

A Cautionary Tale: Canada's COVID-19 Vaccine Rollout for Older Canadians



National Institute on Ageing

Suggested Citation:

National Institute on Ageing (2021). A Cautionary Tale: Canada's Vaccine Rollout Among Older Adults. Toronto, ON: National Institute on Ageing, Ryerson University.

Mailing Address:

National Institute on Ageing
Ted Rogers School of Management
350 Victoria St.
Toronto, Ontario
M5B 2K3
Canada

About the National Institute on Ageing

The National Institute on Ageing (NIA) is a public policy and research centre based at Ryerson University in Toronto. The NIA is dedicated to enhancing successful ageing across the life course. It is unique in its mandate to consider ageing issues from a broad range of perspectives, including those of financial, physical, psychological, and social well-being.

The NIA is focused on leading cross-disciplinary, evidence-based, and actionable research to provide a blueprint for better public policy and practices needed to address the multiple challenges and opportunities presented by Canada's ageing population. The NIA is committed to providing national leadership and public education to productively and collaboratively work with all levels of government, private and public sector partners, academic institutions, ageing-related organizations, and Canadians.

The NIA further serves as the academic home for the National Seniors Strategy (NSS), an evolving evidence-based policy document co-authored by a group of leading researchers, policy experts and stakeholder organizations from across Canada and first published in 2014.

The NSS outlines four pillars that guide the NIA's work to advance knowledge and inform policies through evidence-based research around ageing in Canada: Independent, Productive and Engaged Citizens; Healthy and Active Lives; Care Closer to Home; and Support for Caregivers.

Authors

Cameron Feil, MSc

Research Coordinator, National Institute on Ageing, Ryerson University

Natalie Iciaszczyk, MA, JD

Policy Analyst, National Institute on Ageing, Ryerson University

Emily Boucher, BHSc (Hon)

Junior Research Fellow, National Institute on Ageing, Ryerson University

Samir K. Sinha, MD, DPhil, FRCPC, AGSF

Director of Health Policy Research, National Institute on Ageing, Ryerson University; Director of Geriatrics, Sinai Health System and University Health Network; Professor of Medicine, Family & Community Medicine, Health Policy, Management and Evaluation, University of Toronto

Table of Contents

Executive Summary	06
Introduction	08
Part 1: An Overview of Canada's National Vaccine Rollout	11
Vaccine Approval, Priority Populations, and Eligibility	11
Canada's Vaccine Rollout Among its LTC Home Populations and Community-Dwelling Older Adults (December 2020 to June 2021)	15
Issues Affecting Canada's Vaccine Rollout for Older Canadians	26
Part 2: How does Canada's COVID-19 Vaccine Rollout for its Older Populations Compare to that of 5 Other Early International Vaccination Leaders?	35
Part 3: Lessons Learned	57
Part 4: Policy Recommendations	62
Conclusion	67
References	68

Executive Summary

By the end of July 2021, Canada had become a global leader in COVID-19 vaccination coverage, with more than 70% of its population at least partially vaccinated against the virus. Despite a slow start, due in part to vaccine shortages and delays, Canada has now fully vaccinated over 60% of its total population, surpassing other leading international countries such as the United States and United Kingdom. This success includes significant advancements for Canada's most vulnerable populations.

Canada has successfully vaccinated more than 90% of Canadians aged 60 years and older with at least one dose of a COVID-19 vaccine.

Vaccinating Canadians aged 60 years and older is particularly important in reducing the impacts of COVID-19 infections. During all three waves of the pandemic, this group has been disproportionately impacted by the virus, accounting for approximately 64% of all COVID-19-related hospitalizations and 94% of Canada's 26,601 deaths as of July 31, 2021.¹ While Canada's current COVID-19 vaccination achievements are substantial, it must be noted that since the beginning of its vaccination rollout, many important opportunities to vaccinate as many older Canadians as possible were missed. This only prolonged the highly preventable and serious health risks and impacts that additional cases of COVID-19 have had on older Canadians. This should make Canada's vaccine rollout a cautionary tale for other nations considering their approaches to vaccinating their populations.

On December 14, 2020, Canada officially launched its national COVID-19 vaccination rollout. Residents, staff and family caregivers in long-term care (LTC) homes, retirement homes and other congregate settings for older persons, were prioritized to receive the initial vaccine doses, as were high-risk healthcare workers and adults in Indigenous communities. As the vaccine rollout for these groups neared completion in January and February 2021, provinces and territories began to expand eligibility to other high priority populations — including adults aged 70 years and older in community settings, health care workers, home care recipients, adults with chronic conditions, and essential workers.

This report captures Canada's vaccination rollout in LTC settings and for its community-dwelling older adults, from December 2020 to July 2021. Analyzing Canada's vaccine rollout at the federal, provincial, and territorial levels, identified several inhibiting and enabling factors, which affected the vaccine rollout for older adults. These include: (1) vaccine supply issues, (2) adherence to the recommended guidance for priority populations, and (3) second dose interval timing. Canada's provinces and territories that had more consistent vaccine supply at the beginning of the rollout, adhered to the national guidance for priority populations and prioritized providing second doses for their older populations. In the Yukon, Nunavut, the Northwest Territories, Alberta, and Saskatchewan a greater proportion of older adults were vaccinated with first and second doses more quickly, compared with other provinces. This was exemplified in a case study comparing second dose timing between

Alberta and Ontario, which found that older Albertans had a significantly lower risk of death due to COVID-19 because they received their first and second doses of a COVID-19 vaccine earlier than older Ontarians.

In addition, this report compares Canada's vaccine rollout for older Canadians to that of five other early international vaccination leaders: the United Kingdom, Israel, the United States, Denmark, and Chile.

Three key enabling factors of effective vaccine rollouts were identified through this NIA international comparative analysis: speed, centralized governance, and simple prioritization strategies. Countries that accomplished all three factors, notably the United Kingdom and Israel, were able to vaccinate their older populations more effectively and significantly reduce the burden of hospitalization and death in their respective countries.

In analyzing how Canada's COVID-19 vaccine rollout compared to leading international jurisdictions, the NIA identified five lessons learned on the characteristics that enabled efficient and effective older adult vaccine rollouts:

1. Vaccine supply security leads to improved stability of vaccine rollout plans, which enables better decision making and direction from national to local governments
 2. The most effective rollout strategies rely on scientific evidence and avoid politicization
 3. Greater efforts to address both socio-economic and cultural barriers along with the physical and cognitive limitations of older adults are needed to facilitate access to vaccine appointments
 4. Faster, efficient vaccine rollouts save lives
 5. Vaccines are highly effective at preventing hospitalization and death among older adults
- Based on the above lessons learned, the NIA has identified five specific actionable policy recommendations to improve future vaccine rollouts and better protect older adults or other particularly vulnerable populations. These recommendations can be adopted by other comparable high-income countries that have yet to, or only recently begun, their COVID-19 vaccination programs, as well as across Canadian jurisdictions if booster COVID-19 vaccinations are needed in the future. The NIA's policy recommendations are:
1. Invest in the creation of greater domestic vaccine production capacity
 2. Vaccine rollout strategies should be kept simple, evidence-based, and focused on targeting the highest-risk populations whenever possible
 3. Strengthen Canada's digital health infrastructure capacity to more efficiently facilitate vaccination appointments
 4. Expand access to vaccines through pharmacies, community clinics, and targeted homebound vaccination programs
 5. Develop a national health emergency preparedness plan and train healthcare workers to deliver effective emergency preparedness and response measures

The speed at which older adults have been vaccinated has made a significant difference in reducing hospitalizations and deaths among this group that remains the most vulnerable to COVID-19.

Adopting the NIA's recommendations will enable jurisdictions to vaccinate their older populations more quickly and effectively, and ultimately prevent any more unnecessary deaths.

Introduction

As of July 31, 2021, Canada had become a global leader in COVID-19 vaccination coverage, with 71% of its population vaccinated with at least one COVID-19 vaccine.² Over the course of its vaccine rollout, Canada has made significant efforts to vaccinate its most vulnerable populations, including older Canadians. Among adults aged 60 years and older, more than 90% are partially and 82% are now fully vaccinated against COVID-19. However, the decisions and policies of many of Canada's provincial governments, throughout their vaccine rollouts, failed to adequately protect their older populations. This only prolonged the highly preventable and serious health risks and impacts that additional cases of COVID-19 have had on older Canadians. This should make Canada's vaccine rollout a cautionary tale for other nations considering their approaches to vaccinating their populations.³

The first reported Canadian case of COVID-19, caused by the novel SARs-COV-2 virus, was detected in Canada on January 25, 2020.⁴ Canada's federal and provincial/territorial governments responded by implementing various public health measures such as stay-at-home orders and travel restrictions. Despite their efforts, cases of COVID-19 continued to rise and fall over the coming 18 months. Canada's COVID-19 pandemic experience to date can be categorized into three significant waves of infection: Wave 1 (March 2020 to August 31, 2020), Wave 2 (September, 2020 to February 2021), and Wave 3 (March 2021 to present).

Canadians aged 60 years and older have been disproportionately impacted by COVID-19 throughout all three pandemic waves, accounting for approximately 64% of all COVID-19-related hospitalizations, and 94% of Canada's 26,601 deaths as of July 31, 2021.⁵

The deaths and hospitalization due to COVID-19 among older Canadians have been highly concentrated among residents of Canada's long-term (LTC) and retirement homes, with 15,178 deaths in these settings as of July 5, 2021. However, a recent June 2021 report suggests that at least two thirds of Canada's COVID-19 deaths outside LTC homes may have been missed, meaning that the actual number of COVID-19 related deaths amongst community-dwelling older Canadians was likely even higher.⁶

Clinical research shows that older adults remain at a significantly higher risk of experiencing hospitalization and death due to COVID-19 compared to younger adults. One study, comparing 46 clinical conditions as potential predictors of death from COVID-19, concluded that age alone was the greatest predictor of death after being infected with the SARs-COV-2 virus.⁷ The United States Center for Disease Control and Prevention reports that when comparing the risk of hospitalization and death for older adults

to adults aged 18 to 29 years old, the health consequences for older adults are much more serious. It found that adults aged 65 to 75 years old are six times more likely to be hospitalized and 95 times more likely to die from COVID-19, while the risks for adults aged 75 to 84 years old are nine and 230 times higher, respectively. For adults aged 85 years and older, they are 15 times more likely to face hospitalization and 600 times more likely to die due to COVID-19.⁸

A global race to create vaccines against the SARs-COV-2 virus began early in the pandemic. On December 14, 2020, Canada officially launched its national COVID-19 vaccination rollout.⁹ Residents, staff and family caregivers in LTC homes, retirement homes and other congregate settings for older persons were prioritized to receive initial vaccine doses, as well as high-risk healthcare workers and adults in Indigenous communities. As the vaccine rollout for these groups neared completion, in January and February 2021, provinces and territories began to expand eligibility to other high priority populations — including adults aged 70 years and older in community settings, health care workers, home care recipients, adults with chronic conditions, and essential workers.

This report describes and analyzes Canada's vaccine rollout experience among older Canadians aged 60 years and older. It highlights the early challenges to Canada's vaccine rollout, including inconsistent vaccine supply, variability in provinces and territories, adoption of the recommended guidelines for priority populations and second dose interval for older adults. In particular, the three territories along with Alberta and Saskatchewan, had the most effective older

adult vaccine rollouts within Canada. Canada's vaccine rollout experience is further compared to that of five international jurisdictions: the United Kingdom, Israel, the United States, Denmark, and Chile. Our comparative analysis identified three key characteristics that appear to particularly enable efficient and equitable vaccine rollout policies and strategies: precision, speed, and centralized planning. Specifically, the United Kingdom and Israel leveraged all three enabling characteristics and achieved the fastest and most effective older adult vaccine rollout possible.

This report concludes with lessons learned and policy recommendations to improve the efficiency of future vaccination rollouts at the national and provincial/territorial levels, which also need to prioritize older adults and other vulnerable populations. Our analysis identified several missed opportunities to vaccinate older Canadians more efficiently during Canada's COVID-19 vaccine rollout. These findings have further served to illustrate the continued neglect and deprioritization of older adults that has characterized other aspects of Canada's COVID-19 pandemic response. They also demonstrate a failure to acknowledge that older Canadians continue to face the greatest risks from COVID-19, and that a better prioritization of their needs would have saved lives and resulted in far fewer deaths over the course of the pandemic.

Part 1: An Overview of Canada's National Vaccine Rollout

Vaccine Approval, Priority Populations, and Eligibility

At the onset of the global COVID-19 pandemic, governments, international organizations, and private actors began to research, develop, and produce COVID-19 treatments and vaccines. In March 2020, two vaccine developers — Moderna and Pfizer-BioNTech — established themselves as leading candidates in the development of a COVID-19 vaccine, using a novel 'messenger RNA' (mRNA) delivery mechanism.^{10,11} After promising phase 1 and 2 clinical trial results, both Pfizer-BioNTech and Moderna were approved to begin late-stage human trials in late July 2020 and became two of the first vaccines approved for use before the end of the year.¹²

Canada's National Advisory Committee on Immunization (NACI) released its first guidelines on prioritizing populations for COVID-19 vaccination beginning in November 2020. By early December, the guidelines were updated to clearly recommend that initial vaccine doses be prioritized for residents, staff and family caregivers in LTC homes, retirement homes and other congregate settings for older persons. This decision was made in light of the fact that 74% of Canada's COVID-19-related deaths occurred in LTC settings from March 1, 2020 to August 31, 2020 and

61% from September 1, 2020 to February 15, 2021.¹³ Adults over 70 years of age, starting with those over 80 years of age, were also prioritized along with front-line health-care workers, and adults living in Indigenous communities (see Figure 1).¹⁴

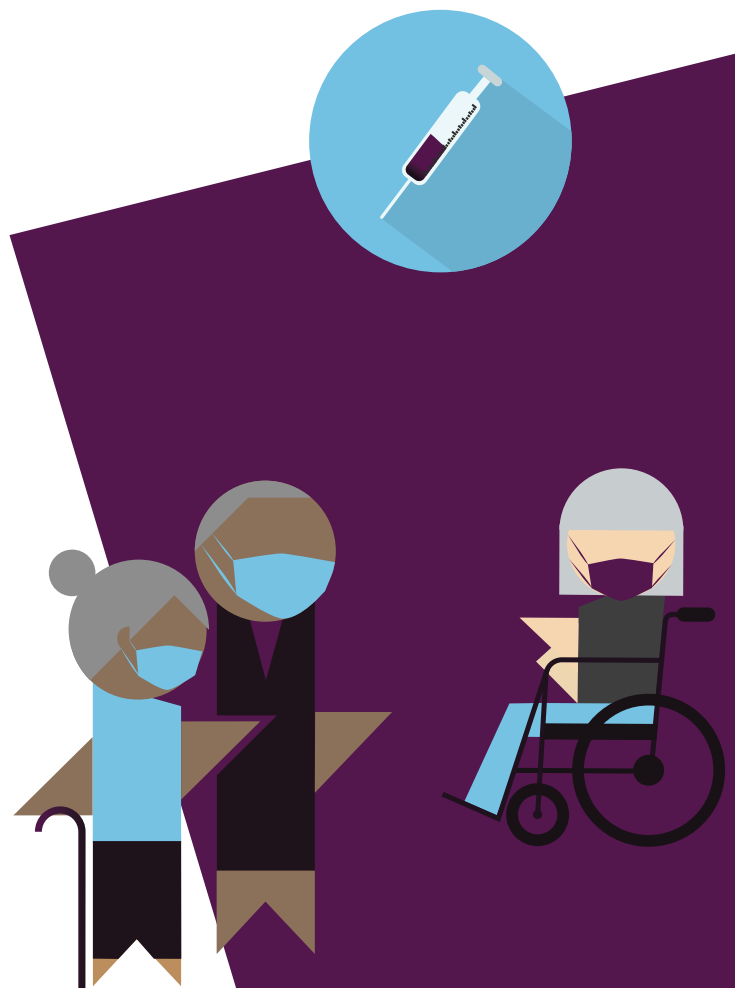
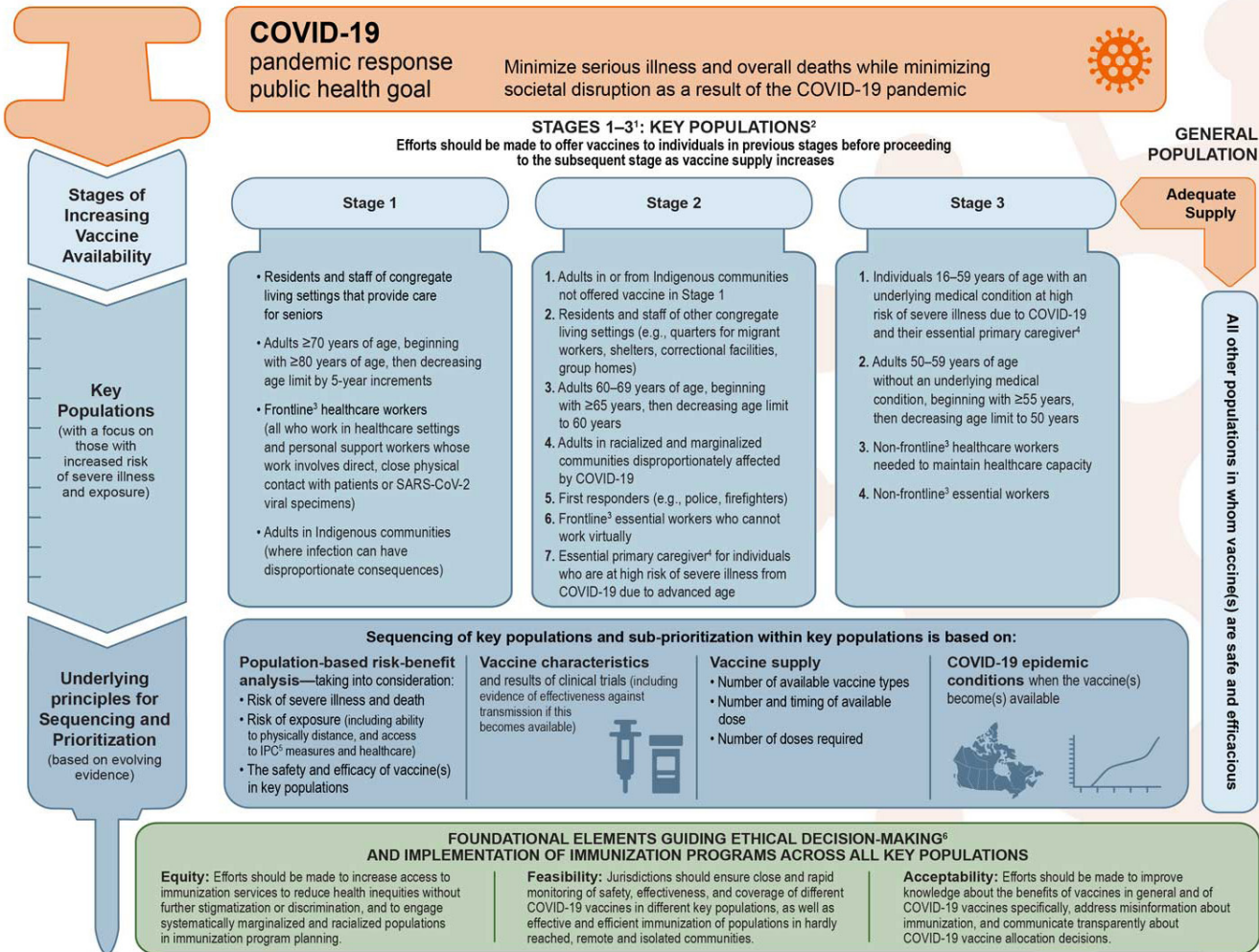


Figure 1: Summary of the Preliminary NACI Recommendations on Key Populations for Early COVID-19 Immunization



1 Key populations in Stages 2 and 3, recommended since the previous NACI guidance on Stage 1, are listed in order of priority. Examples listed within key populations are suggestions that are not listed in order of priority.
2 Key populations are not mutually exclusive and may overlap. Sequencing and sub-prioritization may differ between jurisdictions based on differences in local epidemiology and logistical contexts.
3 Having direct close physical contact with the public.

4 The adult primarily responsible for taking care of a family member or loved one who cannot care for themselves.
5 IPC = infection prevention and control measures.
6 Based on the systematic assessment of ethics, equity, feasibility and acceptability using an evidence-informed framework, available at: <https://doi.org/10.1016/j.vaccine.2020.05.051>

Estimates show that Canada has invested more than \$9 billion to secure over 400 million doses of COVID-19 vaccines with seven vaccine manufacturers (**See Table 1**).¹⁵ Securing contracts for vaccines was an early priority for the federal government as Canada lacked (and

continues to lack) the capacity to produce any of the early COVID-19 vaccine candidates domestically, which made the country reliant on receiving their vaccines from international sources.¹⁶

Table 1: Summary of Vaccines Approved by Health Canada

Vaccine	Approval Date	Type	Doses Required	Approved Maximal Dose Interval	Manufacturer Recommended Dose Interval	Recommended for Adults 60+?
Pfizer-BioNTech	Dec 9, 2021	mRNA	2	16 weeks	3 weeks	Y
Moderna	Dec 23, 2021	mRNA	2	16 weeks	4 weeks	Y
AstraZeneca	Feb 26, 2021	Viral Vector	2	16 weeks	4 weeks	Y
Johnson & Johnson	March 5, 2021	Viral Vector	1	N/A	N/A	Y
Novavax	N/A	Viral Vector	2	N/A	N/A	N/A
Medicago	N/A	Viral Vector	2	N/A	N/A	N/A
Sanofi	N/A	Viral Vector	2	N/A	N/A	N/A

On December 14, 2020, Canada's vaccine rollout officially began. Pfizer-BioNTech and Moderna vaccines, the only two approved by Health Canada at the time, were allocated to provinces and territories on a per-capita basis. Under the *Canada Health Act*, provinces and territories are responsible for administering vaccines. This includes interpreting NACI guidelines, developing their own vaccination rollout strategies, prioritizing how they will vaccinate their own populations, related logistical planning and expected timelines to achieve their aims.

Subsequently, Health Canada approved two additional vaccines; AstraZeneca (February 26, 2021) and Johnson & Johnson (March 5).¹⁷ However, the use of both vaccines has been limited due to subsequent production issues and safety concerns with respect to both. **Box 1** outlines the specific challenges that each vaccine has faced in Canada.

Box 1: Timeline of Changes in NACI and Health Canada Recommendations for the use of AstraZeneca and Johnson & Johnson Vaccines

AstraZeneca	Johnson & Johnson
<p>February 26, 2021: Health Canada approved the AstraZeneca vaccine for use on February 26, 2021. NACI recommended the vaccine to be used on individuals aged 65 years and younger due to the “superior efficacy” of the and Moderna mRNA vaccines on older adults.</p>	<p>March 5, 2021: Health Canada approved the Johnson & Johnson vaccine for use on adults aged 18 years and older</p>
<p>March, 2021: Reports of rare blood clotting related to the use of the AstraZeneca vaccine began to be reported around the world.¹⁸</p>	<p>April 30, 2021: The first scheduled shipment of Johnson & Johnson vaccines arrived in Canada. However, these vaccines had yet to be approved for use by Health Canada due to quality control concerns within the US plant where they originated.²²</p>
<p>March 15, 2021: NACI extended the recommended age group for the use of the AstraZeneca vaccine to those aged 65 years and older. This was based on the limited supply of vaccines and rising COVID-19 infections in Canada at the time.¹⁹</p>	<p>May 3, 2021: NACI released its guidance for the use of the Johnson & Johnson vaccine, recommending it for use for people aged 30 and older. In the statement, NACI claimed that mRNA vaccines were “preferred”.²³</p>
<p>March 29, 2021: NACI recommended suspending the use of the AstraZeneca vaccine for adults aged 55 and younger due to safety concerns. The majority of provinces adopted this guidance immediately after.²⁰</p>	<p>June 28, 2021: Johnson & Johnson released a statement saying there are no plans to ship its vaccine to Canada at this time despite Canada having ordered 10 million doses to have arrived by the end of June.²⁴</p>
<p>April 18, 20, 2021: Many provinces lowered the age eligibility for the AstraZeneca vaccine to adults aged 40 to 55.</p>	
<p>April 23, 2021: NACI expanded its recommended eligibility for the AstraZeneca vaccine to anyone aged 30 years and older. NACI recommends that the AstraZeneca vaccine may be offered to Canadians 30+ if (1) the benefits outweigh risks of waiting for an mRNA vaccine, (2) decision is informed by risks and consequences of VITT, (3) delay to receive an mRNA vaccine is substantial.²¹</p>	

Canada's Vaccine Rollout Among its LTC Home Populations and Community-Dwelling Older Adults (December 2020 to June 2021)

Canada's Vaccine Rollout for its LTC Home Populations

As reported in the NIA's regular series entitled *The Rollout of COVID-19 Vaccines in Canada's Long-Term Care Homes* — published weekly from February to April 2021 by the International Long-Term Care Policy Network based at the London School of Economics — all of Canada's 10 provinces and three territories followed NACI's early recommendation of prioritizing their initial vaccine doses for residents and staff of LTC homes. Five jurisdictions also prioritized the vaccination of essential/family caregivers in these settings as well.²⁵

Some provinces, however, made decisions that significantly slowed their LTC home vaccination rollouts. As a result, while the slow start of Canada's vaccine rollout was principally due to early supply issues, significant variation in the speed and level of LTC home vaccine coverage quickly emerged between the provinces and territories due to the way they executed their early vaccine rollouts.

