic in the short- or perhaps even long-term.

Perhaps a better place to begin addressing the consequences of vaccine nationalism would be to inspect the reasons that have compelled countries to compete for limited resources in the first place. Currently, COVID-19 vaccines are protected by patents under the *Trade Related Intellectual Property Rights* (TRIPS) agreement, limiting their production to only those holding exclusive licenses. Improving access to vaccines globally not only demands bolstered sharing of vaccines with developing countries, but also a massive scale up in vaccine manufacturing itself, which is only possible if knowledge is shared more equitably.

Oxford University and AstraZeneca partnered with the Serum Institute of India, the world's largest vaccine manufacturer, to produce 1 billion doses of the ChAdOx1 vaccine (marketed as Covishield) to low- and middle-income countries.<sup>33</sup> Vaccine developers should similarly share their data and expertise with other eligible manufacturers to improve global capacity for vaccine production. However, unsurprisingly, where countries in the global south have advocated for a TRIPS waiver on the intellectual property rights of all COVID-19 health technologies until the pandemic is declared over, richer countries have opposed the waiver, in effect preventing the scale-up and distribution of COVID-19 vaccines to the poorest countries. These neocolonialist acts only serve to perpetuate, and widen, health inequities between rich and poor nations.

The first part of the global fight against COVID-19 was making safe and effective vaccines. How the global community collaborates to effectively distribute these very vaccines to realise their best possible use will be a referendum on current systems of global health diplomacy and governance. If we fail to make epidemiologically and ethically sound use of the fruits of our global collective efforts to develop a vaccine, we risk reverting our progress and delaying the resolve of the COVID-19 pandemic.

### Acknowledgments

I would like to extend my gratitude and appreciation to Dr. Lawrence Loh for providing technical insights and to Sarai Keestra for her constructive comments on this manuscript. The content presented within the commentary do not represent either of their personal views.

### References

1. Ball P. The lightning-fast quest for COVID vaccines – and what it means for other diseases. *Nature* [Internet]. 2020 [cited 2021 Feb 14]. Available from: <https://www.nature.com/articles/d41586-020-03626-1>
2. Zimmer C, Corum J, Wee S-L. Coronavirus Vaccine Tracker. *New York Times* [Internet]. 2021 [cited 2021 Feb 14]. Available from: <https://www.nytimes.com/interactive/2020/science/coronavirus-vaccine-tracker.html>
3. Government of Canada. Vaccines for COVID-19. Government of Canada [Internet]. 2021 [cited 2021 Feb 14]. Available from: <https://www.canada.ca/en/public-health/services/diseases/coronavirus-disease-covid-19/vaccines.html>
4. World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19 – 5 February 2021. World Health Organization [Internet]. 2021 [cited 2021 Feb 14]. Available from: <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19-5-february-2021>
5. Government of Canada. Procuring vaccines for COVID-19. Government of Canada [Internet]. 2021 [cited 2021 Feb 14]. Available from: <https://www.canada.ca/en/public-services-procurement/services/procuring-vaccines-covid19.html>
6. Ghebreyesus TA. Vaccine nationalism harms everyone and protects no one. *Foreign Policy* [Internet]. 2021 [cited 2021 Feb 14]. Available from: <https://foreignpolicy.com/2021/02/02/vaccine-nationalism-harms-everyone-and-protects-no-one/>
7. Turner M. Vaccine procurement during an influenza pandemic and the role of advance purchase agreements: lessons from 2009-H1N1. *Glob Public Health* [Internet]. 2016;11(3):322–35. Available from: <http://dx.doi.org/10.1080/17441692.2015.1043743>
8. McMahon DE, Peters GA, Ivers LC, et al. Global resource shortages during COVID-19: Bad news for low-income countries. *Samy AM, editor. PLoS Negl Trop Dis* [Internet]. 2020 Jul 6;14(7):e0008412. Available from: <https://dx.plos.org/10.1371/journal.pntd.0008412>
9. World Health Organization. COVAX Announces additional deals to access promising COVID-19 vaccine candidates; plans global rollout starting Q1 2021. World Health Organization [Internet]. 2020 [cited 2021 Feb 15]. Available from: <https://www.who.int/news/item/18-12-2020-covax-announces-additional-deals-to-access-promising-covid-19-vaccine-candidates-plans-global-rollout-starting-q1-2021#:~:text=The goal of COVAX is,by the end of 2021>