For example, Quebec announced that it had completed offering first doses to all of its LTC residents on January 8, 2021, while Ontario did not achieve this same goal until February 14, 2021. The slower LTC vaccine rollouts in the Atlantic provinces — with the exception of PEI — also highlighted this issue across Canada. For example, New Brunswick and Nova Scotia did not complete offering first doses to 100% of their LTC residents until March 2021.

Table 1 presents figures on LTC vaccinations across Canada's provinces and territories as of April 24, 2021. It also includes national coverage for LTC and other group living settings for older adults in Canada, as reported by the Public Health Agency of Canada as of April 10, 2021. These remain the most recently available public figures at the national level. By April 10, 2021, the Public Health Agency of Canada reported that 96% of LTC home residents across Canada had received at least one dose of a COVID-19 vaccine (**See Table 2**).²⁶ Clearly, the speed at which vaccinations in Canadian LTC homes (for both residents and staff) were completed was unequal across Canadian jurisdictions for several reasons, including varying interpretation of NACI guidance, the use of available vaccines to prioritize the vaccination of other populations, early and ongoing inconsistent vaccine supply issues, and vaccine access and hesitancy issues particularly among LTC staff.

Table 2: LTC Resident Vaccination Coverage Across Canadian Jurisdictions as of April 24, 2021*

Prov / Territ	Date Completed for 1st Dose Vaccination in LTC Settings	% of LTC Home Residents Offered and Accepted at Least 1st Dose of the COVID-19 Vaccine	% of LTC Home Staff Given at Least their 1st Dose of the COVID-19 Vaccine	Target Date for Completed 1st Dose Vaccination in non-LTC Settings
Alta.	2021-01-18	Unknown	Unknown	Unknown**
BC	2021-02-01	95%	95%	Unknown
Ont.	2021-02-14	95%	85%	April 2021
Que	2021-01-08	92%	56.7-62.8%†	Unknown
Sask	2021-01-21	92%	79%	Unknown
Man	2021-01-30	Unknown	Unknown	2021-03-31
NFLD	2021-02-26	Unknown	Unknown	Unknown
NB	March 2021	<90%***	59%	Unknown
NS	March 2021	91%****	85%	Unknown
PEI	2021-01-22	Unknown	100%	Unknown
YT	2021-01-20	Unknown	100%	Unknown
NWT	2021-02-03	Unknown	Unknown	Unknown
Nun	Unknown	Unknown	Unknown	March 2021
Canada		96.68%†	N/A	N/A

Notes:

*This table was updated with data on vaccinations in LTC settings up to and including April 24, 2021, after which point updated information was no longer readily available as the focus for vaccinations shifted from LTC settings to community-dwelling individuals.

** While Alberta completed first dose vaccinations by January 18, 2021, these were only in publicly funded long-term care and designated supportive-living facilities, and did not initially include lodges and other congregate seniors facilities.

<https://www.cbc.ca/news/canada/edmonton/kenney-shandro-alberta-vaccine-update-1.5920305>

<https://edmonton.ctvnews.ca/why-some-seniors-in-long-term-care-haven-t-been-vaccinated-despite-milestone-announcement-1.5272246>

***New Brunswick has completed vaccinating all residents of LTC as of April 9, 2021. However, the total number of residents in LTC across the province is unknown and no specific figure has been provided on the number of residents accepting their first dose. A recent CBC news article cited that “over 90 percent” of LTC residents have been vaccinated.

<https://www.cp24.com/news/who-have-provinces-pegged-to-receive-covid-19-vaccines-in-the-coming-weeks-1.5380609>

<https://www.cbc.ca/news/canada/new-brunswick/covid-roundup-thursday-livestream-1.5997607>

****Nova Scotia has vaccinated 6390 LTC residents as of April 6, 2021. The denominator of 7000 total LTC residents is used from a Provincial Report released in June 2020.

nsnu.ca/sites/default/files/LTC%20Staffing%20Report.pdf

<https://experience.arcgis.com/experience/204d6ed723244dfbb763ca3f913c5cad>

† This figure is accurate as of April 10, 2021 via the federal government's vaccination coverage tracker. As of April 17, 2021, the federal government was no longer reporting on vaccination coverage among adults in group living settings for seniors, which was the source the NIA used to estimate the proportion of residents in LTC who had received at least one dose of a COVID-19 vaccine. Moreover, this figure is likely an underestimate given that, as the federal government itself stated, “definitions for this population vary across the provinces and territories and it is difficult to accurately estimate the number of people belonging to this group”.

<https://health-infobase.canada.ca/covid-19/vaccination-coverage/#a3>

‡ These figures are accurate as of April 20, 2021. A range is reported because the share of staff vaccinated with at least one dose varies for private (56.7%) and public (62.8%) CHSLDs in Quebec.

https://twitter.com/Francine_D/status/1385332953832624128/photo/1

An important factor in Canada's LTC vaccine rollouts was the early and ongoing inconsistent supply of vaccines. This caused provinces and territories to make a variety of challenging decisions about how to best allocate their COVID-19 vaccine doses to their designated priority populations. Notably, the federal government prioritized exclusively administering the Moderna vaccine in Canada's northern territories due to its superior ease of portability compared to the Pfizer-BioNTech vaccine.^{27,28,29} With an earlier and more consistent supply of vaccine doses, Canada's northern territories achieved relatively high vaccination rates quickly, within their LTC and overall populations compared to Canada's provinces. Initial concerns about the ability to transport the Pfizer-BioNTech vaccine into LTC settings caused some provinces to prioritize other high-risk groups over LTC residents. For example, Ontario made hospitals the preferred initial settings to provide first doses to high-risk groups, including LTC staff and essential/family caregivers.³⁰ As a result, LTC residents in Ontario, who were unable to leave their homes, were left to wait until Moderna vaccines became available. While Moderna could be easily transported to LTC homes weeks later, there was a much lower forthcoming supply of this vaccine to the provinces, which resulted in delays for many older adults.

On December 18, 2020, Pfizer-BioNTech released updated guidelines permitting the vaccine to be stored at much lower temperature than the original guidance, which enabled easier transportation of the vaccine to PHAC and Canada's provinces.³¹ Quebec and British Columbia responded promptly to this guidance, immediately expanding access to Pfizer-BioNTech vaccines across their LTC

settings. However, provinces such as Ontario and Manitoba continued to initially hesitate on using their Pfizer-Biotech vaccine in LTC settings. Ontario, for example, only began using the Pfizer-Biotech vaccine in its LTC settings on January 5, 2021, while Quebec completed their first-dose vaccination of their LTC residents by January 8, 2021.³² These unnecessary delays were a key reason why provinces like Ontario saw significantly slower initial LTC resident vaccination rollouts through December and well into January 2021.³³

The uptake of COVID-19 vaccines among LTC residents has been consistently high. However, considerably lower uptake levels have been observed amongst LTC staff throughout Canada's vaccine rollout. For example, vaccine uptake among LTC staff ranged from 26.7-96.4% in at least one part of Ontario. Less than 74% overall uptake by staff had been reported by the end of April 2021 in some settings, especially across New Brunswick, Ontario and Quebec, when 96% of Canada's LTC residents had been vaccinated with at least one dose.^{34,35} Low vaccine uptake rates among LTC staff was attributed to a number of factors. These include staff often having to go off-site to get vaccinated (unlike their residents), failure to provide staff with paid leave or transportation to get vaccinated, as well as a lack of paid sick leave for staff who needed recovery time from side-effects associated with getting the vaccine.³⁶ Numerous reports also highlighted a greater level of vaccine hesitancy issues among staff in LTC settings stemming from concerns about the COVID-19 vaccine's safety and efficacy. Trust issues also emerged, relating to how poorly staff had been supported by their own jurisdictions or employers, in some cases, during the pandemic.^{37,38,39}

The discrepancy between resident and staff vaccination rates brings to light the finding that older adults, as a demographic group, have consistently exhibited the lowest levels of COVID-19 vaccine hesitancy. The NIA's report *If Older Canadians Want a COVID-19 Vaccine, Why Is Canada Struggling to Get Them Vaccinated?* demonstrated that older adults were more willing to get vaccinated both before and through the entirety of Canada's COVID-19 vaccine rollout.⁴⁰ For example, 86% of adults aged 65 years and older reported to be likely to get a COVID-19 vaccine compared to 73.9% of adults aged 64 years and younger in September 2020. The *Leger North American Tracker* surveyed Canadians throughout Canada's vaccine rollout. It found adults aged 55 years and older were consistently more willing than their younger counterparts to get a COVID-19 vaccine from February 2021 onward. The most recent results from May 16, 2021, found 86% of Canadians aged 55 and older report that they intend to get vaccinated, compared to 68% of Canadians aged 35-54 and 74% of those aged 18-34 years old.⁴¹ Thus, not only are older adults at the greatest risk of severe illness and death related to COVID-19, but vaccinating them as quickly as possible also became understood as the most efficient pathway to achieving the highest possible proportion of the population being vaccinated. As a result, prioritizing older adults would also have the greatest impact on COVID-19-related hospitalization and deaths.

Evidence from Canada's LTC vaccination rollouts quickly showed that vaccinating residents had a major impact on their health and well-being. It proved to be the most effective way to prevent hospitalizations and deaths from COVID-19 within this population. Two separate analyses published by the Institut National de Santé du Québec (ISNPQ) and British Columbia Center for Disease Control found that LTC home residents

and staff that have at least one dose have 80% protection against infection.^{42,43} Both provinces were able to greatly reduce COVID-19 outbreaks in their LTC settings from January to February 2021. Deaths in LTC homes declined by 82% in Quebec and by 80% in British Columbia.⁴⁴ Additionally, Alberta and Ontario reported reductions in resident hospitalizations and deaths since the beginning of the LTC vaccination rollout. Alberta's premier stated in early March that outbreaks in LTC facilities had declined by more than 95% since the beginning of their LTC vaccination efforts.⁴⁵ Also, Ontario's COVID-19 Science Advisory Table found that weeks after beginning to vaccinate LTC residents and staff, COVID-19 infection rates decreased 89% among residents and 79% among staff. COVID-19-related deaths had decreased by 96% among LTC residents.⁴⁶

Canada's Vaccine Rollout for its Community-Dwelling Older Adult Populations

By late February 2021, after completing vaccinations in LTC and other congregate settings like retirement homes, all Canadian jurisdictions began administering vaccines to their community-dwelling older adults. This includes those receiving home care services.⁴⁷ The majority also adopted the recommended approach of first providing vaccines to their oldest populations, followed by incrementally decreasing age cohorts, along with high-risk frontline healthcare workers.

As with the vaccine rollout amongst LTC residents, considerable differences quickly emerged in how Canada's provinces and territories structured their vaccine rollouts for their older community-dwelling populations. This created additional early and significant vaccine uptake issues amongst older populations across the country, which unnecessarily prolonged their risk of experiencing COVID-19-related hospitalizations and deaths. A number of factors contributed to significantly varying first and second dose COVID-19 vaccine coverage levels across Canada's provinces and territories. These include issues related to the deployment of vaccine booking systems, differential approaches to supporting access to vaccines through primary care providers and pharmacies vs. mass vaccination clinics, variable efforts to address vaccine access issues for homebound older adults, and finally the adoption by the majority of Canada's provinces of a NACI recommendation in early March 2021⁴⁸ to implement second-dose interval delays by as much as 16 weeks.

What the slow and variable LTC vaccination rollout across parts of Canada clearly demonstrated was that older Canadians did not have a hesitancy problem. Rather, they were not adequately prioritized for access to these vaccines.⁴⁹ This is why the NIA recommended early into Canada's vaccine rollout that it should not only continue to routinely prioritize and target older adults for vaccination, but also take additional specific actions to further increase their access to vaccination. Solutions that the NIA highlighted early on included: creating culturally appropriate information campaigns; providing a variety of methods to book vaccination appointments, expanding vaccine administration via primary care providers, pharmacies, and community clinics; developing comprehensive mobile outreach strategies targeting homebound adults; and shortening the interval between first and second doses for older persons. Provinces and territories that subsequently made efforts to improve the effectiveness of their vaccination access rollouts for their older populations, ultimately saw better and more effective vaccination results among their general population as well.

While the speed, efficiency, and equity of Canada's vaccine rollout improved substantially over the spring and summer of 2021, specific high-risk populations of older adults still continue to face barriers to accessing a vaccine, despite remaining at highest risk of hospitalization and death due to COVID-19.

Table 3: Proportion of Canadians Aged 70+ with At least 1 Dose, January 30-July 31, 2021

Region	Jurisdiction	January	February	March	April	May	June	July
	Canada	3.11%	9.57%	47.66%	87.71%	91.75%	94.06%	95.21%
Atlantic	NFLD	1.37%	5.45%	26.79%	81.14%	84.97%	87.43%	97.21%
	PEI	8.43%	12.75%	32.27%	89.81%	94.14%	97.45%	98.95%
	NS	1.12%	2.32%	16.23%	84.54%	93.08%	97.45%	97.27%
	NB	N/A	5.29%	23.83%	83.62%	90.96%	93.69%	94.90%
Central	QUE	4.59%	14.71%	62.86%	93.25%	96.13%	97.95%	99.09%
	ONT	N/A	6.74%	42.20%	85.00%	89.43%	91.55%	92.70%
Prairies	MAN	6.24%	8.13%	30.28%	89.60%	94.81%	97.66%	99.90%
	SASK	8.23%	14.85%	57.73%	87.46%	90.87%	92.82%	93.84%
	ALTA	5.94%	14.70%	68.13%	84.54%	88.27%	90.50%	91.33%
West	BC	5.73%	6.40%	38.58%	87.87%	91.37%	94.25%	95.78%
Northern Territories	YK	73.35%	83.40%	90.19%	93.48%	95.53%	97.57%	99.58%
	NWT	84.52%	88.78%	92.95%	95.11%	96.50%	99.42%	100.00%
	NUN	42.50%	54.75%	85.34%	91.41%	93.01%	97.37%	98.51%

Data presented is for the following dates: January 30, 2021; February 27, 2021; March 27, 2021; May 1, 2021; May 29, 2021; June 26, 2021; July 24, 2021. Source: Public Health Agency of Canada, Canadian COVID-19 vaccination coverage report, July 30, 2021.

Table 3 displays the proportion of older adults aged 70 years and older, who received at least one dose of a two dose COVID-19 vaccine between January through July 2021. The table groups provinces into their respective regions — Northern Territories, Atlantic Canada, Central Canada, the Prairies, and Western Canada.

With the exception of Canada's three northern territories, no province was able to vaccinate more than 15% of adults aged 70 years and older until March 2021.

In March 2021, Quebec, Saskatchewan and Alberta were able to significantly increase the proportion of their adults aged 70 years and older with at least one dose. Specifically, both of these provinces faced heavy criticism for their management of COVID-19 outbreaks across their LTC homes but clearly made it a priority to quickly vaccinate older adults in their LTC homes and thereafter their community-dwelling older adults. Another factor to consider is that Alberta is one of the youngest provinces in Canada — which enabled them to vaccinate their older population more quickly with their similar per capita allocation compared to other provinces.⁵⁰ Contrary to Quebec, Saskatchewan and Alberta, the Atlantic provinces of Newfoundland, Nova Scotia, and New Brunswick, achieved significantly lower vaccination coverage rates for their older populations during this initial time period. This may have been attributed to the relatively low community rates of COVID-19 cases in these provinces over the entirety of the pandemic and their decision to prioritize vaccinating other populations first. It should be noted, however, that Alberta and Quebec, maintained an approach more in line with the NACI recommendations for prioritizing older populations for vaccination, and thus maintained an early strong and sustained leading level of vaccination rates amongst their older populations.

In April 2021, nearly all provinces made significant increases in the proportion of their older populations aged 70 years and older vaccinated with at least one dose. Specifically, no province had fewer than 83% of their adults aged 70 years and older vaccinated. Heading into May 2021, with the exception of Ontario and Alberta, all jurisdictions had vaccinated over 90% of their adults aged 70 years and older with at least one dose. This highlights the significant efforts made by Canada's provinces over the spring of 2021 to prioritize vaccinating

their older populations. While it is important to acknowledge the overall improvements made by provinces in getting their older populations vaccinated, the time it took some to do so also appeared to reflect their continued general lack of prioritization of this population across the entirety of their COVID-19 pandemic responses in these provinces.

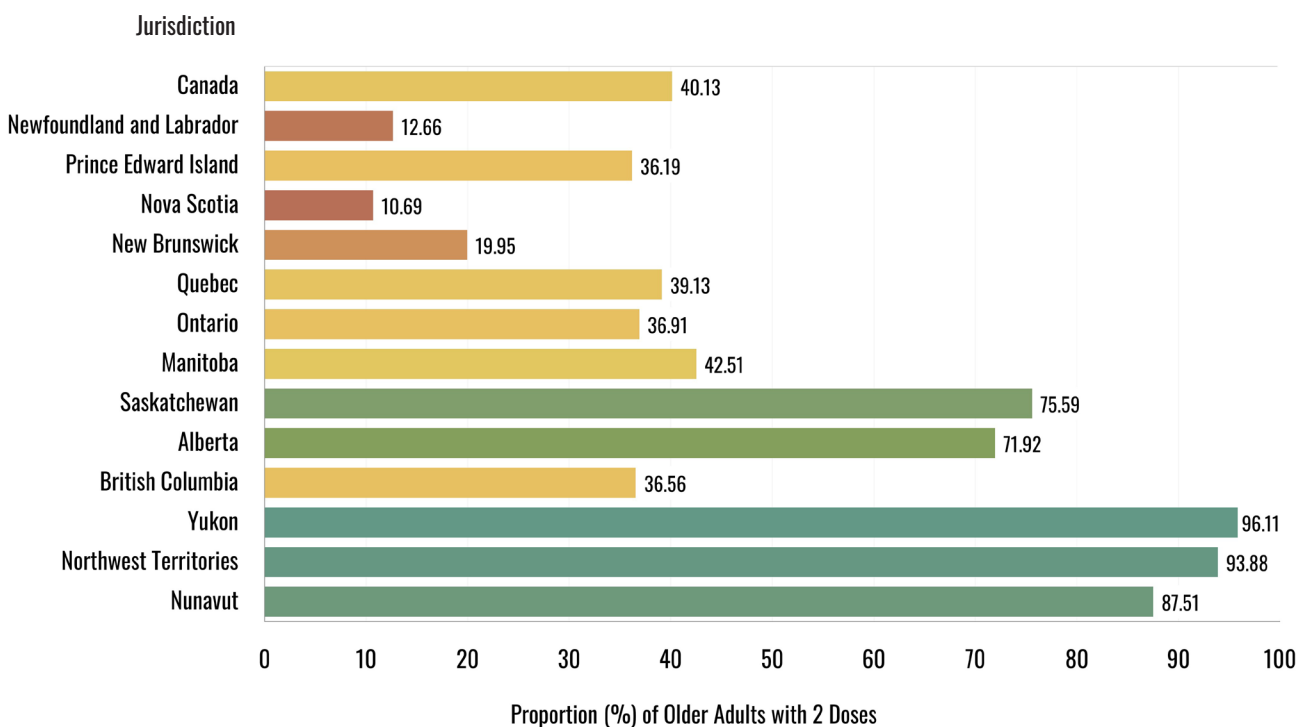
Canada's three territories have been notable exceptions, achieving disproportionately high rates of vaccination amongst their adults aged 70 years and older despite facing significant geographical challenges in vaccinating small but widely dispersed populations.

It is also important to consider that the early success of the territories, Alberta and Saskatchewan have translated into early and disproportionately high second dose vaccination rates for adults aged 70 years and older compared to the remaining provinces.

Figure 2 shows the proportion of older adults (aged 70 years and older) who had received both vaccine doses of a COVID-19 vaccine and completed their vaccination series as of June 12, 2021. By prioritizing second vaccine doses for older adults early in their vaccine rollouts, the three territories, Alberta, and Saskatchewan were able to fully vaccinate a significantly larger share of their populations aged 70 years and older. Vaccination coverage across these jurisdictions exceeded two-thirds

of the population aged 70 years and older, and ranged from roughly 72% in Alberta to more than 96% in the Yukon. On the other hand, none of the remaining provinces had yet to vaccinate even 50% of their populations aged 70 years and older. Overall, about 40% of Canadians aged 70 years and older had received both doses of a COVID-19 vaccine as of June 12, 2021.

Figure 2: Proportion of Canadians Aged 70+ with 2 Doses, June 12, 2021

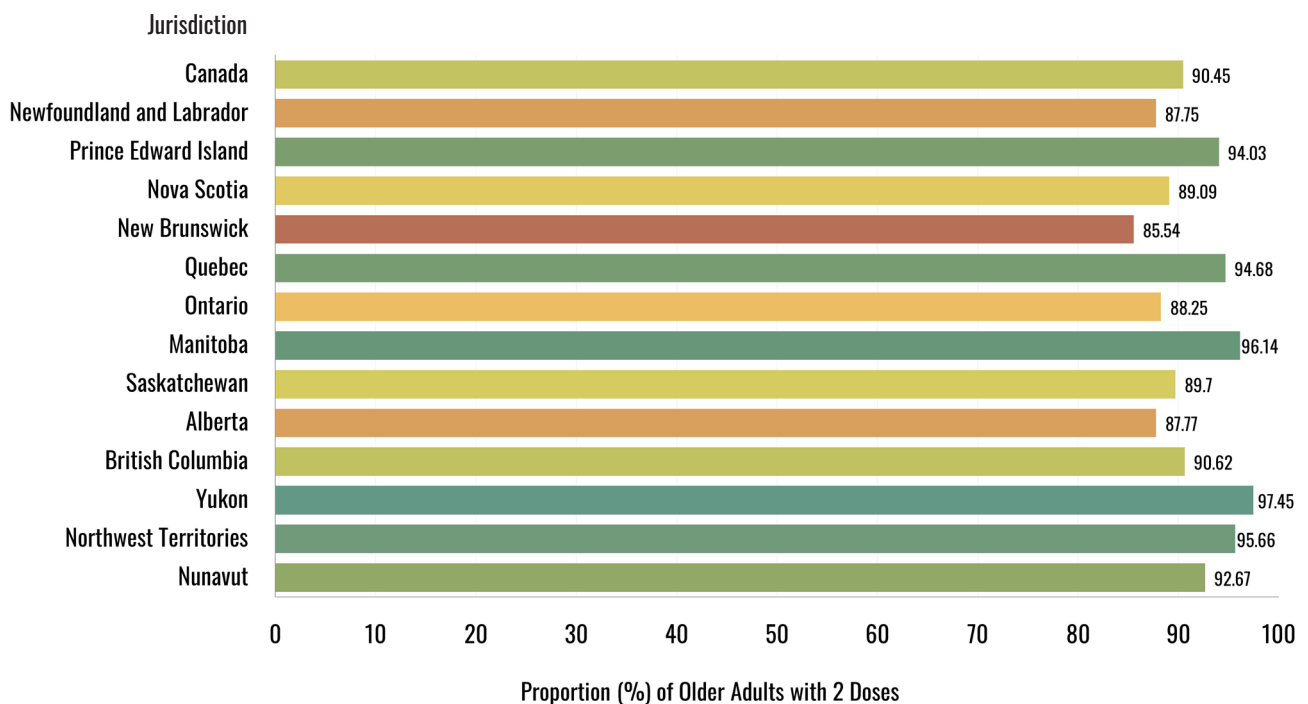


During the remaining weeks in June 2021, second dose vaccinations accelerated quickly across the remaining jurisdictions in Canada.

Figure 3 shows the proportion of older adults (aged 70 years and older) who had received both doses of a COVID-19 vaccine and completed their vaccination series by July 31, 2021. Most provinces were able to vaccinate large shares of their populations aged 70 years and older to catch up to Canada's three northern territories, Alberta and Saskatchewan. In fact, Prince Edward Island,

Quebec, Manitoba, and British Columbia were able to exceed the share of fully vaccinated older adults in Alberta and Saskatchewan by the end of July 2021, with between 91% and 96% of their respective populations aged 70 and older having received both doses, compared to 88% in Alberta and 90% in Saskatchewan. Across Canada, more than 90% of Canadians aged 70 years and older had received both doses of a COVID-19 vaccine by the end of July 2021.

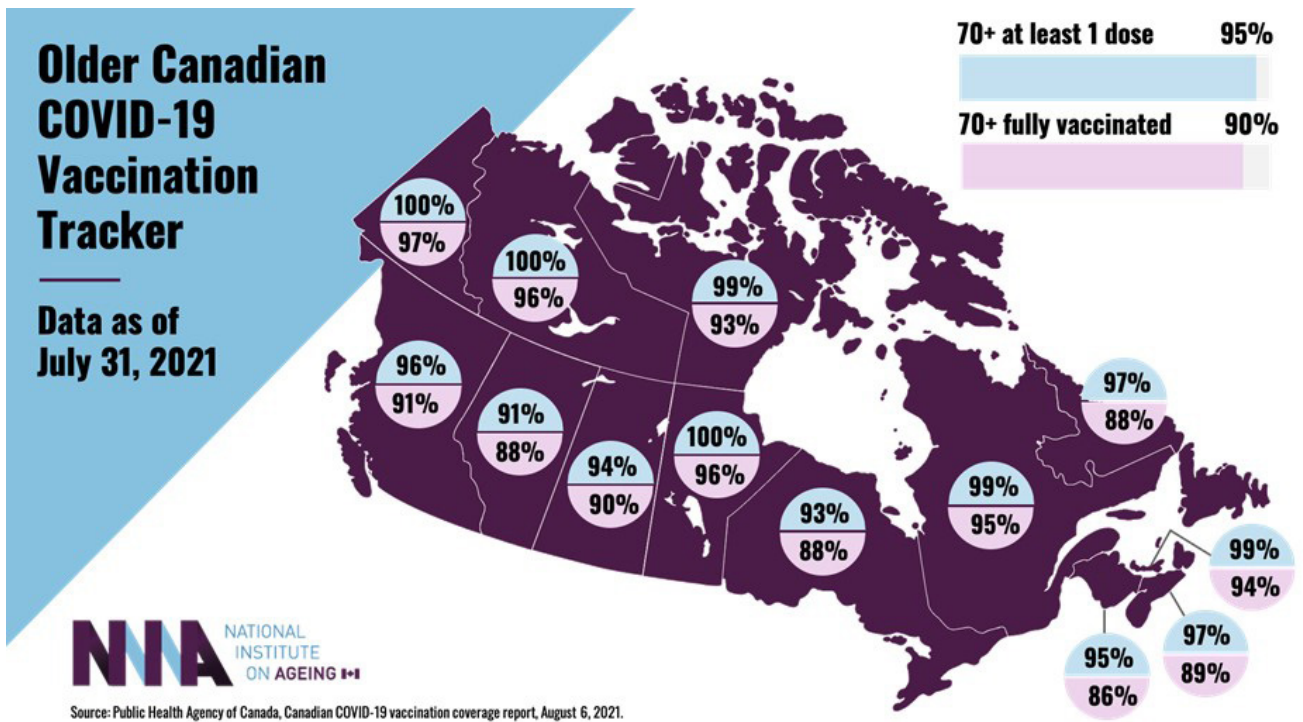
Figure 3: Proportion of Canadians Aged 70+ with 2 Doses, July 31, 2021



Overall, by the end of July 2021, most jurisdictions in Canada were able to comprehensively offer their populations aged 70 years and older at least one dose of a COVID-19 vaccine. As **Figure 4** demonstrates, every province and territory had vaccinated more than 90% of their populations aged 70 years and older with at least one dose by July

31, 2021. While second dose coverage also increased considerably, there remained more variation across Canada, with Newfoundland and Labrador, Nova Scotia, New Brunswick, Alberta and Ontario having achieved second dose coverage rates of between 86 and 89% vs a national average of 90%.

Figure 4: Proportion of Canadians Aged 70+ with At Least 1 Dose and Both Doses, July 31, 2021



Issues Affecting Canada's Vaccine Rollout for Older Canadians

Early Vaccine Supply Availability

The Canadian government moved quickly to secure contracts with as many vaccine suppliers as possible, prior to Health Canada issuing its approval for their use. This was due to concerns over Canada's inability to produce COVID-19 vaccines domestically and its expected dependence on international suppliers. This concern proved to be true, as the early Canadian vaccine rollout experience was plagued by uncertain and unforeseen delays in overseas vaccine production and shipment issues with all four approved vaccines.

Canada's early and inconsistent supply issues resulted in an initial lag behind some other OECD and G7 countries, both in terms of vaccine doses being delivered on a per capita basis and the total proportion of its population being vaccinated during the first five months of its vaccine rollout.⁵¹

In late January and early February 2021 Pfizer-BioNTech, Moderna, and AstraZeneca announced delays in their scheduled vaccine deliveries. Pfizer-BioNTech's delays were caused by unanticipated decisions to upgrade their European production facilities to increase their vaccine manufacturing capacity, decreasing the expected number of COVID-19 vaccine doses delivered to Canada by 50% over a four-week period.⁵² The European Union (EU) also imposed export restrictions on vaccines to Canada, additionally delaying shipments of the Moderna vaccine. Also, in early February 2021, the supplier at the time for the AstraZeneca vaccine announced they would be unable to ship vaccines to Canada until April 2021.⁵³ The federal government responded by securing a

contract for an additional 2 million doses of the AstraZeneca vaccine from the Serum Institute of India.⁵⁴

Canada's COVID-19 vaccine security and supply increased dramatically in March when the federal government secured new contracts with Pfizer-BioNTech, Johnson & Johnson, and the Government of the United States for additional vaccines.^{55,56} Pfizer-BioNTech agreed to deliver an additional 1 million vaccine doses per week, beginning March 22, 2021 moving up the delivery of 5 million vaccine doses from 'late' to 'early' summer.^{57,58} The Canadian federal government also announced a new contract with Johnson & Johnson, securing the delivery of 44 million vaccine doses by July 1, 2021. Also, the United States agreed to loan to Canada 1.5 million doses of the AstraZeneca vaccine.⁵⁹

However, on April 16, 2021, Moderna informed Canada that they would be unable to meet their original supply commitments due to production issues at their European facilities. In response, the federal government announced on the same day that it signed an agreement with Pfizer to receive an additional 8 million vaccine doses.⁶⁰ Also, on April 30, 2021, Canada received its first shipment of 310,000 Johnson & Johnson vaccine doses. However, they currently remain unapproved for use by Health Canada due to quality control issues stemming from the production facility where they were manufactured in the United States. Canada has given back the shipment to the supplier, deciding against its use, and is assessing provincial demand for the Johnson & Johnson vaccine before proceeding with further shipments.^{61,62,63}

Canada's inability to produce vaccines domestically significantly hindered the COVID-19 vaccination rollout.

The lack of domestic vaccine production resulted in an over-reliance on securing vaccine doses from international suppliers, particularly the European Union and the United States, putting Canada at risk of trade restrictions that threatened vaccine supply.

On June 14, 2021, Canada announced that it would donate 100 million doses to the COVAX program, which provides vaccines to low- and middle-income countries — 13 million of which are surplus doses.^{64,65} Canada also received a donated shipment of 1 million Moderna vaccine doses from the United States. The intent behind this donation was to speed up the process of reopening the border between Canada and the United States.⁶⁶

Overall, Canada had received 40 million vaccine doses by the end of June, 2021, more than enough to offer all 36 million Canadians a first dose.⁶⁷ As of July 26, 2021, Canada has received a total of 56,130,580 million vaccines from Pfizer Bio-NTech (35.21 million), Moderna (17.83 million), and AstraZeneca (3.0 million).⁶⁸ Canada will have an additional 124 million excess vaccine doses once the three additional suppliers — Sanofi, Medicago, and Novavax complete their clinical trials.⁶⁹

Varying Jurisdictional Interpretation and Responses to NACI Guidance for Prioritization of Older Adults for Vaccination and Delaying Second Doses

There have been variations in the adoption of

NACI's recommended guidance on populations to prioritize vaccination amongst Canada's provinces.

Specifically, some provinces have more strictly followed NACI's guidance that limited the addition of other population groups to their early vaccine rollout strategies. This resulted in a more efficient and equitable vaccine rollout for LTC and community-dwelling older populations in these jurisdictions.

Examples of provincial and territorial jurisdictions that closely followed NACI's guidance, emphasizing the prioritization of LTC and community-dwelling older populations, were Alberta,^{70,71} Saskatchewan,⁷² the Yukon,⁷³ Northwest Territories,⁷⁴ and Nunavut.⁷⁵ These jurisdictions directly adopted the NACI guidance which resulted in an early and relatively high proportion of older adults vaccinated through March and April 2021. For example, as soon as they completed first-dose vaccinations of their LTC residents, Saskatchewan expanded its vaccine eligibility to anyone aged 70 years and older.⁷⁶

On the other hand, Ontario added additional population groups beyond what NACI recommended to be vaccinated early, such as non-high-risk health care workers, essential workers like police officers etc. that NACI recommended prioritizing during the second phase of provincial/territorial vaccine rollouts.⁷⁷ This approach ultimately delayed Ontario's vaccine rollout amongst its community-dwelling older populations until March — as opposed to January 2021 in other provinces like Alberta, ultimately resulting in

a significantly higher number of preventable deaths amongst its older population. Similarly, New Brunswick immediately prioritized vaccines for high school teachers before adults aged 80 years and younger, ultimately prolonging the time that older adults remained unprotected from the virus despite being at a much higher risk of severe illness and death.⁷⁸ Also, Prince Edward Island (PEI) initially adopted the NACI guidance for prioritizing older adults for the first dose of COVID-19 vaccines. However, due to ongoing concerns over vaccine supply, PEI prioritized vaccinating every adult with at least one dose, even if it meant delaying second vaccine doses for higher risk groups, such as older adults.⁷⁹

Delaying Second Vaccine Doses

On March 5, 2021, NACI recommended extending the maximum interval between the first and second dose of the Pfizer-BioNTech and Moderna vaccines from three or four weeks, as per the manufacturer's recommendations, to up to 16 weeks.⁸⁰ The majority of Canada's provinces immediately adopted this approach, extending the length of time between first and second vaccine doses from between 8 to 16 weeks. This decision was made in response to the early and anticipated ongoing low supply of vaccines. At that time, evidence suggested a high proportion of the population with one dose of a COVID-19 could confer a significant level of protection, along with new evidence supporting the safe extension of the manufacturer's recommended dose interval.⁸¹

Two studies published since then suggest that the effectiveness of a single vaccine dose over a prolonged period is much lower for older adults compared to younger adults. A British study, for example, found that individuals aged 70-79 and 80 years or older had only a 48.7% and 34.7% prevalence of antibodies 21 days or more

after their first dose of the Pfizer-BioNTech vaccine, compared to 92.7% and 87.8% after a second dose.⁸² On the other, the prevalence of antibodies was found to be much higher among younger age groups after receiving only one vaccine dose. For example, individuals aged 18-29 and 30-39 had a 94.7% and 90.0% prevalence of antibodies 21 days after one dose of the Pfizer-BioNTech vaccine. Similarly, Canada's COVID-19 Immunity Task Force found that LTC home residents (the majority of whom are usually aged 80 or older) were demonstrating a weaker immune response to their first dose of the Pfizer-BioNTech vaccine than younger health-care workers in Vancouver.⁸³

The NIA further analyzed public health data from Alberta and Ontario to better compare the impact of prioritizing second doses for older populations in Alberta vs Ontario. These provinces make for an ideal comparison on the effects of providing older adults with on-time vs delayed second vaccine doses, given that both Alberta and Ontario were experiencing similarly high rates of COVID-19 activity in late winter and early spring.

The results of the NIA's analysis found that older adults living in Alberta, which was able to prioritize providing on-time second vaccine doses early for its older population, achieved a significantly lower probability of death for older Albertans compared to older Ontarians.

A case study outlining the provinces two approaches and their impacts are below in **Box 2.**

Box 2: A Comparative Analysis of the Impact of Two Different Canadian Provincial COVID-19 Vaccine Strategies for their Older Populations

Alberta began booking appointments for first dose COVID-19 vaccinations for community-dwelling older adults aged 75 years and older starting February 24, 2021.⁸⁴ In contrast, Ontario did not open first dose vaccine appointments to community-dwelling adults aged 80 years and older until approximately three weeks later on March 15, 2021 (although some Ontario public health units began offering vaccines earlier).^{85,86} Between March 15 and 19, Alberta further expanded vaccine eligibility to all of its community-dwelling adults aged 64 years and older.^{87,88} However, by mid-April 2021, similar rates of first-dose vaccinations were achieved among the older populations in both provinces.

In Alberta, community-dwelling older adults aged 75 years and older were also eligible to receive their second vaccine within 4-6 weeks after their first dose (up to twice the interval recommended by the manufacturer).^{89,90,91} Alberta later adopted NACI's recommendation to increase the interval between first and second doses to 16 weeks in light of emerging evidence suggesting that one dose was largely protective. However, this policy was only applied to appointments booked after March 10, meaning that most older Albertans aged 75 years and older had already received their second dose by the time the longer dose interval policy was implemented.⁹²

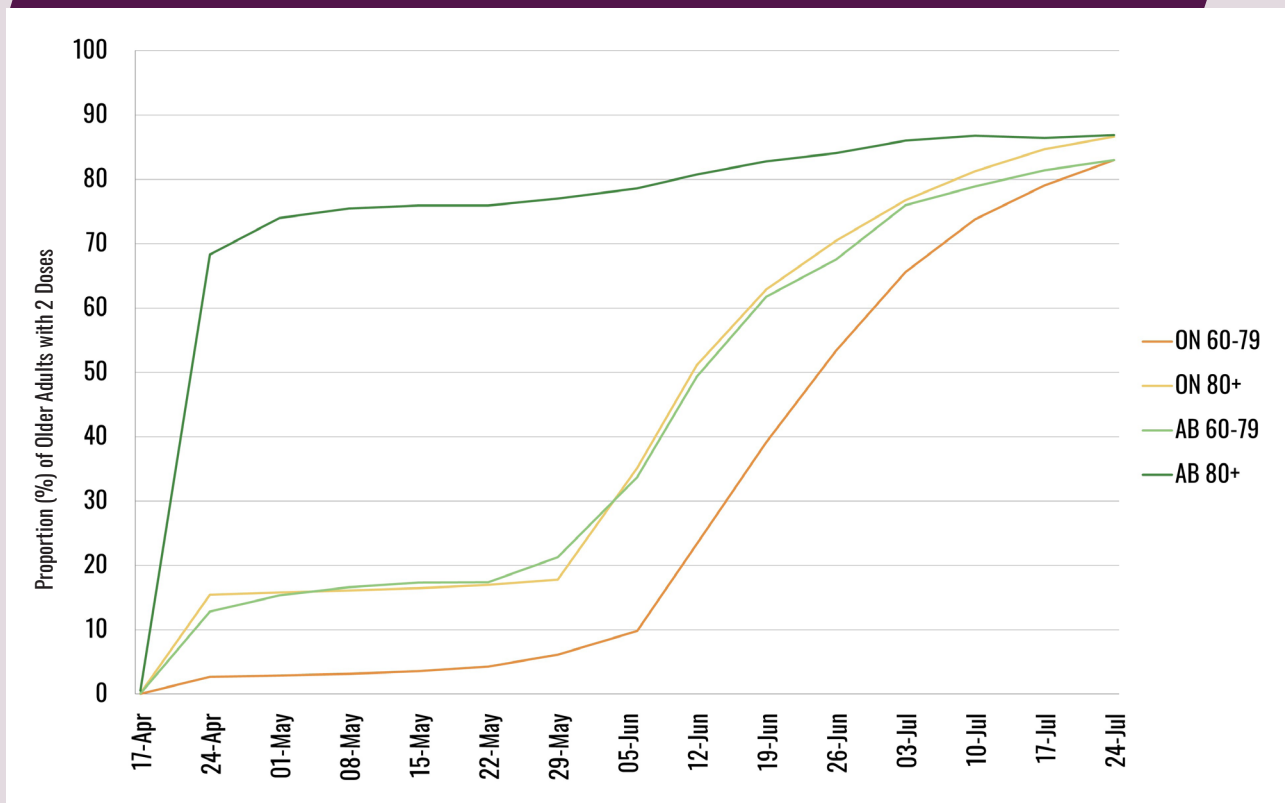
In contrast, in Ontario, the maximum interval between first and second doses of any mRNA vaccine was established at 16 weeks regardless of age, although similar to Alberta, second doses could be administered earlier if there was an adequate supply of vaccine.⁹³ Due to the delay in opening access to vaccinations for its community-dwelling older adults, second doses generally were not offered to community-dwelling older Ontarians aged 80 years and older until May 31, 2021 in Ontario — or over two months after Alberta started administering second doses to its older population.⁹⁴ As **Figure 5** shows, by mid-April 2021, when new cases of COVID-19 were rising sharply in both Alberta and Ontario due to a significant third wave of infections, almost three and eight times more Albertans compared to Ontarians aged 80 years and older and aged 70-79 years respectively had received both doses of their COVID-19 vaccines:⁹⁵

- Adults aged 80 years and older: 57% (Alberta) vs 15% (Ontario);
- Adults aged 70-79 years: 25% (Alberta) vs 3% (Ontario);
- Adults aged 60-69: 3% (Alberta) vs 2% (Ontario);

In fact, while Alberta quickly administered second doses to the population aged 80 years and older, the delay in offering second doses to community-dwelling older adults in Ontario led vaccine coverage for Ontarians aged 80 years and older to mirror that of Albertans aged 60-79. **Figure 5** makes clear that Alberta was able to fully vaccinate almost three-quarters of its older adults 80 years and older — the group facing the greatest risks from COVID-19 — a full month before vaccine coverage for the same group even began to rise in Ontario, when Ontario started administering second doses to its

community-dwelling older adults. Furthermore, while the gap in vaccination coverage between both provinces narrowed by the end of June 2021, the proportion of older adults fully vaccinated in Alberta remained about 10% higher than in Ontario. As of July 3, 2021, Alberta had administered two doses of a COVID-19 vaccine to 76% of Albertans aged 60-79 and 86% of adults aged 80 years and older, while Ontario had administered two doses to 66% and 77% of its respective older populations. However, Ontario managed to increase second dose coverage and close the gap relative to Alberta during the month of July. As of July 24, 2021, Alberta and Ontario have each vaccinated 83% and 87% of their populations aged 60-79 and 80 years and older.

Figure 5: Proportion of Older Adults with 2 Doses in Ontario and Alberta, April 17-July 24, 2021



Comparing Associated COVID-19 Mortality Rates for Older Adults in Alberta vs Ontario

In order to understand the resulting impact of providing more delayed second doses amongst older adults in Ontario vs Alberta, we compared age-specific mortality rates (daily average) in both provinces from January 2 to April 16, 2021 and from April 17 to June 11, and June 12 to July 27, 2021 using provincial public health data from Ontario and Alberta, as well as national census data.^{96,97,98} These dates were chosen because most community-dwelling Albertans aged 75 years and older who received both vaccines were assumed to have reached full immunity by mid-April, whereas relatively few Ontarians were fully vaccinated by this time⁹⁹ and by June 12, Ontario and Alberta had achieved comparably high rates of full vaccination among older adults, as shown in **Figure 5**.

Both Alberta and Ontario saw broadly similar increases in new cases of COVID-19 as part of their third waves in April 2021. The observed risk of death, however, from COVID-19 was substantially (76-150%) higher in Ontario than in Alberta for their older populations during this time, even as the rate of new cases continued to climb in Alberta into early May 2021, eventually reaching a peak rate approximately twice as high as that in Ontario (Table 4).¹⁰⁰ The difference in mortality rates between the two provinces is partly explained by Alberta's success in achieving significantly greater proportional reductions in COVID-19 mortality rates amongst its older populations than Ontario between mid-April and mid-June compared to the preceding months. Among people aged 60-79 years, the risk of dying from COVID-19 decreased 34% in Alberta vs 2% in Ontario, and among people aged 80 years and older, the risk of dying from COVID-19 decreased 81% in Alberta compared to 62% in Ontario between these two periods.

If Ontario had achieved the same proportionate reduction in reported age-specific mortality rates as Alberta did between mid-April and July 2021 and the preceding months, we estimate that there could have been up to 141 fewer deaths amongst Ontarians 60-79 years (24% fewer) and 210 fewer deaths among Ontarians 80 years and older (44% fewer) between mid-April and mid-June. Although there could be additional explanations for these findings, the faster rollout of vaccines and shorter interval between the administration of first and second vaccine doses in Alberta likely contributed to these findings. Public Health Ontario has also reported that there were 80 confirmed COVID-19 deaths among partially vaccinated (>14 days after first dose) Ontarians aged 60-79 years and 201 among people 80 years and older between mid-December and mid-June 2021, supporting the latter explanation. In contrast, only 6 COVID-19 deaths occurred among fully vaccinated Ontarians aged 60-79 and 27 among Ontarians 80 years and older during the same time period.¹⁰¹

In comparing these two provinces, Alberta's older population appears to have significantly benefited by fully vaccinating a large percentage of its older population against COVID-19 earlier instead of prolonging the interval between doses to stretch vaccine supplies and provide more first doses to its younger populations. However, Ontario, which did not offer second doses to its older population until well after its third wave began, saw much higher COVID-19 mortality rates among its older population than Alberta. Despite having an older population than Alberta, Ontario received sufficient vaccines to fully vaccinate older Ontarians 75 years and older up to four weeks or a month earlier had it, like Alberta more closely adhered to NACI's Guidance to better prioritize vaccinating its older population before other Ontario populations that were at a lower risk of hospitalization and death from COVID-19. Indeed, Ontario's approach potentially led to the preventable and unnecessary loss of up to 351 mostly community-dwelling older Ontarians.

Table 4. Comparison of COVID-19 older adult mortality rates per 1M population in Ontario and Alberta from January 2 to July 27, 2021

Time period	COVID-19 mortality rate per 1M population (daily average)					
	60-79 years			80 years and older		
	ON	AB	Difference ON-AB (%)	ON	AB	Difference ON-AB (%)
January 02 to April 16	3.28	2.45	0.84 (34%)	29.07	20.64	8.43 (41%)
April 17 to June 11	3.67	2.09	1.58 (76%)	13.07	5.22	7.85 (150%)
June 12 to July 27	1.37	<1	NA	3.98	<1	NA

The % increase represents the % by which deaths in Ontario compare to Alberta, and is analogous to the relative risk, i.e. $(ON/AB-1)*100$. For example, among those living in Ontario aged 60-79 years, the risk of dying from COVID-19 was 34% higher between January 2 and April 16 than in Alberta. Note: data may be affected by delays in reporting.

Vaccine Booking Systems Issues

Many provinces suffered from poorly thought out and hastily designed vaccine booking systems and from providing people a lack of options to schedule appointments that are more suitable to the needs and preferences of older adults, such as by providing phone or in-person booking options rather than just an online or telephone booking option. This was particularly problematic because estimates in Canada suggest that only about half of the population aged 80 years and older uses the internet.¹⁰²

Specifically, many provinces were unprepared to accommodate the preferences and needs of older adults regarding booking their vaccine appointments. This was especially true for those who may not have access to or comfort with the required technologies or who did not feel comfortable navigating these processes in English or French.^{103,104,105} This was noted particularly in Ontario, as one of the main contributors to why over 200,000 older adults over 80 years of age across Ontario remained without first-dose vaccine appointment by the end of March 2021. In Ontario, appointments could only be booked online or by phone across the entire province in the latter half of March 2021.¹⁰⁶

The challenges associated with organizing vaccination appointments becomes magnified among older persons with physical and cognitive disabilities — particularly among those who do not have routine access to family members or caregivers. This has been magnified in several provinces as their vaccination appointment booking systems crashed and left people waiting for several hours. Alberta, Manitoba, New Brunswick, Ontario, and Nova Scotia all reported booking

system crashes during the beginning of their booking system rollouts.^{107,108,109,110} In Ontario, the launch of its booking system became so delayed that several local public health units launched their own booking systems to help facilitate older adults getting their vaccination appointments prior to March 15, 2021.¹¹¹ Manitoba's booking system launch failed all together, with the province announcing in February that its booking system would not be ready until April 2021.¹¹²

Also, many of the provinces failed to make vaccine information and appointment booking accessible and culturally competent early in their rollouts. Public health and vaccine information across Canada was predominantly communicated in English and French, despite the burden of COVID-19 being highest in low socio-economic neighbourhoods where a high proportion of residents do not speak English or French as their first language.¹¹³ Saskatchewan and British Columbia, however, proved to be leaders on culturally responsive accessibility. For example British Columbia provided booking options in dozens of languages both online and over the phone.¹¹⁴ Saskatchewan announced on March 11, 2021 the launch of its new booking system that made online booking much simpler, but also allowed adults to book over the phone or allow a family member or friend to book on behalf of someone who is currently eligible.¹¹⁵ Ontario, upon eventually launching its booking system, added a phone line booking option that enabled people to book their appointments in over 300 languages.¹¹⁶ Quebec and Manitoba also launched efforts to expand language accessibility of vaccine services. Quebec launched an awareness campaign with advertisements and online information about vaccines in 21 languages early March 2021.¹¹⁷ Manitoba, for its part, began offering telephone

vaccine booking in over 100 languages, and the option to request spoken language interpreter services for appointments scheduled at mass vaccination sites in late April 2021.¹¹⁸

Accessing Vaccination Centres

With many older adults limited in their ability to access mass vaccination clinics, several provinces and territories made additional efforts to ensure that all older adults were reached to make vaccine appointments. This included expanding their vaccine rollouts to include primary care providers and pharmacists, along with the development of vaccination strategies to better serve the homebound. Alberta, Manitoba, New Brunswick, Nova Scotia and Quebec in particular expanded vaccine delivery to primary care and pharmacies early in their rollout.^{119,120,121,122} For example, by March 15, 2021 Montreal had over 350 pharmacies delivering vaccines. This came in response to many older adults having to wait outside in the cold for their vaccine appointments.¹²³ This strategy was effective as many older adults are registered with primary care providers and have continuous interactions with their pharmacists. Comparatively, Ontario was slow in allowing pharmacies and primary care providers into its vaccine rollout. For example Ontario reached 350 pharmacies delivering vaccines by April 1, 2021, over two weeks after Quebec.¹²⁴ This was noted as one of the main contributors to why over 200,000 older adults over 80 years of age across Ontario remained without first-dose vaccine appointment by the end of March, 2021.¹²⁵ The outcomes between these decisions is apparent, as an article released in March, 2021 found that Quebec had administered over 70% of its vaccines to adults aged 60 years and

older, while Ontario had administered 58% of its vaccine supply to adults aged 70 years and older.¹²⁶

Moreover, provinces varied in their efforts to vaccinate homebound older persons. Homebound older persons were identified as an early priority in British Columbia, making mobile clinics in self-contained vehicles for homebound older adults with mobility issues available beginning in January 2021.¹²⁷ In comparison, Ontario did not begin to even acknowledge that it needed to vaccinate its 75,000 homebound older adults until March, 2021. Specifically, only 26.5% of Ontarians aged 75 years and older had received at or booked an appointment for a COVID-19 vaccine as of March 29, 2021.¹²⁸ The lack of government support in Ontario led local jurisdictions such as Toronto and Hamilton to plan their independent homebound vaccination strategies, both of which documented the high demand for vaccines among this population of older adults as well.^{129,130}

Both the lack of early integration of pharmacies and primary care providers, and strategies to vaccinate homebound adults, presented missed opportunities to efficiently vaccinate older adults and prevent more unnecessary deaths in many communities in Canada.