10. Immunization Vaccines and Biologicals Strategic Advisory Group of Experts on Immunization (WHO). WHO SAGE roadmap for prioritizing uses of COVID-19 vaccines in the Context of limited supply. World Health Organization [Internet]. 2020 [cited 2021 Feb 15]. Available from: <https://www.who.int/publications/m/item/who-sage-roadmap-for-prioritizing-uses-of-covid-19-vaccines-in-the-context-of-limited-supply>
11. National Advisory Committee on Immunization (Government of Canada). Guidance on the prioritization of initial doses of COVID-19 vaccine(s). Government of Canada [Internet]. 2020 [cited 2021 Feb 15]. Available from: <https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci/guidance-prioritization-initial-doses-covid-19-vaccines.html>
12. Wingert A, Pillay J, Gates M, et al. Risk factors for severe outcomes of COVID-19: A rapid review. *medRxiv*. 2020
13. Fergusson K, Caplan A. Love thy neighbour? Allocating vaccines in a world of competing obligations. *J Med Ethics* [Internet]. 2020 Dec 11;medethics-2020-106887. Available from: <https://jme.bmj.com/lookup/doi/10.1136/medethics-2020-106887>
14. Communitarianism. *Stanford Encyclopedia of Philosophy* [Internet]. 2020 [cited 2021 Feb 15]. Available from: <https://plato.stanford.edu/entries/communitarianism/>
15. The History of Utilitarianism. *Stanford Encyclopedia of Philosophy* [Internet]. 2014 [cited 2021 Feb 15]. Available from: <https://plato.stanford.edu/entries/utilitarianism-history/>
16. Fergusson K, Caplan A. Love thy neighbour? Allocating vaccines in a world of competing obligations. *J Med Ethics* [Internet]. 2020.
17. Ritchie H, Ortiz-Ospina E, Beltekian D, et al. Coronavirus (COVID-19) Vaccinations. *Our World in Data* [Internet]. [cited 2021 Feb 15]. Available from: <https://ourworldindata.org/covid-vaccinations>
18. African Union. Statement to African Union Member States on the deployment of the AstraZeneca COVID-19 Vaccine to the continent and concerns about adverse event reports coming from Europe. *Africa Centres for Disease Control and Prevention* [Internet]. 2021. Available from: <https://africacc.org/news-item/statement-to-african-union-member-states-on-the-deployment-of-the-astrazeneca-covid-19-vaccine-to-the-continent-and-concerns-about-adverse-event-reports-coming-from-europe/>
19. Chinazzi M, Davis JT, Dean NE, et al. Estimating the effect of cooperative versus uncooperative strategies of COVID-19 vaccine allocation: a modeling study. *Network Science Institute* [Internet]. 2020. Available from: <https://www.networkscienceinstitute.org/publications/estimating-the-effect-of-cooperative-versus-uncooperative-strategies-of-covid-19-vaccine-allocation-a-modeling-study>
20. WHO Emergency Response Team. Weekly epidemiological update - 16 February 2021. World Health Organization [Internet]. 2021 [cited 2021 Feb 16]. Available from: <https://www.who.int/publications/m/item/weekly-epidemiological-update--16-february-2021>
21. European Centre for Disease Prevention and Control. Threat assessment brief: rapid increase of a SARS-CoV-2 variant with multiple spike protein mutations observed in the United Kingdom. *European Centre for Disease Prevention and Control* [Internet]. 2020 [cited 2021 Feb 16]. Available from: <https://www.ecdc.europa.eu/en/publications-data/threat-assessment-brief-rapid-increase-sars-cov-2-variant-united-kingdom#no-link>
22. Wibmer CK, Ayres F, Hermanus T, et al. SARS-CoV-2 501Y.V2 escapes neutralization by South African COVID-19 donor plasma. *bioRxiv* [Internet]. 2021 Jan 1;2021.01.18.427166. Available from: <http://biorxiv.org/content/early/2021/01/19/2021.01.18.427166.abstract>
23. Tegally H, Wilkinson E, Giovanetti M, et al. Emergence and rapid spread of a new severe acute respiratory syndrome-related coronavirus 2 (SARS-CoV-2) lineage with multiple spike mutations in South Africa. *medRxiv* [Internet]. 2020 Jan 1;2020.12.21.20248640. Available from: <http://medrxiv.org/content/early/2020/12/22/2020.12.21.20248640.abstract>
24. Moderna Inc. Moderna announces it has shipped variant-specific vaccine candidate, mRNA-1273.351, to NIH for Clinical Study [Internet]. 2021. Available from: <https://investors.modernatx.com/news-releases/news-release-details/moderna-announces-it-has-shipped-variant-specific-vaccine>
25. Pfizer Inc. Pfizer and biotech initiate a study as part of broad development plan to evaluate COVID-19 booster and new vaccine variants [Internet]. 2021. Available from: <https://www.pfizer.com/news/press-release/press-release-detail/pfizer-and-biotech-initiate-study-part-broad-development>
26. International Monetary Fund. World economic outlook, October 2020: A long and difficult ascent. *World Economic Outlook Reports* [Internet]. 2020 [cited 2021 Feb 17]. Available from: <https://www.imf.org/en/Publications/WEO/Issues/2020/09/30/world-economic-outlook-october-2020>