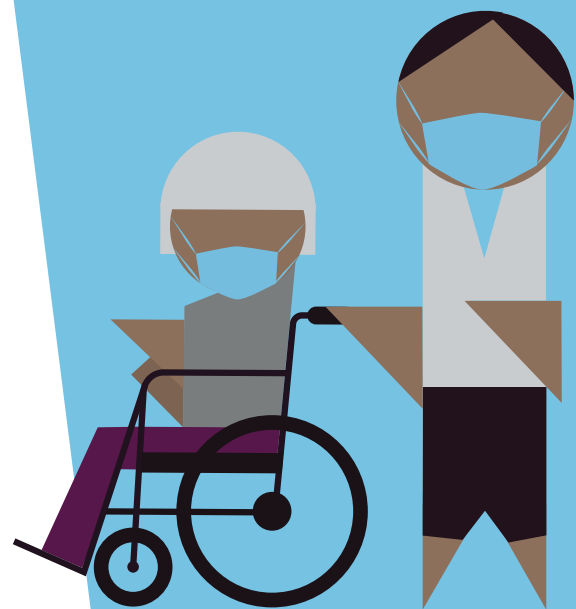
Part 2: How does Canada's COVID-19 Vaccine Rollout for its Older Populations Compare to that of 5 Other Early International Vaccination Leaders?

Five countries, the United Kingdom, Israel, the United States, Denmark, and Chile, had relatively successful early COVID-19 vaccine rollouts. The following section provides an overview of each country's healthcare system governance and decision-making structures, their respective vaccine rollout strategies, and their experience in vaccinating their older populations during the COVID-19 pandemic.

Tracking the experiences of these countries identified common themes contributing to their successful vaccine rollouts amongst their older populations, furthering the NIA's understanding of likely determinants of successful vaccine rollouts for older adults.

Specifically, three key emerging factors identified that appear to contribute to an effective rollout and higher vaccine coverage levels among older populations are:

- (1) The importance of having centralized governance and decision-making processes,
- (2) The ability to develop a simple and clear prioritization strategy for vaccinating those who will benefit the most, and
- (3) The implementation speed of a vaccination program's rollout



The United Kingdom



All residents of the United Kingdom (UK) are offered comprehensive, universal access to health care through the National Health Service (NHS). Under the auspices of the UK Department of Health, each of the UK's national jurisdictions — Scotland, Northern Ireland, and England — are responsible for governing their own NHS, which is responsible for managing national health initiatives like vaccine rollouts.¹³¹ The UK's structure of centralized governance and local implementation allows for decisive and uniform decision-making.

The United Kingdom's federal government was extremely proactive in securing vaccine doses. In June 2020, the UK had secured a contract with AstraZeneca for 100 million doses of its forthcoming vaccine. It then secured a deal with Pfizer-BioNTech for 40 million doses of its forthcoming vaccine in October, 2020.¹³² The UK also secured a deal with Moderna later in November 2020 to supply vaccines beginning in March, 2021 and 10 million doses were delivered April 13, 2021.^{133,134,135} As of July 3, 2021, approximately 0.2% of the population aged 70 years and older, and 0.5% of the population aged 50 to 69 years had tested positive for COVID-19, compared to 1.4% of the population aged 25 to 34 years.¹³⁶ Further, the United Kingdom has vaccinated more than 90% people aged 50 and older with one and two doses of a COVID-19 vaccine, as of July 22, 2021.¹³⁷

United Kingdom's Joint Committee on Vaccination and Immunization (JCVI) advised both the UK's Department of Health and its respective NHS on implementing their national vaccine rollout strategies. The JCVI prioritized first vaccine doses for residents of

care homes and their care providers, followed by adults aged 70 years and older and social care workers.¹³⁸ From the beginning of the rollout, general practitioners were focused on vaccinating older adults, while hospitals focused on vaccinating health care workers.¹³⁹ Similar to Canada, the UK's vaccine rollout featured the use of Pfizer-BioNTech, Moderna, and AstraZeneca vaccines. However, unlike Canada, the UK had the capacity to produce its AstraZeneca vaccine supply domestically.¹⁴⁰

The UK was the first jurisdiction in the world to begin its national vaccine rollout campaign on December 13, 2020. Everyone included in its first phase covering four priority groups — people aged over 70, care home residents, health care workers and people required to shield — were offered a dose by mid-February. The rollouts then prioritized adults aged 60 years and above, along with people who have chronic health conditions, followed by people aged 50 years and older. The UK made rapid progress in its vaccine rollout over the winter and early spring.

The British Broadcasting Corporation (BBC) reported that among people aged 50 years and older, 98% in Scotland, 95% in England, 92% in Wales, and 89% in Northern Ireland were vaccinated with at least one dose, based on data available between April 25 to 28, 2021.¹⁴¹ By May 6, 2021, 67% of adults aged 60 years and older had been vaccinated with two doses. This included 93.7% of adults aged 80 years and older, 94% aged 75 to 79 years and older, and 89% of adults aged 70 to 74 years and older.¹⁴²

In response to the emerging Delta Variant of the SARS-COV-2 virus, the UK announced that it would accelerate second doses for people aged 50 years and older by reducing

their required time between first and second doses from 12 to 8 weeks.^{143,144} The government further proposed to vaccinate all people aged 50 years and older with a second dose by June 21, 2021.¹⁴⁵ As of July 8, 2021, the NHS reported that 93% of people aged 50 years and older across the UK had received a second dose of a COVID-19 vaccine.¹⁴⁶ Furthermore, NHS England has mandated vaccination for all home care workers beginning in October, and is currently considering an extended mandate to frontline workers in the NHS. The vaccine mandating policy offers an additional layer of protection for the most vulnerable populations.^{147,148}

Overall, the UK's rollout has been highly effective at preventing hospitalization and mortality amongst older adults. Two preliminary studies were conducted in the UK to determine the real-world efficacy of Pfizer-BioNTech and AstraZeneca vaccines among older adults. Public Health England released a preliminary real-world study that found the vaccines to be more than 80% effective at preventing hospitalization three to four weeks after the dose was received among people aged 80 years and older.¹⁴⁹ While a Scottish Study of 1,331,993 older adults with a median age of 65 years old, found the first dose of the vaccines to be 91% and 88% effective against reducing hospital admission at 4 to 5 weeks after vaccination. When restricting the analysis to participants aged 80 years and older, the combined effects of the vaccines was 83% at 4 to 5 weeks post vaccination.¹⁵⁰

Evidence from the UK's COVID-19 vaccine rollout has demonstrated its impact on saving the lives of older adults.

Public Health England estimated that COVID-19 vaccines prevented 6,100 additional deaths among people aged 80 years and older by the end of February 2021.¹⁵¹ A more recent report published in April 2021 found that the vaccine rollout saved an estimated 10,600 lives of people aged 60 years and older.¹⁵²

Furthermore, the BBC, using official government data, has reported that deaths among people aged 65 years and older fell by 63% from February 19 to March 5, 2021, compared to 53% among the general population.¹⁵³

The United Kingdom announced that it is planning to provide a third dose to vulnerable populations, including adults aged 70 years and older, followed by adults aged 60 years and older beginning in September 2021.¹⁵⁴

The effectiveness of the UK's COVID-19 vaccine rollout has largely been attributable to its early and proactive negotiations with vaccine manufacturers and its ability to produce vaccines domestically, which helped to secure an early and sufficient and stable quantity of vaccine doses. This was combined with decisive government action, as well as strong coordination between the UK Department of Health and local NHS vaccine administrators such as primary care clinics. Collectively, the actions taken across the UK to ensure an efficient and equitable vaccine rollout amongst its older adults has likely resulted in thousands of older lives saved, highlighting the importance and impact of prioritizing the protection of the most vulnerable populations during the COVID-19 pandemic.



Israel mandates through law that all of its citizens are entitled to access comprehensive universal health coverage. Although governance and population health functions are all controlled by Israel's national government, individuals are required to choose from one of four competing non-profit healthcare plans to deliver their health care.^{155,156} As of July 28, 2021, 87% of adults aged 60 to 69 years, 92.8% of adults aged 70 to 79 years, 91.3% of adults aged 80 to 89 years, and 89.9% of adults aged 90 years and older had been vaccinated with two doses of a COVID-19 vaccine.¹⁵⁷

Israel benefited from having a centrally planned healthcare system and utilizing its experience in disaster management and response, along with its robust primary health care system to plan and deliver its COVID-19 vaccine rollout strategy. This includes maintaining a relatively high proportion of nurses working in community settings that are trained in immunization practices, along with previously established Epidemic Management Teams and a National Immunization Technical Advisory Group, which were leveraged to quickly plan and implement a national COVID-19 vaccination strategy.¹⁵⁸

As of July 3, 2021, there are zero confirmed COVID-19 cases among adults aged 80 years and older in Israel. Among adults aged 60 to 79 years, COVID-19 cases have declined 95% relative to COVID-19 cases recorded at the peak of the second wave on January 16, 2021.¹⁵⁹

Israel's vaccine rollout relied on a simple prioritization process for the administration of its vaccines to its population based entirely on age, while additionally prioritizing the vaccination of healthcare workers and first responders.¹⁶⁰ The initial groups prioritized for first doses of COVID-19 vaccines were adults over the age of 60, long-term care home residents, other people at very high-risk due to specific serious medical conditions, and front-line health care workers. Moreover, Israel's strong pre-existing digital health network, through which all four of its competing healthcare plans are required to keep their digital patient records. This includes records of a complete medical history of every individual since their birth.¹⁶¹ This was leveraged to rapidly identify, contact, and schedule vaccine appointments for individuals in the priority populations and track vaccine administration efforts. Moreover, Israel is one of few countries in the world with an integrated national childhood vaccine program, offering every child free access to vaccines and tracking it in a centralized database.¹⁶²

Israel officially began its vaccination rollout on December 20, 2020. Not only did Israel make use of its sophisticated platform to quickly target older adults, but it also prioritized fully vaccinating its older adults.¹⁶³ By January 7, 2021, Israel had become the first country in the world to have offered a first vaccine dose to every care home resident across Israel. By January 4, 2021, Israel had vaccinated 60% of its adults aged 60 years and older with at least one dose. Furthermore, by January 25, 2021, 60% of Israelis aged 60 years and older had received two vaccine doses.¹⁶⁴ By February 5, 2021, over 90% of the population aged 60 years and older had received both vaccine doses. By the end of

February, 2021, national reports stated that over 90% of Israelis aged 50 over had received two COVID-19 vaccine doses.¹⁶⁵

On March 8, 2021 Israel celebrated its 5 millionth COVID-19 vaccination, stating that it had vaccinated 80% of its adult population with at least one dose, and more than 40% had received two doses.¹⁶⁶

Israel continued to vaccinate a high proportion of its older adults into March.

By March 15, 2021, 91% of Israel's adults aged 70 to 79 had received two doses of COVID-19 vaccines, and 96% had received one.¹⁶⁷

By March 24, 2021, over 50% of Israel's total population had been vaccinated — 72.5% of the eligible population — with both doses. More specifically, 89% of Israelis aged 60 years and older had received at least one dose, and 80% had received at least two doses in late March.¹⁶⁸ By mid-April, it appeared that Israel had met the population thresholds for reaching population-level herd immunity, as 68% of the total population was estimated to have either been vaccinated or had COVID-19 in the last 14 days.¹⁶⁹

On July 30, 2021, Israel announced a plan to vaccinate adults aged 60 years and older with a third dose of a COVID-19 vaccine. Individuals will be required to prove that they received a second dose within the past five months in order to be eligible for a third dose.¹⁷⁰

Preliminary results from Israel's Ministry of Health showed a resulting 41% drop in infections in people aged 60 years and older, and 31% drop in hospitalizations due to COVID-19 had been achieved between mid-January to early February 2021.¹⁷¹

An additional study found that the impact of the vaccine rollout had resulted in significantly fewer hospitalizations among individuals aged 60 years and older compared to younger Israelis.

Moreover, the study analyzed the speed of vaccination, finding hospitalizations and severe hospitalizations declined by 88% and 79% in cities where vaccinations were available early, compared to 78% and 66% among older adults who were vaccinated later from August 28, 2020 to January 8, 2021.

The analysis concluded that two months after the beginning of Israel's vaccination rollout began, the country had vaccinated approximately 85% of its population aged 60 years and older. This resulted in a 77% decrease in COVID-19 cases, a 45% drop in positive tests, a 68% drop in hospitalizations, and a 67% drop in severe hospitalizations compared to its "peak values".¹⁷²

Israel's vaccine rollout has been heralded as a model of excellence. Israel's prioritization of older adults for first and second doses of COVID-19 significantly reduced hospitalization and mortality due to COVID-19 amongst them in particular. A particular strength of Israel's government was the development of a clear and simple prioritization strategy based on age. This strategy, in combination with leveraging its highly integrated digital health network, a healthcare workforce trained in emergency response, and centralized decision-making clearly enabled Israel to further vaccinate all of its older adults in a timely and efficient manner.

The United States



In the United States, residents can choose to receive their care from competing private insurers or may qualify for one of two types of publicly funded health insurance — Medicare and Medicaid, the former of which is offered to eligible adults over the age 65 – to receive their care.¹⁷³ This system of multiple private and public insurers has resulted in care fragmentation and also leaves a sizable proportion of the American population without access to health care services. The US federal government, however, mandated early that all COVID-19 vaccines would be made available free of charge to those who wanted one. The US relied on three vaccine manufacturers, Pfizer-BioNTech, Moderna, and Johnson & Johnson for its vaccine supply. All three companies also have production facilities in the US.^{174,175,176} As of July 28, 2021, 89% of the population aged 65 years and older had received at least one, and 79% had received at least two doses of a COVID-19 vaccine.¹⁷⁷

The Centers for Disease Control (CDC) — the United States' federal public health agency — recommended that healthcare workers and people living in congregate settings receive its first vaccines, followed by adults aged 75 years and older.¹⁷⁸ The United States adopted a *first dose first* vaccine rollout strategy, which prioritized administering as many people as possible with at least one dose of a COVID-19 vaccine.¹⁷⁹ This resulted in the US being an early international leader in doses administered per 100 people, but also caused an inequitable and fragmented response. Vaccines were distributed to individual states on a per capita basis. Once vaccines arrived in states, similar to Canada, it was left up to

local state jurisdictions to determine how the vaccines were to be delivered and which populations were to be given priority to accessing a vaccine.¹⁸⁰

The United States officially began its vaccine rollout on December 14, 2020. In January 2021, the federal government advised states to expand vaccine eligibility to persons aged 65 years and older. However, states interpreted the term 'older adults' broadly — opening vaccination from the ages of 65, 70, and 80 onwards.¹⁸¹ As of February 22, 2021, a total of 41 states and the District of Columbia had expanded their vaccination plans to include adults 65 years and older.¹⁸² In early March, several states including Connecticut, Maine, Rhode Island and Vermont chose to break federal guidelines, skipping over essential workers to specifically vaccinate their populations based entirely on age.¹⁸³

The United States vaccinated 60% of adults aged 75 years and older on March 8, 2021, followed by adults aged 65 to 74 years on March 13, 2021, and adults aged 50 to 64 years old by April 25th. At least 60% of populations in these age groups received their second doses by April 8, 2021 (aged 75 and older), April 12 (aged 65 to 74 years old), and June 8, 2021 (aged 50 to 64 years old).

On March 19, 2021, the US announced that it has administered 100 million doses of COVID-19 vaccines and that 65% people aged 65 years and older were fully vaccinated.¹⁸⁴

Nearly all states began to expand vaccine eligibility to the general population (people

aged 16 years and older) beginning in late March or early April.¹⁸⁵ On April 14, 2021, the US announced that it would temporarily halt the use of the Johnson & Johnson vaccine, citing the move as being made under “an abundance of caution”.¹⁸⁶ Eleven days after this initial stoppage, the US announced that it would resume and continue vaccinating people with the Johnson and Johnson vaccine, making 10 million Johnson & Johnson doses available for immediate use.¹⁸⁷

As of April 26, 2021, 80.8% of people aged 75 years and older had been vaccinated with at least one dose, followed by 82.9% of people aged 65-74 years old, and 60.8% of people aged 50-64 years old. Moreover, the US achieved a relatively high proportion of the population receiving second doses, as 67.7% of people aged 75 years and older, 68.1% of people aged 64-75, and 41.2% of people aged 50 to 64 years of age having received them.¹⁸⁸ Preliminary findings from the United States have demonstrated the beneficial effect of the vaccine rollout on older adults, with hospitalizations among people aged 85 years and older having reportedly declined by 90% over the winter peak.¹⁸⁹

Despite its fast start, the pace of the United States vaccination rollout has now begun to slow as a significant proportion of the population remains unwilling to get the vaccine.¹⁹⁰ Recent polling results from several states — including Wyoming, Montana, North Dakota, Kentucky and Ohio show that greater than 20% of their respective populations will “definitely not” or “probability not” receive a COVID-19 vaccine.¹⁹¹ Despite a high level of vaccine hesitancy amongst its general population, 87% and 77% of adults aged 65 years and older had received one and two doses of a COVID-19 vaccine as of June 23,

2021.¹⁹² The Department of Veteran Affairs, which runs the nation's largest publicly-funded health system, mandated that all front-line workers must receive a COVID-19 vaccine on July 26, 2021. The vaccine mandate will provide an additional layer of protection for veterans, many of whom are older adults, especially given the rising concerns about the Delta variant.¹⁹³

Overall, the United States' vaccination rollout amongst its older populations has been highly successful. This was primarily due to its prioritization of older adults early in its rollout, and the speed at which the rollout was implemented. As more results arise, it will be important to understand how the prioritization strategy and speed adopted by the United States impacted older adults. Moreover, the experience of the United States continues to reiterate that vaccine hesitancy remains lowest among older adults compared to younger populations, reinforcing that vaccinating older adults likely remains one of the most efficient means to achieving population level-herd immunity.

Denmark



All residents of Denmark are enrolled in a publicly funded health insurance program. The national government is responsible for governance functions, including the general planning and allocation of funds to municipalities to deliver certain services. Similar to Canada, regions are responsible for planning and delivering local health services.¹⁹⁴ However, in the specific context of COVID-19 vaccinations, Denmark made its federal Danish Health Authority responsible for planning and implementing its national COVID-19 vaccine rollout strategy.¹⁹⁵ As of June 26, 2021, older adults have the lowest COVID-19 cases per 100,000 people in Denmark. For example, adults aged 60 to 69 years (3.17 per 100,000), 70 to 79 years (2.15 per 100,000), and 80 to 89 years (2.66) have relatively fewer COVID-19 cases compared to younger populations. This includes adults aged 20 to 29 years (7.49 per 100,000), 30 to 39 years (5.92 per 100,000), and 40 to 49 years (5.6 per 100,000). As of July 28, 2021, 100% of adults aged 80 years and older, 99% of adults aged 70 to 79 years, and 95% of adults aged 60 to 69 years are fully vaccinated against COVID-19 in Denmark.¹⁹⁶

The Danish Health Authority COVID-19 vaccination program has three main objectives — minimizing mortality and severe illness due to COVID-19, minimizing the spread and infection of COVID-19, and ensuring societal functions. Denmark focused its initial rollout on vaccinating priority populations of high-risk individuals first.¹⁹⁷ These included persons living in LTC homes, people aged 65 years and older who receive personal assistance, and people aged 85 years and older. People aged 80-84, 74-79,

and 65-74 years were ranked as the 7, 8, and 9th priority populations, respectively.¹⁹⁸ Denmark became the second country in the world to complete offering its entire LTC home population first doses by January 8, and pledged to complete its vaccination program by June 27, 2021, far faster than nearly any other country.¹⁹⁹ Denmark began its vaccine rollout program on December 27, 2020.

The Danish government began vaccinating people over 65 with the Pfizer-BioNTech and Moderna vaccines, saving the AstraZeneca vaccine for people aged under 65 years.²⁰⁰ On March 1, 2021, the Danish Health Authority set out a timeline and prioritization plan for offering COVID-19 vaccines to the general population. People aged 80-84 years started receiving their vaccinations on March 8, 2021 and were estimated to have their vaccinations completed by April 19, 2021. While people aged 79 to 75 years were to begin and finish one week later. Lastly, people aged 74 to 65 years were to begin their vaccinations by April 1, 2021 and were originally scheduled to complete their second vaccinations by May 17, 2021.²⁰¹

However, due to safety concerns that emerged with the AstraZeneca vaccine, Denmark was unable to reach these targets. Regardless, Denmark was able to achieve relatively high vaccination rates among its older adult population in a timely manner compared to other countries, vaccinating 60% of adults aged 80 years and older with two doses by April 9, 2021, and adults aged 60 to 69 years older on May 14, 2021.

On March 2, 2021, Denmark (and Austria) announced that they would no longer rely on EU manufacturing to produce its COVID-19 vaccines, citing the slow rollout in the EU

(7.5% of populations) compared to Israel (71%) and UK (31%).²⁰² In response, Denmark partnered with Israel and Austria to begin developing and manufacturing future vaccine doses.²⁰³

The Danish Health Authority announced that it recommended the AstraZeneca vaccine to anyone aged 18 years and older — including those aged 65 years and older on March 5, 2021. Secondly, it announced that the original full vaccination completion date would be pushed back three full weeks from June 27 to July 18, 2021. As a part of this change, it released a schedule stating all people aged 65 years and older would have been offered a vaccine by the end of March 2021.

On March 11, 2021, the Danish Health Authority announced that it would temporarily halt its use of the AstraZeneca vaccine after reports of blood clot-related side-effects.²⁰⁴ This decision was cited as a “precautionary” measure to determine if the vaccine caused the blood clots. Despite other countries concluding that the vaccine was safe and that the benefits of vaccination outweigh any potential risks, the Danish Health Authority decided to proceed with the suspension of the AstraZeneca vaccine for the week of March 11, 2021.²⁰⁵ Denmark further announced that it planned for a full return to normal — including the opening of schools, universities, shops, restaurants and bars, libraries, etc. by the end of May — once everyone over the age of 50 had been vaccinated.²⁰⁶

On April 14, 2021, Denmark became the first European country to stop using the AstraZeneca vaccine altogether due to ongoing concerns about blood-clot-related side-effects.²⁰⁷ The Danish Health Authority

cited the higher risk — estimated at one in 40,000 — as their primary rationale for halting its use of the vaccine. A Danish health official said that the availability of other vaccines, the fact that its epidemic was largely under control, and that its remaining priority groups also had a low probability of becoming seriously ill from COVID-19 were factors in its decision.^{208,209} In addition to the Danish Health Authority decision to halt the use of the AstraZeneca vaccine, it also announced on May 3, 2021 that it would completely cut out the use of the Johnson & Johnson vaccine for its vaccine rollout. It is estimated that the Johnson & Johnson vaccine accounted for nearly one third of Denmark's procured vaccine supply, thus delaying its planned completion of its vaccination rollout further with this subsequent decision.²¹⁰

As of May 3, 2021, it was estimated that Denmark had vaccinated 11.3% of its population. As infection rates continued to decline, cities continued to re-open in March 2021. The Danish Health Authority Announced that they were considering implementing an optional vaccination scheme. This scheme would allow individuals to voluntarily put themselves forward to receive the AstraZeneca, and possibly the Johnson & Johnson vaccine.²¹¹

On June 6, 2021, Denmark reported that 95% of people in its first priority groups — including the most vulnerable and at-risk citizens to COVID-19 had been vaccinated. Specifically, 95.7% of its LTC home residents, 91.9% of people over 65 requiring personal care, 95.4% of people aged 85 years and older, 96% of people aged 80-84 years, 95.8% of people aged 75-79 years, and 94.6% people aged 65 to 74 years had received at least one dose of a COVID-19 vaccine.^{212,213}

The Danish COVID-19 vaccine rollout experience highlights the importance of committing to a strict priority population policy despite ongoing limitations to its vaccine supply and availability. While unforeseen circumstances such as the decisions to stop using the AstraZeneca and Johnson & Johnson vaccines could have severely prohibited its vaccine rollout for its oldest populations, the Danish government's demonstrated strong political will to get its most vulnerable and highest risk populations, including older adults, vaccinated as quickly as possible remained evident. This approach most likely saved thousands of lives in the process.



Chile has a hybrid public-private health care system. Citizens are entitled to free publicly funded, universal healthcare, but have the ability to 'opt out' of this coverage and select private insurers to provide their care.²¹⁴ This two-tiered system has produced significant inequities in access to quality health care across socioeconomic status.^{215,216} Despite this, Chile has ranked among one the most successful countries in terms of early COVID-19 vaccine rollouts.

Even with recent political unrest, Chile secured over 90 million vaccines — enough to vaccinate their population of 19.2 million people with two doses more than twice over.

Chile also secured a diverse range of vaccines, including the AstraZeneca, Pfizer-BioNTech, Johnson & Johnson vaccines, but was one of the only high-income countries to purchase CoronaVac, a vaccine developed and manufactured in the People's Republic of China. Despite its relatively weaker economic advantage when compared to other high-income countries, Chile offered to participate in many vaccine developers' phase three clinical trials, helping to establish strong ties and leverage amongst global vaccine manufacturers.²¹⁷

As of early March 2021, the Chilean vaccination rollout was comparable in speed to the US' rollout – in having vaccinated over 5 million people (one quarter of the population). Chile planned to vaccinate 15 million people, or three-quarters of its population, by the end of June, 2021. The effectiveness of the Chilean vaccine rollout has been attributed to its robust primary health care systems and functional national

immunization tracking systems.²¹⁸ Chile's publicly funded National Immunization Program has been in existence since the 1800's and has proven to still be highly effective at delivering and tracking vaccines on a mass scale.²¹⁹

Furthermore, Chile also relied on a simple and clear population prioritization system based on age and communication mechanisms.²²⁰ Its rollout began on February 3, 2021, offering doses to those aged 90 years and older first. Within three weeks, Chile had vaccinated over 1.98 million people over the age of 65.²²¹ The Chilean government also published a calendar which clearly outlined who was eligible for a vaccine on what forthcoming day, with no appointments for vaccinations required, and priority based purely on age and birth year, dropping a birth year per day in many circumstances.^{222,223}

In early April 2021, COVID-19 cases in Chile began to rapidly increase. Experts attributed this to prematurely relaxed COVID-19 restrictions and an increase in the prevalence of COVID-19 variants. Also, while the CoronaVac vaccines manufacturers, primarily being used in Chile, reported a 90% efficacy rate, more updated results in Brazil showed that it appeared to be only 50% effective in preventing COVID-19 transmission despite still being 100% effective against hospitalization. Moreover, the vaccine requires two doses for it to reach over 50% effectiveness, and was reportedly found to only be 3% effective after only one dose is administered.²²⁴ More recent research shows that two doses of the vaccine are 67% effective at preventing symptomatic transmission of COVID-19, 80% effective at preventing mortality, 85% effective at preventing hospital admissions, and 87% effective at preventing ICU admissions.²²⁵

By mid-April, COVID-19 cases in Chile soared, overwhelming its health care system and

requiring strict lockdown measures. In combination with the low efficacy rates of the vaccines being used, it appeared that Chile had reopened and loosened restrictions too soon. For example, Chile opened its borders allowing people to travel for summer vacations in November, 2020 and January, 2021.²²⁶ However, restrictions in Santiago did not allow people to leave their houses to buy essential services without a permit, and people were allowed to exercise outside between 7-8:30am. As of April 18, 2021, 96% of ICU beds in the country were occupied and seven variant strains had been identified.²²⁷

On June 11, 2021, despite having vaccinated over 60% of its population with at least one dose, Chile announced that all 8 million residents of Santiago had to stay at home at all times. A total of 58% of the population had been vaccinated with both doses, however, individuals with only one COVID-19 vaccine dose continued to become severely ill due to the CoronaVac's low vaccine efficacy after a single dose.²²⁸ The only other vaccine in use in Chile was the Pfizer-BioNTech. As of May 10, 2021, Chile had administered 14 million doses of the CoronaVac vaccine compared to 2.4 million doses of the Pfizer-BioNTech vaccine.²²⁹

Additionally, Chile announced on August 5, 2021 that it will begin vaccinating adults aged 55 years and older with a third dose of a COVID-19 vaccine. The doses will be primarily AstraZeneca vaccine, despite the majority of the population receiving the CoronaVac vaccine for their first and second doses.²³⁰

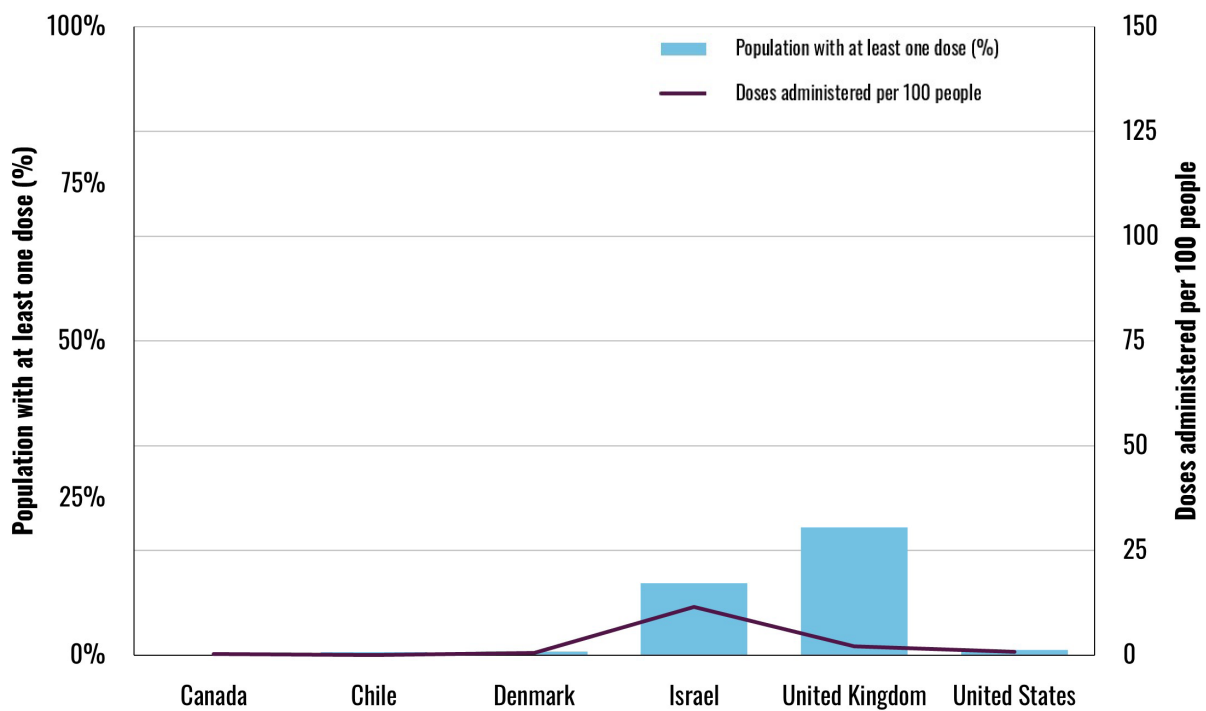
Despite limitations to the quality of the main initial vaccine being used, Chile has been a model example of how to execute a mass-vaccination program. This is due to their past experience in emergency preparedness, which leveraged community and primary care

providers to deliver vaccines. However, the Chilean experience is a cautious reminder to all jurisdictions that vaccines are not a solution in themselves and that strong public health measures must be continuously in place and slowly lifted in order to continue

protecting the most vulnerable, including older persons.

The Evolution of COVID-19 Vaccine Rollouts Across Canada, Chile, Denmark, Israel, the United Kingdom, and the United States

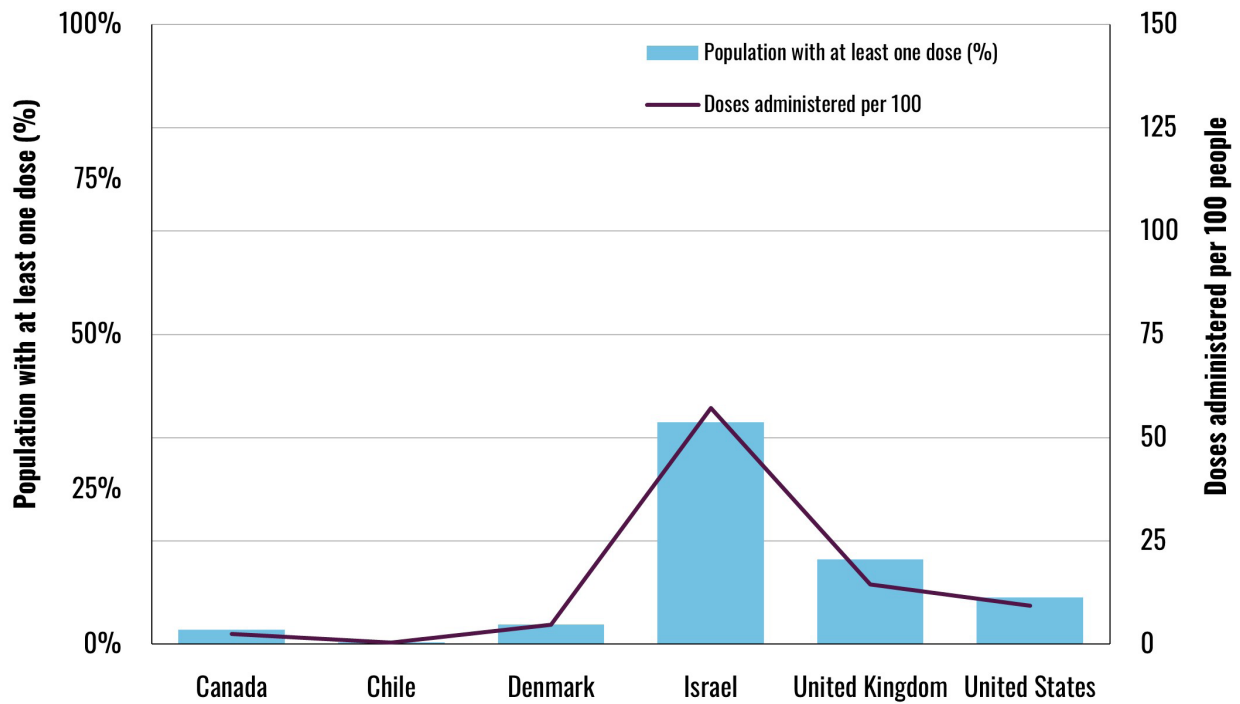
December 15 to December 31, 2020



At the beginning of its COVID-19 vaccine rollout, Israel was able to vaccinate a higher proportion of its population very quickly — with 11.43 doses administered at the end of December, 2020 – respectively 9.36 and 11.17 doses per 100 people ahead of the United

Kingdom and Canada. Data from Canada, Chile, Denmark, and the United States was limited at the end of December, 2020.

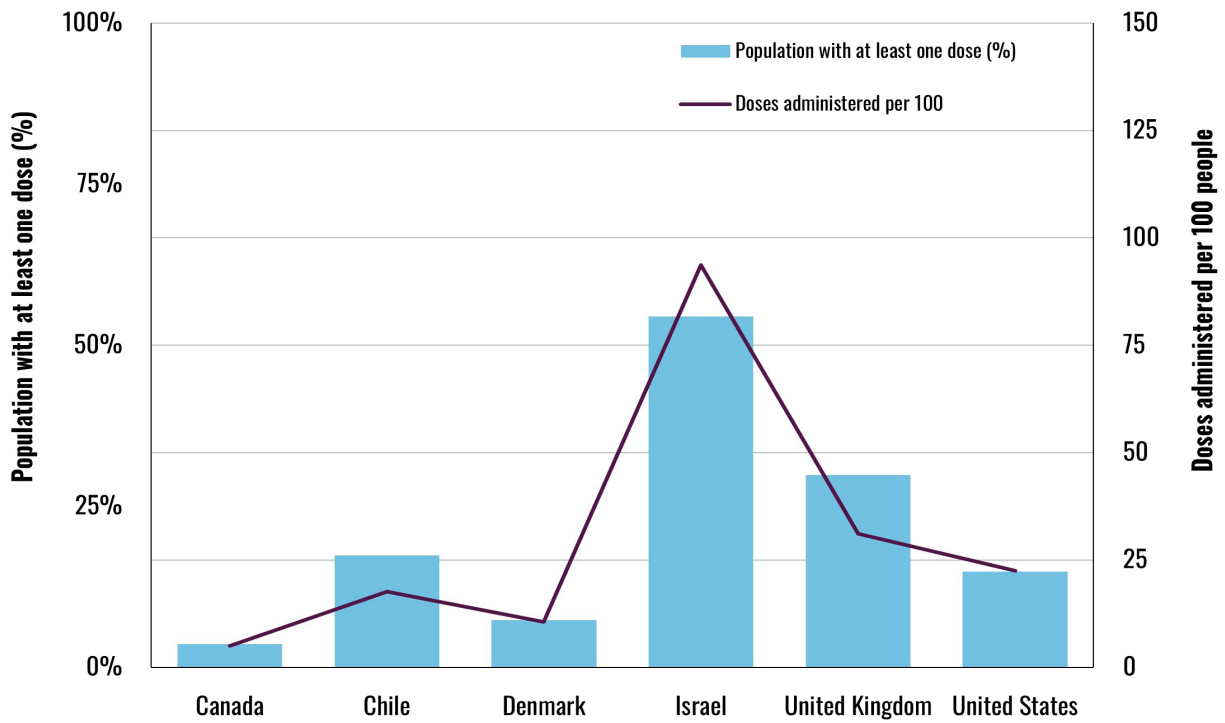
January 1 to January 30, 2021



With the exception of Chile, the vaccine rollouts in Israel, the UK, US, Denmark, and Canada began to fully take shape during the month of January. All five countries saw substantial increases in COVID-19 vaccine doses being administered, with Israel increasing its vaccination rate five-fold compared to January, followed by the United Kingdom (6.85 times), the United States (11.08 times), Denmark (7.85 times), and Canada (9.76 times). The higher a country's COVID-19

vaccine doses administered per 100 people, the greater the share of its people who had received at least one dose of a COVID-19 vaccine — with over 35% of Israel's population receiving at least one dose, followed by the United Kingdom (13.8%), the United States (7.54%), Denmark (3.18%) and Canada (2.18%).

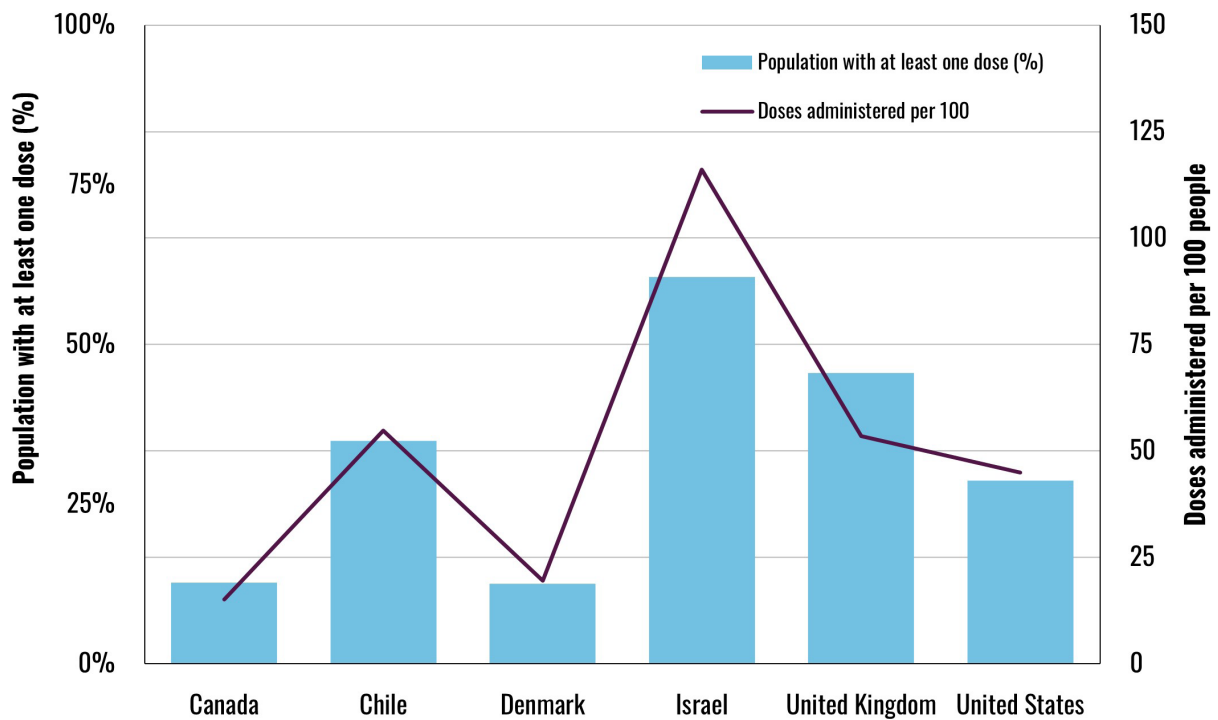
February 1 to February 29, 2021



February, 2021 saw Canada fall far behind this analysis' five comparator countries, both in terms of speed (COVID-19 vaccines doses per 100 people) and coverage (share of people who received at least one dose of a COVID-19 vaccine). In direct comparison to Denmark, the second slowest and lowest vaccination coverage rates in February among the selected countries, Canada's doses per 100 people was 53% less COVID-19 doses per 100 people compared to Denmark. At the same point in time, Denmark had vaccinated nearly twice the share of its population (7.74%

compared to 3.73%). Also, Chile began its vaccination rollout in February, vaccinating over 18% of its population of 19.12 million in under one month. While Israel and the United Kingdom increased the total proportion of their populations with at least one vaccine dose by 17.78% and 16.37%, respectively.

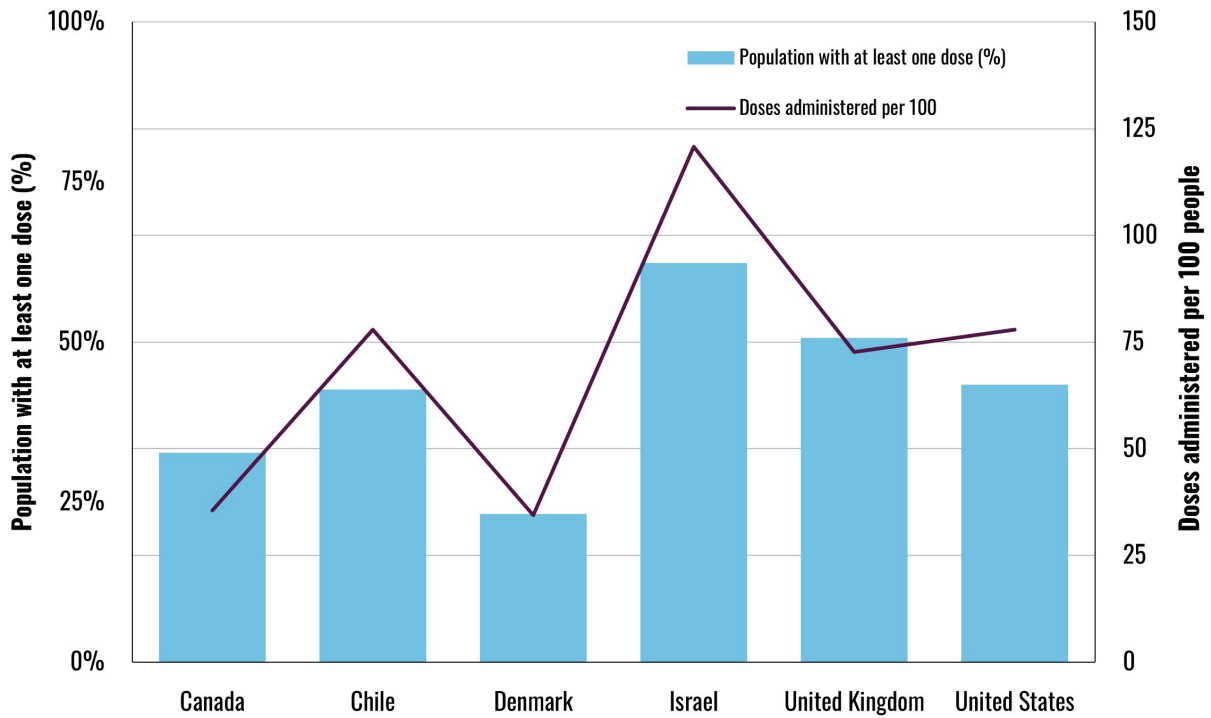
March 1 to March 30, 2021



By the end of March, 2021 Israel, followed by Chile, the United Kingdom, and the United States had made significant improvements in both the speed and coverage of their vaccination rollouts. While Denmark and Canada lagged behind. Specifically in comparing the doses administered per 100 people, Israel (116 per 100 people) was administering over twice as many doses per 100 people compared to Chile (54.89 per 100 people), the United Kingdom (52.53 per 100 people), and the United States (44.93 per 100 people). While Israel's vaccine doses administered per 100 people was nearly *six* and *seven* times higher than Denmark and Canada. This gradient was also consistent

across coverage rates, with Israel having vaccinated 60.62% of its population with at least one dose by the end of March. While the United Kingdom, Chile, and the United States vaccinated 44.88%, 35.64%, and 29.18% of their populations with at least one vaccine dose during the same period. Lastly, Canada and Denmark fell far behind, only having vaccinated 13.26% and 12.84% of the populations with at least one dose, respectively.

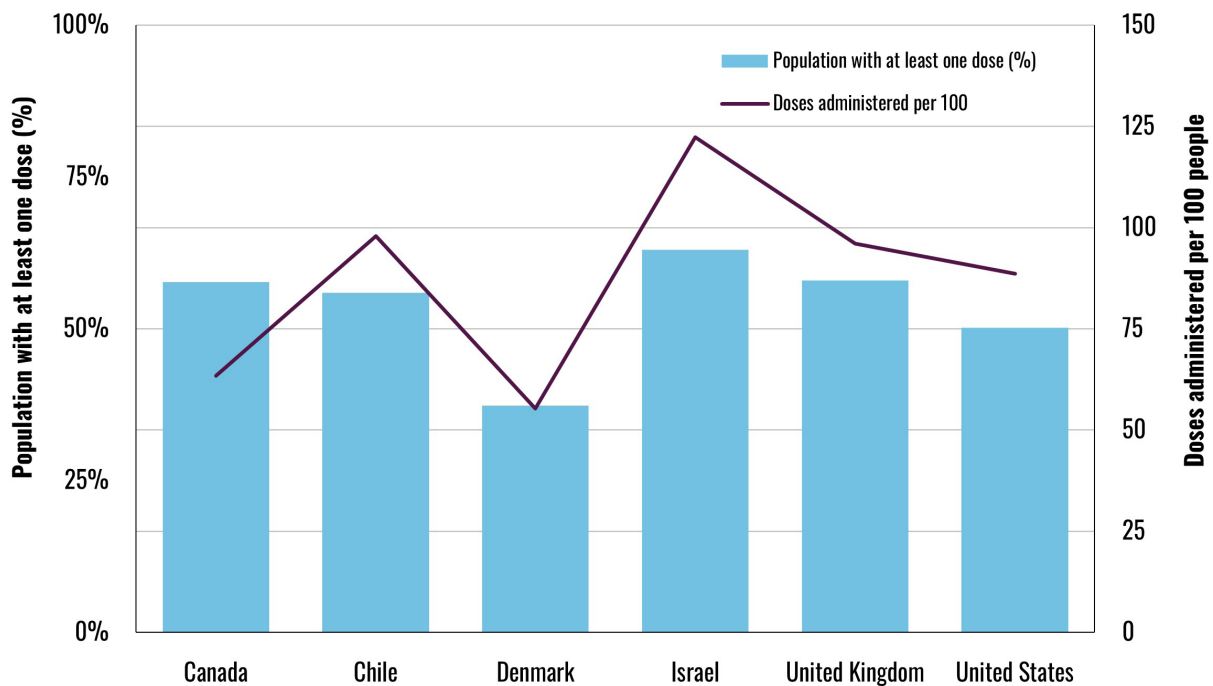
April 1 to April 30, 2021



The trends identified in March 2021 were consistent through April 2021. Israel continued to vaccinate its population at a substantially higher rate (120.71 per 100,000 people) and had vaccinated a far greater proportion of their population (62.39%) compared to the five additional countries. While Chile, the UK, and USA were administering vaccines at a relatively similar speed (77.67 to 71.81 per 100,000) and had similar proportions of their populations vaccinated with at least one dose (50.62 to 40.43%). Meanwhile, Denmark and Canada's vaccination rates were nearly 50%

lower compared to the UK, USA, and Chile. Although, both countries had significantly increased the proportion of their population vaccinated with at least one dose, as Canada and Denmark increased their vaccine coverage by 19.41% and 10.37% since March 31, 2021 respectively.