27. Kretchmer H. Vaccine nationalism – and how it could affect us all. World Economic Forum [Internet]. 2021 [cited 2021 Feb 18]. Available from: <https://www.weforum.org/agenda/2021/01/what-is-vaccine-nationalism-coronavirus-its-affects-covid-19-pandemic/>
28. Çakmaklı C, Demiralp S, Kalemlı-Özcan Şebnem, et al. The economic case for global vaccinations: an epidemiological model with international production networks. International Chamber of Commerce [Internet]. 2021. Available from: <https://iccwbo.org/publication/the-economic-case-for-global-vaccinations/>
29. World Health Organization. Urgent priorities & financing requirements at 10 November 2020. World Health Organization [Internet]. 2020 [cited 2021 Feb 19]. Available from: <https://www.who.int/publications/m/item/urgent-priorities-financing-requirements-at-10-november-2020>
30. Trudeau J, Zewde S-W, Moon J, et al. The international community must guarantee equal global access to a covid-19 vaccine. The Washington Post [Internet]. 2020 [cited 2021 Feb 21]. Available from: <https://www.washingtonpost.com/>
31. Win TL. Canada the biggest hoarder of COVID-19 vaccine pre-orders in first world, NGOs say. National Post [Internet]. 2020 [cited 2021 Feb 19]. Available from: <https://nationalpost.com/news/world/canada-the-biggest-hoarder-of-covid-19-vaccine-pre-orders-in-first-world-ngos-say>
32. Dewan A. A fight between the EU and UK reveals the ugly truth about vaccine nationalism. CNN [Internet]. 2021 [cited 2021 Feb 19]. Available from: <https://www.cnn.com/2021/01/30/europe/uk-eu-astrazeneca-vaccine-nationalism-gbr-intl/index.html>
33. AstraZeneca. Serum Institute of India obtains emergency use authorisation in India for AstraZeneca's COVID-19 vaccine [Internet]. 2021 [cited 2021 Feb 19]. Available from: <https://www.astrazeneca.com/media-centre/press-releases/2021/serum-institute-of-india-obtains-emergency-use-authorisation-in-india-for-astrazenecas-covid-19-vaccine.html>