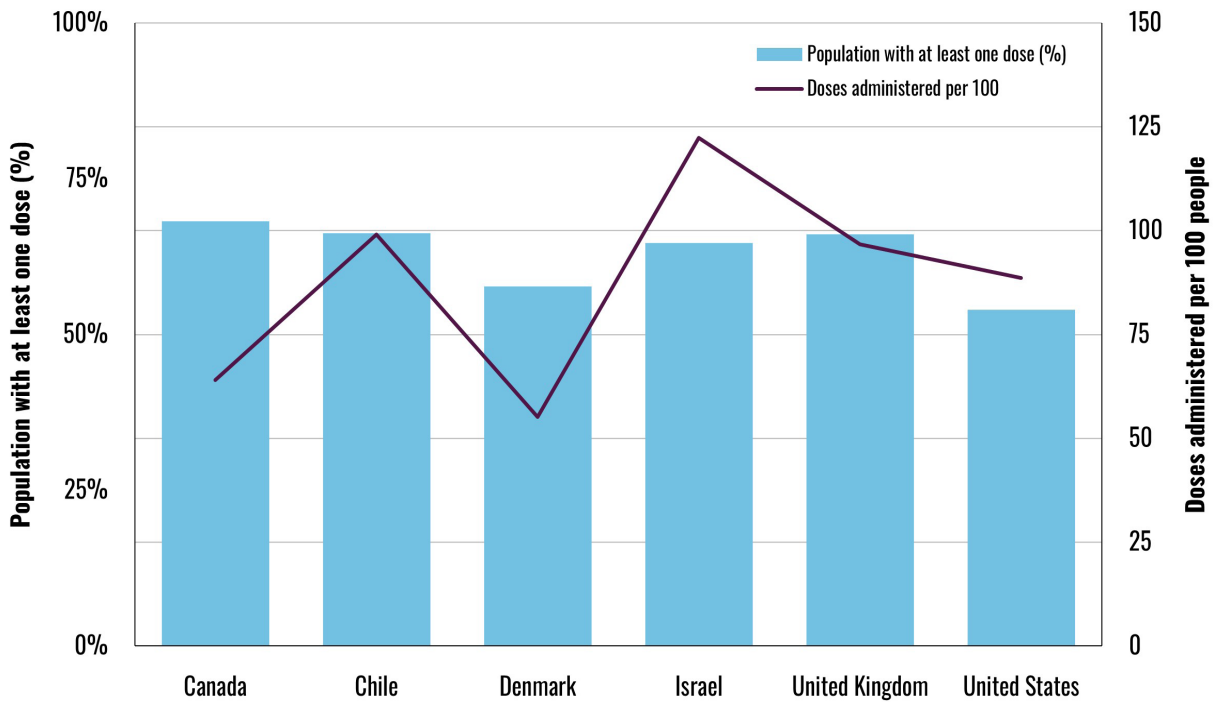
May 1 to May 30, 2021



In May 2021, Canada saw the greatest increase in the share of population vaccinated with at least one dose (25% increase) and doses administered per 100 people (27.7 additional doses administered per 100 people). In fact, by May 2021, Canada (57%) only trailed Israel (63%) and the United Kingdom (58%) in regards to having the greatest share of its population vaccinated with at least one dose. Chile and Denmark increased their share of their populations vaccinated with at least one dose by 13% and 14% in May 2021, respectively. While the United Kingdom,

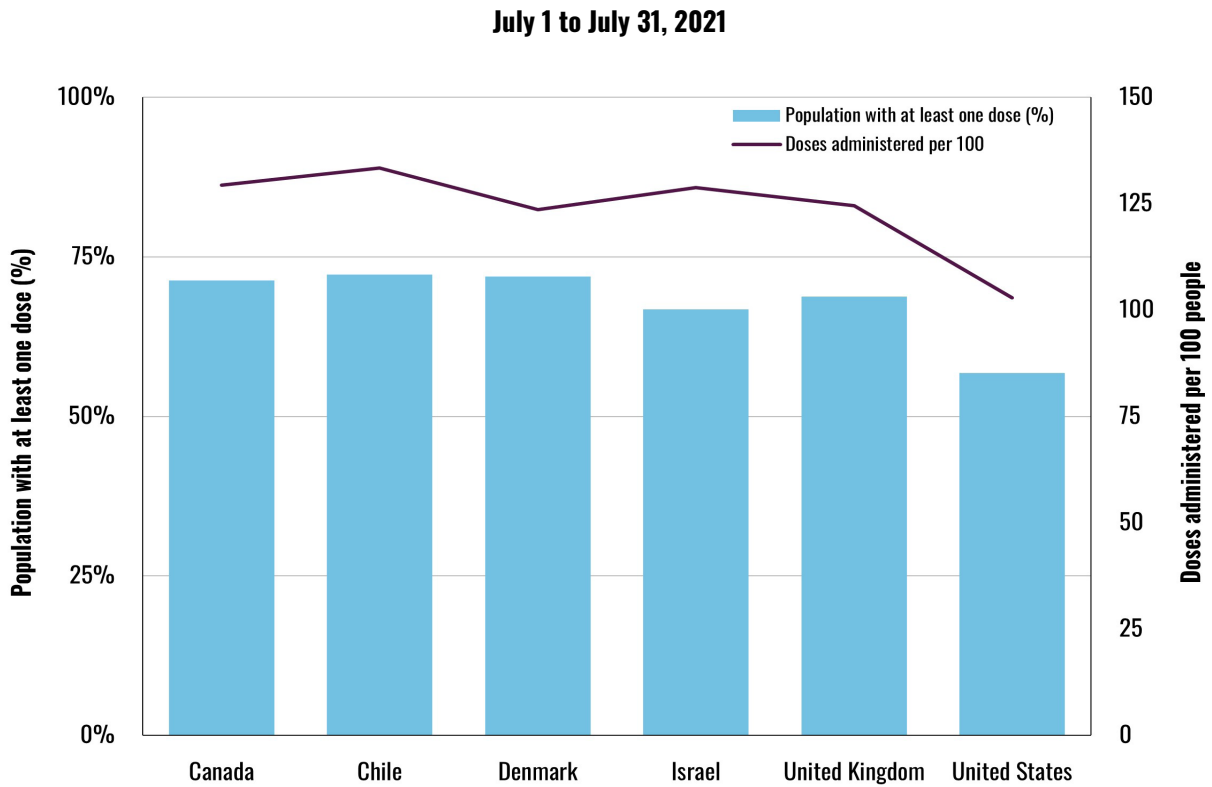
Chile, and Denmark increased the number of doses administered per 100 people by 23, 20, and 19 doses over the previous month. The United States had made small improvements on both fronts, increasing the shares of their populations vaccinated with at least one dose by 7% and the doses administered per 100 people by 10 doses. There were no substantial changes to Israel over the month of May 2021.

June 1 to June 30, 2021



Between the beginning and end of June 2021, Denmark increased the proportion of its population vaccinated with at least one dose of a COVID-19 vaccine by 20.31%. In fact, by the end of July 2021, Denmark was able to surpass the share of the population vaccinated in the United States, with 57.7% of its population having received at least one dose compared to 54.02%, respectively. The United States and Israel made small increases in their vaccination coverage rates throughout June 2021. This was largely due to ongoing hesitancy and access issues in the United States and a push for second doses in Israel. Chile and Canada each increased the proportion of their populations with at least

one dose by approximately 10%, reaching 66.30% and 68% of the population vaccinated, respectively. Finally, the United Kingdom continued to steadily increase its vaccination coverage rate, with an additional 8% of its population receiving at least one dose in June 2021. There were very little changes regarding the number of doses administered per 100 people across all five countries throughout June 2021, suggesting that each country has largely reached its capacity for administration, even though it's now being suggested that to reach herd immunity, in the face of the Delta Variant, 90% of a country's population may now need to be vaccinated.^{231,232,233,234,235}



In July 2021, Canada, Israel, the United Kingdom, and the United States saw little increase in the proportion of the populations that have received at least one dose of a COVID-19 vaccine increasing between 3.15% to 2.11%, respectively. However, Denmark (increase by 14.20%) and Chile (increase by 5.90%) both saw significant increases in the proportion of their population vaccinated with at least one dose. As of July 31, 2021, Chile (72.34%), Denmark (72.59%), and Canada (71.49%) have the highest vaccination rates, followed by the United Kingdom and

Israel (66.80% each), and the United States (57.19%). More significant changes occurred in countries administered per 100 people. In particular, both Denmark (increase by 71.746 per 100 people) and Canada (increase by 66.36 per 100 people) began vaccinating with greater speed. Significant increases also occurred in Chile (increase by 35.19 per 100 people), the United Kingdom (increase by 27.78 per 100 people), and the United states (increase by 14.67 per 100 people).

Three Defining Characteristics of Successful COVID-19 Vaccine Rollouts Among Older Adult Populations: Centralized Planning, Simplicity and Speed

Three defining characteristics of vaccination rollout strategies have helped to explain the discrepancies in vaccine coverage among older populations across the six countries with early COVID-19 vaccine rollouts that the NIA has analyzed.

First, centralized planning refers to the organization and governance of the decision-making processes for the vaccine rollout. Countries with a vertically integrated model of decision-making and delivery, where national government bodies had power over the planning and implementation of the vaccine rollout, have clearly been more efficient at delivering vaccines in a timely manner. Second, simplicity in vaccine rollout strategies, particularly in countries that based their vaccine eligibility criteria mainly on age, also achieved more effective vaccine rollouts for their older populations. Lastly, countries that prioritized the use of speed in their vaccination rollouts were able to vaccinate a greater number of older adults, thus reducing hospitalizations and saving more lives.

Centralized Planning

Centralized planning refers to the decision-making responsibilities across different levels of government. Centrally planned vaccine rollouts utilize a vertical decision-making process where national governing bodies create policy that is directly implemented at the sub-national and regional levels. A decentralized model allocates decision-making control to sub-national and regional jurisdictions. In respect to vaccine rollouts, centralized planning models have appeared

to reduce fragmentation in decision-making and implementation, leading to more efficient vaccine rollouts.

Centrally planned vaccine rollouts are influenced by the pre-existing organizational structures and laws governing their respective healthcare systems. Israel and the United Kingdom have centrally planned healthcare systems, which have proved to be highly effective at distributing (from a national level) and administering vaccines (at a local level). In Denmark, decision-making is typically decentralized to the community, while in Chile health care system governance is heavily fragmented between private and public providers. However, both Denmark and Chile's vaccine rollouts were centrally planned and delivered by their federal governments and health agencies. On the other hand, both Canada and the United States have used decentralized models that require their provinces, territories, and states to develop and implement their own vaccination rollout strategies. This has caused noticeable disparities in older adult vaccination coverage rates across sub-national and regional jurisdictions.

Simplicity

Simplicity refers to the process of defining the eligibility of priority populations for vaccination. Given the overwhelming evidence that continues to demonstrate that age is the number one risk factor predicting morbidity and mortality from COVID-19, countries that based their vaccine rollout eligibility criteria around age tended to have more efficient

vaccine rollouts. Specifically, countries that limited the number of variables, and based their priority populations on the most current evidence, appear to have vaccinated a greater share of their older populations. This led to a greater reduction in morbidity and mortality due to COVID-19 in these populations over similar time periods.

Israel, the UK, Chile, Denmark and Israel all relied on a simple, *risk-based* population prioritization strategy. These strategies followed a similar structure, prioritizing first-doses to residents and staff of LTC homes, health care workers, followed by older adults. Due to a centrally planned vaccine rollout, these countries were able to quickly vaccinate these populations. When older adults were eligible for their first doses, eligibility was based on incremental decreases in age. This method proved to be highly efficient. Simplifying vaccine eligibility based on age necessarily includes an intersection of other 'vulnerable' and high-risk groups and increases uptake within these populations. While both the Canadian and the United States federal advisory boards recommended the prioritization of vaccine eligibility based on age, their decentralized decision-making models also allowed their sub-national jurisdictions to modify vaccine eligibility to include other groups. This quickly resulted in extreme variance in vaccination coverage across levels amongst older adults in Canadian and US provinces/territories and states. It is important to note one major distinction between the allocation of vaccines from federal to sub-national or regional governments between the two countries. Both countries' federal governments allocated vaccines to jurisdiction based on population size. However, the United States accounted for the age in their distribution formulas, while Canada did not. This allowed

relatively younger Canadian jurisdictions like the province of Alberta to also vaccinate their older populations sooner compared to older provinces such as the Atlantic provinces, British Columbia, and Ontario.

Speed

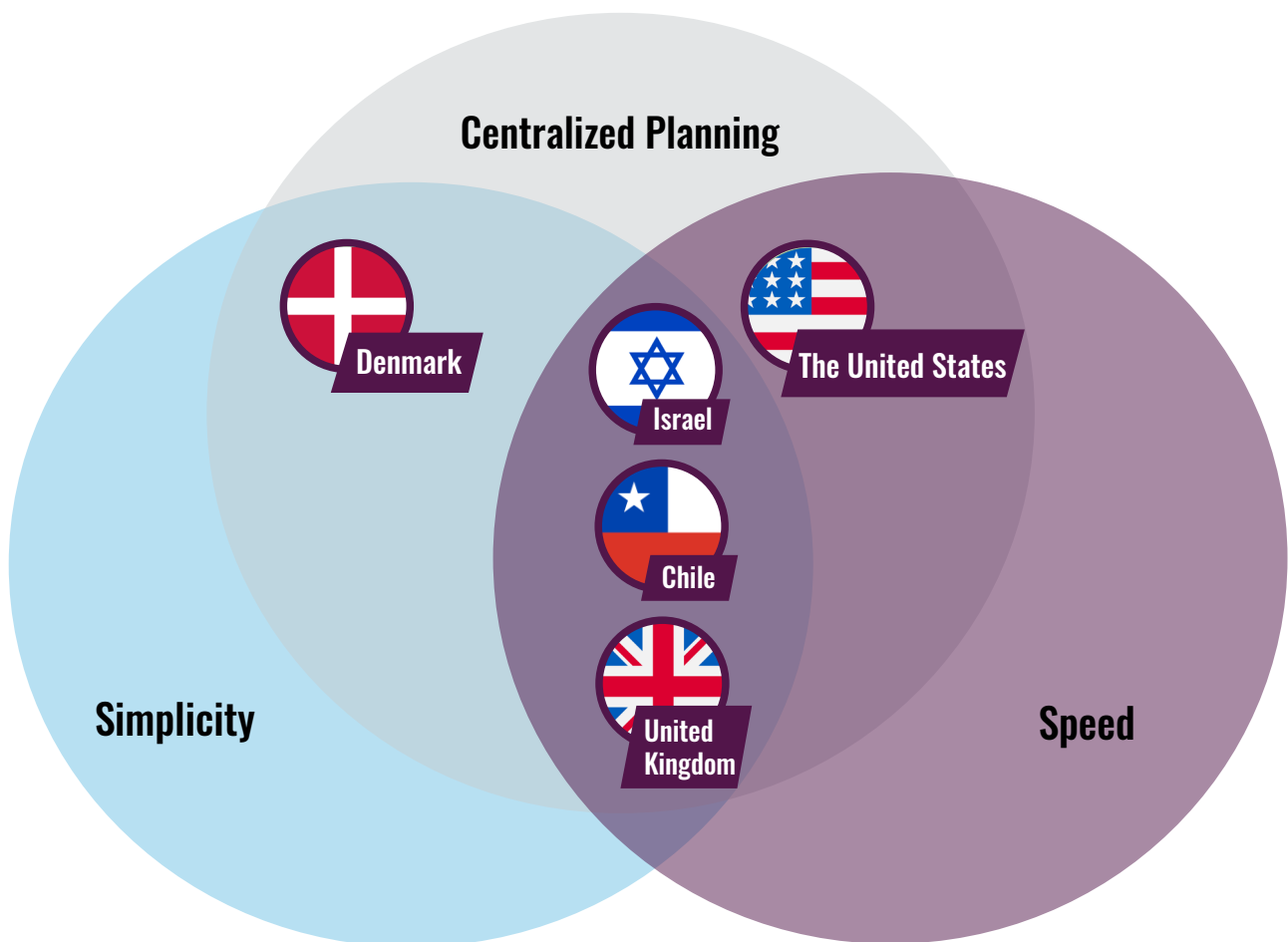
Speed is the ability of a country to administer vaccines in a timely manner. The rate at which vaccines are administered is often dependent on the capacity of a country's healthcare system to efficiently deliver vaccinations. The health care system capacities of the selected countries are similar in terms of economic and health care inputs. In analyzing this report's selected countries — Chile, Denmark, Israel, the United Kingdom, and the United States — this report has found that while vaccine supply did contribute to the consistency in a country's vaccine rollout, prioritizing the use of speed in a vaccination rollout was found to be an explicit political and strategic choice, rather than just a product of system capacity. It is therefore important to consider how these three variables — centralized planning, simplicity, and speed — intersect and work together synergistically.

Another major distinction between the vaccination rollouts between the United States and Canada is that the United States prioritized speed in its rollout. The United States 'first dose first' strategy proved to be highly effective as it was delivering up to 3.38 million doses per day at its peak and a daily average of 530,000 per day.²³⁶ Vaccine rollouts prioritizing speed were also evident in the United Kingdom, Israel, and Chile. Notably, Israel levered its national electronic health registry to rapidly identify eligible individuals and schedule their vaccine appointments. Further, the United Kingdom, Israel, Chile, and the United States immediately engaged

their pharmacies and primary care clinics and providers to administer vaccines. For example, the United Kingdom immediately delegated the vaccination of older adults to its General Practitioners. Also, Israel and Chile have health care workers and administrators who are trained specifically in disaster management and response. Both countries leveraged these to rapidly set up mass vaccination clinics in the communities which were able to vaccinate large groups of people in a timely manner. The speed at which older adults were vaccinated made a significant difference

within countries. Specifically, the NIA's earlier reported comparison of second dose vaccination administration between Alberta and Ontario clearly illustrated the impacts of speed, as the risk of death from COVID-19 among older Albertans was found to be significantly lower than that of older Ontarians between January and July 2021. Speed also made a significant impact in Israel, when comparing vaccination coverage in cities, those that vaccinated a higher proportion of older adults more quickly saw reductions in their overall hospitalization and deaths.

Figure 6: Speed, Simplicity, and Centralized Planning



Part 3: Lessons Learned

Vaccine Supply Security Leads to Improved Stability of Vaccine Rollout Plans, Which Enables Better Decision Making and Direction from National to Local Governments

Consistent vaccine supply at the national level provides greater stability in the execution of proposed vaccination rollout strategies, better enabling jurisdictions to make their rollout decisions based on evidence and in alignment with evidence-based recommendations.

Canada's LTC and early older adult vaccine rollout was plagued by early and inconsistent vaccine shipment and supply issues, causing some provinces, such as Ontario and New Brunswick, to stray early from following NACI's guidance. The inconsistent supply also caused discrepancies in the delivery of second doses, as several provinces prioritized vaccinating all of their residents with at least one dose before offering a second dose to older adults, despite their risk of hospitalization and death significantly increasing as time elapsed.

Internationally, the United States, Israel, and the United Kingdom were able to secure large shipments of vaccines through early contracts. Also, the United States and the United Kingdom were able to produce vaccines domestically, ensuring consistent vaccine shipments throughout the entirety of their rollouts. This allowed them to follow their recommended guidance, prioritizing the vaccination of LTC residents and older adults and vaccinating them in a timely manner.

Denmark is a unique example in that they had an early supply of vaccines and their rollout was initially highly efficient. Reliant on the AstraZeneca vaccine, Denmark was among the first countries to completely stop the use of the vaccine due to safety concerns. Contrary to Canada, the Danish government made decisive actions and provided clear direction and communication on how they were going to proceed with the AstraZeneca vaccine, causing little panic across the country. While Canada deliberated on how to proceed with the AstraZeneca vaccine, this ultimately exacerbated public concerns about its safety and efficacy and likely led to increased vaccine hesitancy amongst its population.

The Most Effective Rollout Strategies Rely on Scientific Evidence and Avoid Politicization

The most efficient and effective vaccine rollouts relied on scientific evidence and used a simple population prioritization strategy that targeted vaccinating their highest risk populations first. Existing evidence makes it indisputably clear that older adults are at the greatest risk of death and hospitalization due to COVID-19, after residents of LTC homes, health care staff, and people with chronic conditions.

As seen across the international rollouts, countries that based their vaccination rollout specifically on age were able to vaccinate a greater share of their population and reduce COVID-19 hospitalizations and deaths faster compared to Canada.

Even among Canadian provinces and territories, those who committed to the NACI guidance and followed an age-based rollout after completing the first phase of their vaccine rollouts in LTC settings were able to vaccinate a greater number of older people with their first and second doses more quickly, thus preventing the greatest numbers of avoidable hospitalizations and deaths. This was demonstrated earlier to have been the result for Alberta versus Ontario whose approach may have led to the preventable and unnecessary loss of up to 527 mostly community-dwelling older Ontarians.

In Canada, NACI's priority populations were based on the most updated evidence on which population groups were determined to be at the highest risk of severe illness and death due to COVID-19. However, the fragmentation of Canada's health care system — in that provinces and territories are individually responsible for planning and implementing their own individual rollout strategies, led to major discrepancies during Canada's rollout. While all of Canada's provinces and territories adopted the same initial priority population recommendations — residents and staff of LTC and health care workers — to receive the first doses of COVID-19 vaccines through the Winter and Spring of 2021, differences

emerged during the second phase of Canada's vaccine rollout, as some provinces deviated from NACI's guidelines by prioritizing lower risk populations above for older adults.

As the vaccination coverage among LTC residents and health care workers increased, a risk-based approach was utilized in varying capacities across Canadian jurisdictions during the second phase of the vaccine rollout. The majority of jurisdictions, and most notably Canada's northern territories, committed to vaccinating the remaining priority populations recommended by NACI. This was also noted in all five of the international jurisdictions studied, in particular Chile, Denmark, Israel and the United Kingdom, as their vaccine rollout strategies consistently followed a priority population strategy based on risk. For example, Chile released a calendar clearly outlining eligibility by calendar dates based on a person's birth year. Some Canadian provinces, including Ontario and New Brunswick, began to include additional populations beyond the NACI recommendations, delaying the administration of their vaccines to members of their most vulnerable populations. This ultimately inhibited the overall effectiveness of these jurisdictions' vaccine rollout in terms of preventing the most avoidable numbers of hospitalizations and deaths. This was quantified in the United Kingdom, where vaccinating older adults was estimated to have saved over 10,000 of their lives by the end of April 2021.

Moreover, basing rollouts on evidence in Canada was also noted in the adoption of provinces to extend and then re-adjust the administration interval between first and second doses of COVID-19 vaccines. While nearly all jurisdictions responded to the

initial extension from 4 to 16 weeks proposed by NACI, several Canadian provinces re-adjusted the length of their dosing intervals as evidence confirmed that older adults are subject to lower immunity after one dose over a longer interval compared to younger adults. The greatest impact of this decision was noted in the NIA's analysis comparing Alberta and Ontario presented earlier in this report, which found that the risk of dying from COVID-19 in Ontario was 76% higher among people 60-79 years and 150% higher among people 80+ years between mid-April and June compared to those living in Alberta in May 2021.

Greater Efforts to Address both Socio-Economic and Cultural Barriers Along with the Physical, and Cognitive Limitations of Older Adults are Needed to Facilitate Access to Vaccine Appointments

COVID-19 has highlighted a major limitation in Canada's digital health care infrastructure. Canada lacks the capacity to appropriately notify and monitor individuals when they are eligible for vaccination. Canadian jurisdictions should invest in developing a national unified health information system that has the capacity to store, monitor, and track individuals' medical and personal information. Such a robust system could be used to contact and empanel patients for vaccine appointments.

Struggles to book older adults for their vaccine appointments were evident across Canadian jurisdictions. Many jurisdictions did not get their booking appointment system running in a timely manner, experienced

early system crashes, and/or failed to consider the many cultural factors along with potential physical and cognitive limitations inhibiting older adults from booking a vaccine appointment.

As the NIA's previous work has demonstrated, older adults in Canada have consistently been the least hesitant to getting a COVID-19 vaccine throughout the entirety of the pandemic. This sentiment has also been documented across several international jurisdictions, including the United States and the United Kingdom.^{237,238} Moreover, compared to younger populations, older adults have demonstrated to have the highest vaccine uptake rates across Canada and internationally. Thus, targeting older adults for vaccines was not only the most effective means to reduce COVID-19-related hospitalizations and deaths, but also the most efficient means to achieve the highest possible rate of COVID-19 vaccinations.

In addition to prioritizing older adults, taking specific steps to facilitate access to vaccines for older adults allowed jurisdictions to successfully achieve high vaccination rates. A number of Canada's provinces utilized primary care providers and pharmacies at the community-level to better reach their older adult populations. Quebec and Alberta pioneered a vaccination delivery system through their pharmacies and primary care clinics, both of which had among the fastest older adult vaccination rollouts. For example, Quebec was one of the first jurisdictions to expand their vaccine distribution system to include over 350 pharmacies in Montreal, expanding to 1550 pharmacies across the province over the spring. In fact, Quebec announced that its pharmacies were expected to administer over 2 million total doses

throughout its entire rollout.²³⁹ Two weeks after beginning this program, Montreal reported to have vaccinated 77% of its residents aged 60 years and older.²⁴⁰ On the contrary, Ontario did not allow pharmacies to deliver vaccines to people aged 60 years and older until March 25, 2021 and only initially did so in 4 of its 34 public health units.²⁴¹ However, the province announced that it would be expanding vaccine delivery to over 1500 pharmacies by the end of April, 2021.²⁴²

Moreover, the United Kingdom, Israel, and United States immediately integrated primary care clinics and pharmacies into their vaccination rollouts. In particular, the United Kingdom designated community primary clinics as the designated sites for older adults to be vaccinated. Both Chile and Israel also developed one of the highest speed vaccination rollouts through the use of mass vaccination clinics and a robust primary health care network, which were particularly favourable models in their warm weather climates and should be considered to help improve the speed and efficiency of Canada's vaccination rollout throughout its summer months.

Faster, Efficient Vaccine Rollouts Save Lives

Rapidly vaccinating an entire population, but particularly older adults first due to their increased risk, has clearly been the most effective measure to reduce hospitalizations and deaths related to COVID-19 beyond significantly reducing community transmissibility. Several jurisdictions, including Canada's territories, Alberta, PEI, and Quebec were able to begin vaccinating their community-dwelling older populations relatively sooner because of

their initial rapid LTC vaccination programs. This was particularly important as their LTC rollouts wrapped up in the peak of Canada's second wave, meaning that prolonging the vaccination of community-dwelling older adults prolonged their risk of being unprotected against COVID-19 during Canada's forthcoming third wave.

The impact of speed was evident in the United Kingdom and Israel.

Preliminary findings by Public Health England found that the early vaccination of older adults saved over 6,000 lives by February 2021 and over 10,000 by April 2021. A study in Israel found that hospitalization and death rates were significantly higher in cities that took longer to vaccinate the same proportion of older adults.

This is a particularly stark finding that highlights how discrepancies between jurisdictions even amongst the fastest vaccine rollouts can reduce hospitalizations and save lives.

The comparison of second dose prioritization between Alberta and Ontario further highlights the importance of how increasing the speed of vaccinating older adults saves lives.

The overall efficiency of Alberta's vaccine rollout allowed them to start vaccinating their community-dwelling older adults at least three weeks sooner, which expedited both their ability to receive their first and second doses, resulting in a much lower COVID-19-related mortality rates among older Albertans from April to July 2021.

Comparatively, the slower vaccination rollout in Ontario prolonged the length of time that older adults were unvaccinated and waited to receive their second doses, significantly increasing the risk of mortality for older Ontarians due to COVID-19.

Vaccines are Highly Effective at Preventing Hospitalization and Death Among Older Adults

Both international and Canadian examples continue to highlight the impact of vaccines on reducing the burden of COVID-19 along with COVID-19-related hospitalizations and deaths. Across all jurisdictions, older adults have been subject to the most significant reductions in hospitalizations and deaths. This was evident across Canada's LTC rollouts, as British Columbia, Ontario, and Quebec reported eight to ten-fold declines in COVID-19-related deaths since the beginning of their vaccine rollouts. Moreover, preliminary results using PHAC data saw hospitalization and

deaths among adults aged 65 years and older decline rapidly by April 26, 2021.²⁴³

This was consistent across international jurisdictions, with rapid declines in hospitalizations and deaths among older adults documented across the United Kingdom, Israel, and United States.

The UK saw a 63% reduction in deaths among adults aged 65 years and older between February 19 and March 5, 2021. Israel saw a 41% drop in infections in people aged 60 years and older and 31% drop in hospitalizations due to COVID-19 by mid-April, and the United States witnessed COVID-19 hospitalizations among older Americans plunge more than 70% between January and April 2021.²⁴⁴

Part 4: Policy Recommendations

In analyzing the Canadian and other early international rollout experiences, the NIA has identified five specific actionable policy recommendations to improve additional COVID-19 and future vaccine rollouts. Addressing these issues immediately will not only improve the efficiency of existing vaccine rollouts for older adults, but will likely have positive spillover effects for the general population, ultimately leading to a most impactful vaccine rollout for all. Moreover, the lessons learned and policy recommendations identified in this report can be adopted by other comparable high-income countries that have yet to, or have only recently begun, their vaccine rollouts as of July 15, 2021. This includes Hong Kong (36.4% of total population with at least one dose), Japan (32.3%), South Korea (31.1%), Australia (27.6%), Taiwan (18.88%), and New Zealand (17.41%).

1. Invest in the Creation of Greater Domestic Vaccine Production Capacity

Canada must invest in its domestic vaccine production capacity to increase access to a reliable supply of vaccines. Currently, unlike countries such as the United States and the United Kingdom, Canada lacks the capacity to produce current COVID-19 vaccines in use domestically, forcing it to rely on vaccine shipments from other countries. This was particularly problematic during the winter and spring months of 2021, as planned shipments of Moderna and Pfizer-BioNTech vaccine doses were often delayed or became subject to import restrictions from the EU. Supply

issues are still ongoing in Canada as a result of ongoing safety and quality issues related to the AstraZeneca and Johnson & Johnson vaccines. Similar problems arose in Israel and Denmark, as both countries made an agreement to research and develop vaccines and production facilities to ensure a long-term supply of booster shots, as part of an ability to more rapidly address emerging issues such as new variants.²⁴⁵

Canada was once a leader in domestic vaccine production throughout the 20th century, but the federal government sold off the companies to private entities in the 1980's and 1990's.²⁴⁶ What remains of Canada's vaccine production facilities, which are owned by large private companies, is dedicated to other important vaccines of which production could not be stopped to manufacture the COVID-19 vaccines. Moreover, the Canadian political landscape is widely considered unattractive to private vaccine manufacturers due to its policies that favour the production of generic drugs, therapeutics, and vaccines. This was one of the main reasons that AstraZeneca rejected a desire to produce COVID-19 vaccines in Canada, when invited by the federal government to do so.²⁴⁷

In response to the ongoing supply issues during the vaccine rollout, Canada's federal government has invested over \$415 million dollars to expand a Sanofi plant in Toronto to be able to produce vaccines to address future pandemics. Additionally, in November 2020 the federal government stated that it was investing in developing a vaccine production facility, along with announcing a partnership with Novavax to produce its anticipated

vaccine in Canada, once it is approved for use by Health Canada. In February 2021 the federal government announced that it was investing \$46 million in a University of Saskatchewan facility that will have the capacity to produce up to 40 million doses of vaccines per year.²⁴⁸

While these are steps in the right direction, Canada urgently needs to also consider readjusting its policy landscape and production capacity to attract pharmaceutical companies to produce vaccines both for potential future COVID-19 booster vaccinations and to deal with emerging epidemic threats. In particular, Canada must do more to incentivize domestic production and support research-based vaccine production centers through universities.²⁴⁹ Such facilities would not only have the capacity to research and produce cutting-edge vaccine technologies, but also provide it with vaccines at the cost of production.

2. Vaccination Rollout Strategies Should be Kept Simple, Evidence-Based, and Focused on Targeting the Highest-risk Populations Whenever Possible

The COVID-19 pandemic overburdened healthcare systems and continues to cause preventable deaths around the globe. In Canada, the majority of hospitalizations and deaths due to COVID-19 have occurred amongst older adults. The greatest tool we have to reduce the incidence and impacts of COVID-19 has been through vaccines. Therefore, vaccine rollout strategies should target populations at the highest risk in order to have the greatest impact. This is not only the most ethical solution to prevent undue illness and death, but also simplifies the

decision-making process and depoliticize the vaccine rollout in general. This was exemplified across Chile, Denmark, Israel and the United Kingdom, as these countries based their priority populations purely on age, enabling them to administer doses more efficiently. Targeting the highest-risk populations also limits concerns or criticisms of political interference, as the evidence clearly supports that reducing COVID-19 cases among older adults is the best way to have the greatest impact on lowering hospitalizations and deaths.

Evidence must be at the forefront of political decisions as Canadian jurisdictions begin to lift public health restrictions, such as wearing a mask indoors and social gatherings. Lessons can be learned from the sudden and complete lifting of restrictions in Chile after the majority of its population had received one dose and COVID-19 cases proceeded to sky rocket.^{250,251} This is also similarly happening now in the United Kingdom.²⁵² Moreover, Israel has re-implemented masking requirements months after removing them due to concerns over the rapidly spreading Delta Variant.²⁵³ As Canadian provinces continue to lift restrictions, notably British Columbia and Alberta, it is important to consider the risks associated with doing so. In particular, jurisdictions must consider the proportion of the older population that has received a second dose of a COVID-19 vaccine. With many jurisdictions choosing to extend second dose intervals, older adults did not achieve the same level of protection compared to younger adults. This meant older adults continued to be at a higher risk of contracting, being hospitalized, or dying due to COVID-19, despite having received one dose. While this issue has now been largely resolved, with most older Canadians now having received both of their vaccine doses, this sort of issue could arise again if booster

vaccinations need to be administered or in the management of future pandemics.

3. Strengthen Canada's Digital Health Infrastructure Capacity to More Efficiently Facilitate Vaccination Appointments

Older adults are more frequently subject to physical and cognitive limitations, or barriers in accessing certain technologies, that can make booking and accessing vaccine appointments challenging. Therefore, it is important to consider these limitations and present solutions such as offering appointment bookings over the phone and in multiple languages, targeting homebound older adults, and leveraging community access points such as primary care clinics and pharmacies. Moreover, these points of access are not limited to older adults, but can be extended to improve access to the remaining population that may be subject to similar physical and cognitive limitations.

A number of solutions could be provided to this problem. Firstly, ensuring that vaccines can be booked outside of an online booking portal. This is particularly important for older adults, as over half of them do not have access to the internet. Expanded options would include the ability to phone in, book through a doctor or pharmacy, or have a family member or friend be able to book appointments on their behalf. Moreover, it is critically important that all vaccination information, including booking services, are provided in a culturally appropriate way, such as being offered in several languages.

Canada should look to Israel as a model for creating a robust digital health infrastructure system. Israel has a centralized digital health

record system which contains every person's health record and contact information. Individuals, including older adults, were notified when they became eligible and their vaccine appointments were booked directly. Such a robust system not only seamlessly booked eligible residents their appointments, but also identified individuals who may require additional support in order to get to their appointment.

A potential solution to Canada's booking system problem may already be available. The Canadian IT company CANImmunize has developed a "digital immunization tracking system that helps Canadians keep track of their vaccinations with a mobile app and web portal."²⁵⁴ The app helps governments, health providers, and patients easily track and book vaccine appointments. The adoption of the technology varies across Canada. However, this technology was adopted to create Nova Scotia's easy-to-use vaccine booking platform and was highly successful, automatically booking residents for the next appointment and sending them reminders.²⁵⁵

4. Expand Access to Vaccines Through Pharmacies, Primary Health Care Providers, Community Clinics, and Targeted Homebound Vaccination Programs

Canada should expand vaccine access points and leverage community-based resources to increase the efficiency, accessibility, and equitability of vaccination. In particular, primary care providers and pharmacies should be effectively integrated into early rollout strategies. The integration of primary care clinics and pharmacies early in the vaccination rollouts of Chile, Israel, the United Kingdom

and United States proved to be an effective method to reach older adults to receive their vaccines. Moreover, both Alberta and Quebec scaled up vaccinations through pharmacies, which proved again to be an effective tool for reaching older adults more quickly. Thus, the NIA recommends that pharmacies, primary care providers, and programs designed to reach homebound older adults be integrated immediately into vaccine rollout strategies.

There is a reluctance on the part of many older adults to go to mass-vaccination sites for a number of reasons. These include transportation, mobility issues, and the fear of coming in close contact with others and contracting the virus. Continued provincial and territorial investments will be needed to expand vaccine access points and ensure that primary care providers and pharmacies have the resources to administer COVID-19 vaccinations, as they usually do for other vaccinations like Influenza on an annual basis.

Moreover, homebound older adults have also been explicitly left out of provincial/territorial vaccination strategies. Homebound adults are also at increased risk of contracting COVID-19 from visitors and home care workers.²⁵⁶ The NIA believes the best solution to addressing the vaccination of homebound adults is the development of a mixed delivery system. This would consist of primary care providers, homecare nurses, and community paramedics that can administer in-home vaccinations for individuals for whom this would be a necessity and not a convenience.²⁵⁷ The United States has made significant efforts to vaccinate homebound adults, including the use of firefighters across California to reach homebound adults.^{258,259}

Outreach strategies should not be limited to older homebound persons, but can be extended to neighborhoods with high concentrations of older adults. For example, the Ontario Science Advisory Table proposed implementing mobile on-site COVID-19 vaccinations in Naturally Occurring Retirement Communities (NORCs) by neighborhood risk in Toronto. The study identified 489 NORCs in Toronto, of which 52% are located in neighborhoods with the highest COVID-19 incidence rates. Targeting NORCs has the potential to reduce multiple equity-related barriers. These include transportation, mobility limitations, along with cultural challenges such as language, ensuring that all older adults are vaccinated in a timely manner.²⁶⁰ Targeting high-risk neighborhoods ensures that more traditionally marginalized populations will be better included in vaccination rollouts, thus producing a more inclusive rollout overall.

5. Develop a National Health Emergency Preparedness Plan and Train Healthcare Workers to Deliver Effective Emergency Preparedness and Response Measures

Canada does not have a dedicated training program for health care workers in disaster or emergency response and preparedness. Many countries, particularly those in high-conflict areas, and regions prone to natural disasters, train their health care workforces in disaster and emergency preparedness and control. Despite being severely impacted by the SARS pandemic in 2003, Canada still appears to lack a comprehensive strategy to respond to health emergencies and does not routinely train health care workers for these situations. Nor does Canada have a dedicated healthcare

workforce ready to be deployed in disaster or emergency situations. Preparing a national vaccine rollout strategy, in combination with identifying the roles and training of health care workers and administrators in a disaster or emergency situation, would enable Canada to respond more immediately and effectively in the wake of another health emergency. The NIA in partnership with the Canadian Red Cross released a report titled [*Closing the Gaps: Advancing Emergency Preparedness, Response and Recovery for Older Adults*](#) in December, 2020. It highlighted the disproportionate number of deaths occurring among older adults compared to younger age groups in the context of disasters and emergencies, both in Canada and internationally. The report recommends that health care personnel be trained to deal with the complex psychosocial and physical needs of older adults under emergency circumstances, that healthcare organizations integrate emergency preparedness planning into all health care worker training, and the establishment of a national advisory committee for emergency preparedness, response and recovery — with a special focus on strategies for older adults.²⁶¹

Canada should look to Israel and Chile as models of health disaster and emergency preparedness and response. Israel and Chile have been able to achieve two of the fastest and precise vaccine rollouts among international leaders. A large contribution to this is their pre-existing capacity to rapidly respond to health emergencies. Both Chile and Israel have a high proportion of health care workers trained in disaster management and response, including nurses working in community settings that are trained in immunization. Further, Chile's recent experiences implementing mass vaccination clinics for influenza for other infectious

diseases programs were leveraged to help organize and manage its COVID-19 vaccine rollout.^{262,263} Moreover, Israel has a robust emergency response plan through its pre-existing Epidemic Management Teams and a National Immunization Technical Advisory Group which were leveraged to quickly plan and implement its highly effective national COVID-19 vaccination strategy.²⁶⁴



Conclusion

Comparing Canada's vaccine rollout with that of five other countries – the United Kingdom, Israel, the United States, Denmark, and Chile — which also initiated early vaccine rollouts against COVID-19, clearly illustrated several missed opportunities to improve vaccination coverage among Canada's older adult population. In particular, the fragmented adoption of NACI recommendations, the inclusion of lower risk groups into priority populations for vaccination by some provinces, and a lower emphasis on speed across some Canadian provincial and territorial rollouts significantly hindered the efficiency and impact of Canada's overall vaccine rollout for its oldest populations.

Moving forward, both in Canada and international jurisdictions that are just beginning their vaccine rollouts, including Japan, Hong Kong, Taiwan, Australia, and New Zealand, it is critical that immunizing older adults with both doses of COVID-19 vaccines is prioritized, and that significant efforts are made to reduce barriers to accessing vaccines for older adults.

Such efforts need to include investing in more domestic vaccine production opportunities, creating evidence-based rollout strategies that support the most vulnerable populations first, better integrating primary care and pharmacies into vaccine rollouts, improving

booking technologies and options, and better preparing and leveraging a health emergency workforce and action plan. Investing in these actions and policies would not only improve the efficiency of current and future vaccine rollouts for older adults, but would also remove bottlenecks, thus improving the efficiency and equity of vaccine rollouts for the entire population across Canada and in other countries the world over.



References

- ¹ Government of Canada. "Canada COVID-19 Weekly Epidemiological Report 25 July to 31 July 2021". August 6, 2021. Retrieved from: <https://www.canada.ca/content/dam/phac-aspc/documents/services/diseases/2019-novel-coronavirus-infection/surv-covid19-weekly-epi-update-20210806-en.pdf>
- ² Hannah Ritchie, Esteban Ortiz-Ospina, Diana Beltekian, Edouard Mathieu, Joe Hasell, Bobbie Macdonald, Charlie Giattino, Cameron Appel, Lucas Rodés-Guirao and Max Roser (2020) - "Coronavirus Pandemic (COVID-19)". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/coronavirus'
- ³ Public Health Agency of Canada. "Canadian COVID-19 vaccination coverage report". July 23 2021.
- ⁴ Canada Health Care Network. "COVID-19 Canadian Timeline." 2021. Retrieved from: <https://www.canadianhealthcarenetwork.ca/covid-19-a-canadian-timeline>
- ⁵ "Canada COVID-19 Weekly Epidemiological Report 25 July to 31 July 2021.". August 6, 2021. Retrieved from: <https://www.canada.ca/content/dam/phac-aspc/documents/services/diseases/2019-novel-coronavirus-infection/surv-covid19-weekly-epi-update-20210806-en.pdf>
- ⁶ Moriarty, T., Boczula, A.E., Thind, E.K., Loreto, N., McElhaney, J.E. "Excess All-Cause Mortality During the COVID-19 Epidemic in Canada. Royal Society of Canada." 2021
- ⁷ Estiri, Hossein, Zachary H. Strasser, Jeffy G. Klann, Pourandokht Naseri, Kavishwar B. Waghlikar, and Shawn N. Murphy. "Predicting COVID-19 mortality with electronic medical records." *NPJ digital medicine* 4, no. 1 (2021): 1-10.
- ⁸ The Centers for Disease Control and Prevention. COVID Hospitalization and Death by Age. July 19, 2021. Retrieved: <https://www.cdc.gov/coronavirus/2019-ncov/covid-data/investigations-discovery/hospitalization-death-by-age.html>
- ⁹ Aiello, Forani. "V-Day: First COVID-19 Vaccines administered in Canada. CTV News. December 14, 2020. Retrieved: <https://www.ctvnews.ca/health/coronavirus/v-day-first-covid-19-vaccines-administered-in-canada-1.5230184>
- ¹⁰ Grady, D. "Moderna coronavirus vaccine trial shows promising early results." *New York Times* (2020). <https://www.nytimes.com/2020/05/18/health/coronavirus-vaccine-moderna.html>
- ¹¹ New York Times. "Pfizer Begins Human Trials of Possible Coronavirus Vaccine" *New York Times* (2020). <https://www.nytimes.com/2020/05/05/health/pfizer-vaccine-coronavirus.html>
- ¹² Pfizer-BioNTech (approved December 9, 2020), Moderna (approved December 23), and AstraZeneca (approved February 26, 2021). Canada began federal vaccinations on December 14th, 2020.
- ¹³ Canadian Institute for Health Information. "The Impact of COVID-19 on Long-Term Care in Canada: Focus on the First 6 Months." Ottawa, ON: CIHI; 2021. Retrieved: <https://static1.squarespace.com/>

static/5c2fa7b03917eed9b5a436d8/t/605c
cc07515dd669a9c81ae5/1616694280553/
impact-covid-19-long-term-care-canada-first-
6-months-report-en.pdf

¹⁴ National Advisory Committee on Immunization (NACI). "Recommendations on the use of COVID-19 vaccine(s)." December 12, 2020. Retrieved: <https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci/recommendations-use-covid-19-vaccines/december-12-2020.html>

¹⁵ Rabson. "Canada paid a premium to get COVID-19 vaccine doses from pfizer earlier than planned". The Canadian Press. June 12, 2021. Retrieved: <https://www.cbc.ca/news/politics/canada-vaccine-contracts-1.6063776>

¹⁶ Lexchin, J. "The roots of Canada's COVID-19 vaccine shortage go back decades." *The Conversation* 6 (2021). Retrieved: <https://theconversation.com/the-roots-of-canadas-covid-19-vaccine-shortage-go-back-decades-154792>

¹⁷ Government of Canada. "Approved COVID-19 Vaccines". 2021. Retrieved: <https://www.canada.ca/en/health-canada/services/drugs-health-products/covid19-industry/drugs-vaccines-treatments/vaccines.html>

¹⁸ European Medicines Agency. "COVID-19 Vaccine AstraZeneca: Benefits still outweigh the risks despite possible link to rare blood clots with low blood platelets. March 18 2021. Retrieved: <https://www.ema.europa.eu/en/news/covid-19-vaccine-astrazeneca-benefits-still-outweigh-risks-despite-possible-link-rare-blood-clots>

¹⁹ National Advisory Committee on Immunization. "Recommendations on the use of COVID-19 vaccines" July 22, 2021. Retrieved: <https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci/recommendations-use-covid-19-vaccines.html>

²⁰ Ibid.

²¹ National Advisory Committee on Immunization. "Recommendations on the use of COVID-19 vaccines" July 22, 2021. Retrieved: <https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci/recommendations-use-covid-19-vaccines.html>

²² Pelley, Laurent. "Health Canada Holding Off on Johnson & Johnson COVID-19 Vaccine Distribution". April 30, 2021. Retrieved: <https://www.cbc.ca/news/health/johnson-johnson-vaccine-hold-health-canada-1.6010065>

²³ Bensadoun, Emerald. "NACI Recommends Johnson & Johnson shot for adults 30 and up, says mRNA preferred." May 3, 2021. Retrieved: [://globalnews.ca/news/7829200/naci-johnson-and-johnson-coronavirus-vaccine/](https://globalnews.ca/news/7829200/naci-johnson-and-johnson-coronavirus-vaccine/)

²⁴ Tasker, John Paul. "Johnson & Johnson COVID-19 vaccine is in limbo with no additional Canadian shipments planned". June 29, 2021. Retrieved: <https://www.cbc.ca/news/politics/johnson-johnson-no-shipments-planned-1.6084140>

²⁵ Sinha S, Feil C and Iciaszczyk N. "The rollout of the COVID-19 vaccines in care homes in Canada as of March 19, 2021." March 2021. Retrieved: <https://ltccovid.org/2021/04/01/the-rollout-of-covid-19-vaccines-in-canadian-long-term-care-homes-30th-march-update/>

²⁶ Government of Canada. "National Vaccination Coverage". 2021. Retrieved: <https://health-infobase.canada.ca/covid-19/vaccination-coverage/#a3>

²⁷ Government of Canada. "Vaccines for COVID-19: Shipments and deliveries". 2021. Retrieved: <https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/prevention-risks/covid-19-vaccine-treatment/vaccine-rollout.html>

²⁸ Hinchey, Grant. "First doses of Moderna COVID-19 vaccine arrive in Yukon, N.W.T." December 28, 2021. Retrieved: <https://www.cbc.ca/news/canada/north/nwt-yukon-moderna-vaccine-arrival-1.5856213>

²⁹ Boynton, Sean. "First shipments of Moderna coronavirus vaccine arrive in Yukon, N.W.T." December 28, 2021. Retrieved: <https://globalnews.ca/news/7545193/yukon-nwt-coronavirus-moderna-vaccine/>

³⁰ The Toronto Star. "Coronavirus Tracker". March 1, 2021. Retrieved: <https://www.thestar.com/news/canada/2021/03/01/coronavirus-covid-19-updates-toronto-canada-march-1.html>

³¹ Government of Canada. "Pfizer-BioNTech COVID-19 Vaccine: Updated Storage and Transportation Conditions". March 8, 2021. Retrieved: <https://healthycanadians.gc.ca/recall-alert-rappel-avis/hc-sc/2021/75083a-eng.php>

³² Ferguson, Rob. "Ontario moves target for 1st doses of COVID-19 vaccines in LTC homes to Feb. 5, delays shots for health-care". January 25, 2021. Retrieved: <https://www.thestar.com/politics/provincial/2021/01/25/ontario-moves-target-for-1st-doses-of-covid-19-vaccines-in->

[ltc-homes-to-feb-5-delays-shots-for-health-care-workers.html](https://www.thestar.com/politics/provincial/2021/01/25/ontario-moves-target-for-1st-doses-of-covid-19-vaccines-in-ltc-homes-to-feb-5-delays-shots-for-health-care-workers.html)

³³ Russel, Jarvus, Campanella, Patel. "A senicide': Strategic missteps, logistical hurdles plague Ontario's early vaccine rollout". January 23, 2021. Retrieved: <https://globalnews.ca/news/7588530/ontario-coronavirus-vaccine-rollout-inside-look/>

³⁴ Iqbal, Maria. "Retirement home with Hamilton's fewest staff vaccinated says city failed to count them as 'high risk'". March 23, 2021. Retrieved: <https://www.thespec.com/news/hamilton-region/2021/03/23/covid-vaccinations-hamilton-retirement-home.html>

³⁵ City of Hamilton. "COVID-19 Vaccine Distribution. 2021." Retrieved: <https://www.hamilton.ca/coronavirus/covid-19-vaccine-distribution>

³⁶ CBC. "Some health care workers are still hesitant to get COVID-19 vaccine". January 16, 2021. Retrieved: <https://www.cbc.ca/radio/whitecoat/some-health-care-workers-still-hesitant-to-get-covid-19-vaccine-1.5872004>

³⁷ Warren, May. "Uptake for the COVID-19 vaccine has been high among Toronto's long-term-care home residents. For staff, not so much". January 16, 2021. Retrieved: <https://www.thestar.com/news/gta/2021/01/16/uptake-for-the-covid-19-vaccine-has-been-high-among-torontos-long-term-care-home-residents-for-staff-not-so-much.html>

³⁸ Hunter, Justine. "Vaccine-hesitant care-home workers present a major challenge for public-health advocates". January 8, 2021. Retrieved: <https://www.theglobeandmail.com/canada/british-columbia/article-vaccine-hesitant-care-home-workers-present-a-major-challenge-for/>

³⁹ CBC. "Some health care workers are still hesitant to get COVID-19 vaccine". January 16, 2021. Retrieved: <https://www.cbc.ca/radio/whitecoat/some-health-care-workers-still-hesitant-to-get-covid-19-vaccine-1.5872004>

⁴⁰ National Institute on Ageing (2021). "If Older Canadians Want a COVID-19 Vaccine, Why Is Canada Struggling to Get Them Vaccinated?". National Institute on Ageing, Ryerson University. Toronto, ON <https://www.nia-ryerson.ca/reports>

⁴¹ Leger, "Leger's North American Tracker. May 16, 2021.

⁴² Les, Perreux. "Quebec COVID-19 data show promising results". February 19, 2021. Retrieved: <https://www.theglobeandmail.com/canada/article-quebec-vaccine-data-show-promising-results/>

⁴³ Kotyk, Alyse. "Single vaccine dose could prevent 8 out of every 10 COVID-19 Cases: BCCDC". February 19, 2021. Retrieved: <https://bc.ctvnews.ca/single-vaccine-dose-could-prevent-8-out-of-every-10-covid-19-cases-bccdc-1.5316120>

⁴⁴ Perreux, Les. "Quebec's race to vaccinate all long-term care residents first brings relief after so many coronavirus deaths". February 12, 2021. Retrieved: <https://www.theglobeandmail.com/canada/article-quebecs-race-to-vaccinate-all-long-term-care-residents-first-brings/>

⁴⁵ Aziz, Saba. "Bingo, movie nights: COVID-19 outbreaks plummet in LTC homes as vaccines bring relief". March 5, 2021. Retrieved: <https://globalnews.ca/news/7677371/coronavirus-vaccines-long-term-care-outbreaks/>

⁴⁶ Brown, K. A., N. M. Stall, and T. Vanniyasingam. "Early impact of Ontario's COVID-19 vaccine rollout on long-term care home residents and health care workers." Science Briefs of the Ontario COVID-19 Science Advisory Table 2 (2021): 13. Retrieved: <https://covid19-sciencetable.ca/sciencebrief/early-impact-of-ontarios-covid-19-vaccine-rollout-on-long-term-care-home-residents-and-health-care-workers/>

⁴⁷ Sinha S, Feil C and Iciaszczyk N. "The rollout of the COVID-19 vaccines in care homes in Canada as of March 19, 2021." March 2021. Retrieved: <https://ltccovid.org/2021/04/01/the-rollout-of-covid-19-vaccines-in-canadian-long-term-care-homes-30th-march-update/>

⁴⁸ National Advisory Committee on Immunization. "Recommendations on the use of COVID-19 vaccines" July 22, 2021. Retrieved: <https://www.canada.ca/en/public-health/services/immunization/naci-recommendations-use-covid-19-vaccines.html>

⁴⁹ National Institute on Ageing (2021). "If Older Canadians Want a COVID-19 Vaccine, Why Is Canada Struggling to Get Them Vaccinated?". National Institute on Ageing, Ryerson University. Toronto, ON <https://www.nia-ryerson.ca/reports>

⁵⁰ Statistics Canada. "Annual demographic estimates: Canada, provinces and territories." (2015). Retrieved: <https://www150.statcan.gc.ca/n1/en/catalogue/91-215-X>

⁵¹ Hannah Ritchie, Esteban Ortiz-Ospina, Diana Beltekian, Edouard Mathieu, Joe Hasell, Bobbie Macdonald, Charlie Giattino, Cameron Appel, Lucas Rodés-Guirao and Max Roser (2020) - "Coronavirus Pandemic (COVID-19)". Published

online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/coronavirus'

⁵² Treble, Patricia. "Why is there a hold-up with Pfizer's COVID vaccines?". January 26, 2021. Retrieved: <https://www.macleans.ca/news/why-is-there-a-hold-up-with-pfizers-covid-vaccines/>

⁵³ MacCharles, Ballingall. "Here's why Moderna's COVID-19 vaccine shipment to Canada have been delayed." February 8, 2021. Retrieved: <https://www.thestar.com/politics/federal/2021/02/08/heres-why-modernas-covid-19-vaccine-shipments-to-canada-have-been-delayed.html>

⁵⁴ Walsh, Marieke. 2021. New deals could speed up vaccination schedules, Trudeau says. *The Globe and Mail*, Mar 04, 2021. <http://ezproxy.lib.ryerson.ca/login?url=https://www.proquest-com.ezproxy.lib.ryerson.ca/newspapers/new-deals-could-speed-up-vaccination-schedule/docview/2495964112/se-2?accountid=13631> (accessed March 4, 2021).

⁵⁵ Mason, Jeff. "US to share 4 million doses of AstraZeneca COVID-1 vaccine with Mexico, Canada". March 18, 2021. Retrieved: <https://www.reuters.com/article/us-health-coronavirus-usa-mexico-exclusi-exclusive-u-s-plans-to-send-four-million-doses-of-astrazeneca-vaccine-to-mexico-canada-official-idUSKBN2BA22S>

⁵⁶ Jones, Ryan. "Trudeau urges Canadians to 'stay strong' as vaccine deliveries accelerate". March 30, 2021. Retrieved: <https://www.cbc.ca/news/politics/trudeau-ministers-covid19-update-march-30-1.5969426>

⁵⁷ Krugel, Lauren. "U.S. working on plan to lend doses of Oxford-AstraZeneca vaccine to Canada, Mexico". March 18, 2021. Retrieved: <https://www.cp24.com/news/u-s-working-on-plan-to-lend-doses-of-oxford-astrazeneca-vaccine-to-canada-mexico-1.5352396?cache=yes>

⁵⁸ Sears, Cochrane. "After slow start, Canada's vaccine rollout is now a race against time." March 17, 2021. Retrieved: <https://www.cbc.ca/news/politics/vaccine-rollout-trudeau-anand-coronavirus-covid-1.5952276>

⁵⁹ Mason, Jeff. "U.S. to share 4 million doses of AstraZeneca COVID-19 vaccine with Mexico, Canada". March 18, 2021. Retrieved: <https://www.reuters.com/article/us-health-coronavirus-usa-mexico-exclusi-exclusive-u-s-plans-to-send-four-million-doses-of-astrazeneca-vaccine-to-mexico-canada-official-idUSKBN2BA22S>

⁶⁰ Tasker, Cochrane. "Moderna slashing vaccine deliveries to Canada, but Pfizer steps up with 8 million more doses". April 16, 2021. Retrieved: <https://www.cbc.ca/news/politics/moderna-delay-1.5990166>

⁶¹ Bensadoun, Emerald. "Feds making 'assessment of demand' from provinces for Johnson & Johnson vaccine supply". June 29, 2021. Retrieved: <https://globalnews.ca/news/7989401/feds-assessing-demand-johnson-and-johnson-vaccine/>

⁶² Canadian Press. "Canada to keep holding back J&J COVID-19 vaccines until U.S. lab probe is complete" May 21, 2021. Retrieved: <https://globalnews.ca/news/7885430/canada-jj-covid-vaccine-hold-continues/>

⁶³ Global News. "Canada could get J&J vaccine shipment in June as quality concerns linger". June 11, 2021. Retrieved: <https://globalnews.ca/news/7941685/eu-jj-covid-shots-u-s-contamination/>

⁶⁴ Bimman, Abigail. "Canada to donate 100M COVID-19 vaccines to world". June 11, 2021. <https://globalnews.ca/news/7941255/canada-covid-vaccine-donation-covax/>

⁶⁵ Taylor Stephanie. "Canada donating 13M surplus COVID-19 vaccine doses to developing countries", June 13, 2021. <https://www.ctvnews.ca/health/coronavirus/canada-donating-13m-surplus-covid-19-vaccine-doses-to-developing-countries-1.5468407>

⁶⁶ Turnbull, Sarah. "As the U.S. sends more Moderna doses to Canada, calls ramp up to reopen border". June 17, 2021. Retrieved: <https://www.ctvnews.ca/health/coronavirus/as-the-u-s-sends-more-moderna-doses-to-canada-calls-ramp-up-to-reopen-border-1.5474595>

⁶⁷ Turnbull, Sarah. "Canada to receive 7m Moderna vaccine doses in June: Anand". June 9, 2021. Retrieved: <https://www.ctvnews.ca/health/coronavirus/canada-to-receive-7m-moderna-vaccine-doses-in-june-anand-1.5462869>

⁶⁸ N. Little. "COVID-19 Tracker Canada". 2020. Retrieved: [COVID19Tracker.ca](https://www.covid19tracker.ca)

⁶⁹ Rabson, Mia. "Canada paid a premium to get COVID-19 vaccine doses from Pfizer earlier than planned". June 12, 2021. Retrieved: <https://www.cbc.ca/news/politics/canada-vaccine-contracts-1.6063776>

⁷⁰ Little, Simon. "Why is B.C. on its 1st age group when Alberta is opening vaccination

to anyone 65+?". March 15, 2021. Retrieved: <https://globalnews.ca/news/7695786/bc-alberta-vaccine-rollout/>

⁷¹ Fitowski, Teri. "Alberta seniors won't receive AstraZeneca vaccine following new recommendations". March 2, 2021. Retrieved: <https://calgary.ctvnews.ca/alberta-seniors-won-t-receive-astrazeneca-vaccine-following-new-recommendations-1.5330080>

⁷² Smith, Marc. "Here's what residents over 70 need to know about getting vaccinated in Sask.". February 24, 2021. Retrieved: <https://regina.ctvnews.ca/here-s-what-residents-over-70-need-to-know-about-getting-vaccinated-in-sask-1.5323306>

⁷³ Canadian Press. "All Yukon residents will be eligible for COVID-19 vaccination starting March 1". February 18, 2021. Retrieved: <https://www.ctvnews.ca/health/coronavirus/all-yukon-residents-will-be-eligible-for-covid-19-vaccination-starting-march-1-1.5314524>

⁷⁴ Government of Northwest Territories. "GNWT Releases Vaccination Strategy". January 5, 2021. Retrieved: <https://www.gov.nt.ca/en/newsroom/gnwt-releases-vaccination-strategy>

⁷⁵ Luara, Sciarpetti. "All Sask. long-term care homes have received 1st vaccine doses; most people could have initial shot by June". March 2, 2021. Retrieved: <https://www.cbc.ca/news/canada/saskatchewan/covid-19-in-sask-tuesday-1.5933705>

⁷⁶ Smith, Marc. "Here's what residents over 70 need to know about getting vaccinated in Sask.". February 24, 2021. Retrieved: <https://regina.ctvnews.ca/here-s-what-residents-over-70-need-to-know-about-getting-vaccinated-in-sask-1.5323306>

⁷⁷ Merali, Farrah. "Ontario seniors 'living in fear' of COVID-19 feel forgotten in vaccine rollout plan Social Sharing". January 18, 2021. Retrieved: <https://www.cbc.ca/news/canada/toronto/ontario-seniors-want-to-be-vaccinated-sooner-1.5875253>

⁷⁸ CBC News. "N.B. COVID-19 roundup: 3 new cases reported, vaccine eligibility continues to expand". March 20, 2021. Retrieved: <https://www.cbc.ca/news/canada/new-brunswick/three-new-covid-cases-new-brunswick-1.5957781>

⁷⁹ The Canadian Press. "PEI health officials expect to give first vaccine dose to all adults by July 1" March 2, 2021. Retrieved: <https://www.thestar.com/news/canada/2021/03/02/pei-health-officials-expect-to-give-first-vaccine-dose-to-all-adults-by-july-1.html>

⁸⁰ NACI. "NACI rapid response: Extended dose intervals for COVID-19 vaccines to optimize early vaccine rollout and population protection in Canada". March 3, 2021. Retrieved: <https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci/rapid-response-extended-dose-intervals-covid-19-vaccines-early-rollout-population-protection.html>

⁸¹ Zimonjic, Peter. "Stretch interval between COVID-19 vaccine doses up to 4 months, national advisory committee recommends". March 3, 2021. Retrieved: <https://www.cbc.ca/news/politics/naci-interval-advice-change-four-months-1.5934563>

⁸² Ward, Helen, Graham Cooke, Matthew Whitaker, Rozlyn Redd, Oliver Eales, Jonathan C. Brown, Katharine Collet et al. "REACT-2 Round 5: increasing prevalence of SARS-CoV-2

antibodies demonstrate impact of the second wave and of vaccine roll-out in England." MedRxiv (2021). <https://www.medrxiv.org/content/10.1101/2021.02.26.21252512>

⁸³ Brockman, Mark A., Francis Mwimanzi, Yurous Sang, Kurtis Ng, Olga Agafitei, Siobhan Ennis, Hope Lapointe et al. "Weak humoral immune reactivity among residents of long-term care facilities following one dose of the BNT162b2 mRNA COVID-19 vaccine." medRxiv (2021).

⁸⁴ Tait, Carrie. "Alberta completes COVID-19 vaccination of all long-term care residents, staff". January 18, 2021. Retrieved: <https://www.theglobeandmail.com/canada/alberta/article-alberta-completes-covid-19-vaccination-of-all-long-term-care-residents/>

⁸⁵ Goodfield, Kayla. "Starting Monday, Hamilton will begin vaccinating residents 85+ and York Region will allow residents 80+ to book appointments". February 26, 2021. Retrieved: <https://toronto.ctvnews.ca/starting-monday-hamilton-will-begin-vaccinating-residents-85-and-york-region-will-allow-residents-80-to-book-appointment-1.5325726>

⁸⁶ Herring, Jason. "Alberta expands vaccinations to more seniors, reveals who's next in Phase 2". February 19, 2021. Retrieved: <https://calgaryherald.com/news/local-news/live-at-12-p-m-kenney-to-announce-seniors-over-75-next-in-line-for-covid-19-vaccine>

⁸⁷ Government of Alberta. "COVID-19 vaccinations expand March 15 with Phase 2A". March 12, 2021. Retrieved: <https://www.alberta.ca/release.cfm?xID=7771292593DC3-CD17-16B1-613BDEBA837D8BE8>

- ⁸⁸ Government of Alberta. "COVID-19 Pandemic in Alberta"/ March 18, 2021. Retrieved: <https://www.alberta.ca/release.cfm?xID=77754C8D9F4C4-9A92-A476-F5795ECFEF0FAF44>
- ⁸⁹ Government of Alberta. "Coronavirus updates for Albertans". June 2021. Retrieved: <https://www.alberta.ca/coronavirus-info-for-albertans.aspx#statement>
- ⁹⁰ Government of Ontario. "Ontario's COVID-19 Vaccination Plan". June 12, 2021. Retrieved: <https://covid-19.ontario.ca/ontarios-covid-19-vaccination-plan#task-force>
- ⁹¹ The Toronto Star. "Today's coronavirus news: National panel advises against using AstraZeneca's vaccine on seniors; Toronto releases its vaccination playbook; Vaccine appointments fully booked in York Region, three hour". March 1, 2021. Retrieved <https://www.thestar.com/news/canada/2021/03/01/coronavirus-covid-19-updates-toronto-canada-march-1.html>
- ⁹² Zimonjic, Peter. "Stretch interval between COVID-19 vaccine doses up to 4 months, national advisory committee recommends". March 3, 2021. Retrieved. <https://www.cbc.ca/news/politics/naci-interval-advice-change-four-months-1.5934563>
- ⁹³ McKenzie-Sutter, Holly. "Ontarians 80 and older start booking second COVID-19 vaccine appointments". May 31, 2021. Retrieved: <https://toronto.ctvnews.ca/ontarians-80-and-older-start-booking-second-covid-19-vaccine-appointments-1.5449877>
- ⁹⁴ Government of Ontario. "Anticipated schedule for second doses of COVID-19 vaccines". May 28, 2021. Retrieved: <https://news.ontario.ca/en/backgrounder/1000220/anticipated-schedule-for-second-doses-of-covid-19-vaccines>
- ⁹⁵ Public Health Agency of Canada, Canadian COVID-19 vaccination coverage report, July 16, 2021.
- ⁹⁶ Public Health Ontario. "COVID-19 Data and Surveillance". <https://www.publichealthontario.ca/en/data-and-analysis/infectious-disease/covid-19-data-surveillance>
- ⁹⁷ Government of Alberta. "Case Data". July 2021. Retrieved: <https://www.alberta.ca/stats/covid-19-alberta-statistics.htm#data-export>
- ⁹⁸ Statistics Canada. "Population estimates on July 1, 2021 by age and sex". October 29, 2020. Retrieved: <https://doi.org/10.25318/1710000501-eng>
- ⁹⁹ N. Little. COVID-19 Tracker Canada (2020), COVID19Tracker.ca. Retrieved: <https://covid19tracker.ca/>
- ¹⁰⁰ Government of Canada. "COVID-19 Outbreak Update". June 2021. Retrieved: <https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection.html>
- ¹⁰¹ Government of Canada. "Coronavirus disease (COVID-19): Outbreak update". Retrieved: <https://www.publichealthontario.ca/-/media/documents/ncov/epi/covid-19-epi-confirmed-cases-post-vaccination.pdf?la=en>
- ¹⁰² Davidson, J., & Schimmele, C. "Evolving internet use among Canadian seniors". 2019. Statistics Canada= Statistique Canada.

¹⁰³ Nerestant, Antoni. "Language, cultural barriers could fuel vaccine hesitancy, Quebec community organizers warn". March 10, 2021. Retrieved: <https://www.cbc.ca/news/canada/montreal/vaccine-covid-19-language-culture-barriers-1.5942462>

¹⁰⁴ Weisgarger, Maria. "Concerns raised about barriers to booking vaccination for seniors in Vancouver's Chinatown area". March 16, 2021. Retrieved: <https://bc.ctvnews.ca/concerns-raised-about-barriers-to-booking-vaccination-for-seniors-in-vancouver-s-china-town-area-1.5350153>

¹⁰⁵ Rosen, Kayla. "Manitoba reducing language barriers at COVID-19 vaccine clinics". April 28, 2021. <https://winnipeg.ctvnews.ca/manitoba-reducing-language-barriers-at-covid-19-vaccine-clinics-1.5405735>

¹⁰⁶ Crawley, Mike. "Nearly 200,000 Ontarians aged 80 and older have not signed up for a COVID-19 vaccination". March 23, 2021. Retrieved: <https://www.cbc.ca/news/canada/toronto/covid-19-vaccine-ontario-booking-appointments-1.5958792>

¹⁰⁷ CBC News. "'Vax-a-thon' for walk-ins coming to supersites July 14: Latest Manitoba COVID-19 vaccine info". January 27, 2021. Retrieved: <https://www.cbc.ca/news/canada/manitoba/when-manitobans-might-get-covid-19-vaccine-1.5890683>

¹⁰⁸ CBC News. "Booking system strained, but Alberta starts vaccinating seniors in latest phase of COVID-19 response". February 24, 2021. Retrieved: <https://www.cbc.ca/news/canada/calgary/alberta-vaccine-booking-overwhelmed-1.5925889>

¹⁰⁹ CBC News. "N.B. COVID-19 roundup: COVID vaccine registration info coming 'soon,' 1 new case". March 1, 2021. Retrieved: <https://www.cbc.ca/news/canada/new-brunswick/covid-19-pandemic-cases-1.5931587>

¹¹⁰ Grant, Taryn. "Flooded with visitors, vaccine booking webpage taken offline for hours". March 1, 2021. Retrieved: <https://www.cbc.ca/news/canada/nova-scotia/flooded-with-visitors-n-s-takes-vaccine-booking-webpage-offline-1.5931854>

¹¹¹ Stone, Laura and Oliver Moore. 2021. "Supply Issue Slows Toronto Vaccinations for People 80 and Older." *The Globe and Mail*, Mar 02. <http://ezproxy.lib.ryerson.ca/login?url=https://www-proquest-com.ezproxy.lib.ryerson.ca/newspapers/supply-issue-slows-toronto-vaccinations-people-80/docview/2494787334/se-2?accountid=13631>

¹¹² CBC News. "'Vax-a-thon' for walk-ins coming to supersites July 14: Latest Manitoba COVID-19 vaccine info". January 27, 2021. Retrieved: <https://www.cbc.ca/news/canada/manitoba/when-manitobans-might-get-covid-19-vaccine-1.5890683>

¹¹³ Wong, Madison. "Lost in translation: Advocates on battling language barriers amid COVID-19". May 1, 2021. Retrieved: <https://globalnews.ca/news/7820644/covid-19-language-barriers-racialized-communities/>

¹¹⁴ Government of British Columbia. "How to get vaccinated for COVID-19". June, 2021. Retrieved: <https://www2.gov.bc.ca/gov/content/covid-19/vaccine/register>.

¹¹⁵ Government of Saskatchewan. "Vaccine Booking System Opening to Seniors 85+ on March 11" March 10, 2021. Retrieved: <https://>

www.saskatchewan.ca/government/news-and-media/2021/march/10/vaccine-booking-system-opening-to-seniors-85-on-march-11

¹¹⁶ Government of Ontario. "COVID-19 booking support" Retrieved: <https://covid-19.ontario.ca/covid-19-vaccine-booking-support>

¹¹⁷ Nerestant, Antoni. "Language, cultural barriers could fuel vaccine hesitancy, Quebec community organizers warn" March 10, 2021. Retrieved: <https://www.cbc.ca/news/canada/montreal/vaccine-covid-19-language-culture-barriers-1.5942462>

¹¹⁸ Empire Advance. "Vaccine clinics, language interpretation for people booking appointments, getting vaccine". April 28, 2021. Retrieved: <https://www.empireadvance.ca/news/local-news/vaccine-clinics-language-interpretation-for-people-booking-appointments-getting-vaccine-1.24312535>

¹¹⁹ MacVicar, Adam. "Alberta Health Services apologizes for 'frustration, worry' due to COVID-19 vaccine rollout errors". February 27, 2021. Retrieved: <https://globalnews.ca/news/7667053/alberta-health-services-apology-covid-19-vaccination-issues/>

¹²⁰ Unger, Danton. "The two priority groups for the AstraZeneca/Covishield vaccine in Manitoba". March 10, 2021. Retrieved: <https://winnipeg.ctvnews.ca/the-two-priority-groups-for-the-astrazeneca-covishield-vaccine-in-manitoba-1.5341675>.

¹²¹ CBC News. "N.B. COVID-19 roundup: 5 new cases announced Sunday; pharmacists prepare for busy week". March 14, 2021. Retrieved: <https://www.cbc.ca/news/canada/new-brunswick/new-brunswick-covid-active-cases-low-1.5949420>

¹²² Grant, Taryn. "COVID-19 vaccines to be made available in Nova Scotia pharmacies". March 2, 2021. Retrieved: <https://www.cbc.ca/news/canada/nova-scotia/covid-19-vaccines-to-be-made-available-in-nova-scotia-pharmacies-1.5933476>

¹²³ Lafromboise, Kalina. "Calm before the storm': Quebec pharmacies will start administering COVID-19 vaccines this month". March 2, 2021. Retrieved: <https://globalnews.ca/news/7672157/quebec-coronavirus-vaccination-rollout-pharmacies/>

¹²⁴ CBC News. "COVID-19 in Quebec: What you need to know this weekend. March 13, 2021. Retrieved: <https://www.cbc.ca/news/canada/montreal/covid-19-in-quebec-need-to-know-march-13-14-1.5948778>

¹²⁵ Crawley, Mike. "Nearly 200,000 Ontarians aged 80 and older have not signed up for a COVID-19 vaccination". March 23, 2021. Retrieved: <https://www.cbc.ca/news/canada/toronto/covid-19-vaccine-ontario-booking-appointments-1.5958792>

¹²⁶ Stone and Perreux. "Quebec has used more COVID-19 vaccine doses on seniors than Ontario". March 19, 2021. Retrieved: <https://www.theglobeandmail.com/canada/article-quebec-has-used-more-vaccine-doses-on-seniors-than-ontario/>

¹²⁷ Buffman, Robert. "B.C. promises more information on COVID-19 vaccine for seniors this week". February 23, 2021. Retrieved: <https://vancouverisland.ctvnews.ca/b-c-promises-more-information-on-covid-19-vaccine-for-seniors-this-week-1.5320559>

¹²⁸ Stall, N. M., Y. Nakamachi, and M. Chang. "Mobile in-home COVID-19 vaccination of Ontario homebound older adults by neighbourhood risk." *Sci Briefs Ont COVID-19 Sci Advis Table 1* (2021): 19.

¹²⁹ Bruno, and Mulligan. "Housebound seniors worried they'll be forgotten in vaccine drive". March 24, 2021. Retrieved: <https://toronto.citynews.ca/2021/03/23/housebound-seniors-covid-19-vaccine/>

¹³⁰ Lepage, and McCallister. "Homebound seniors still waiting for COVID-19 vaccine". May 6, 2021. Retrieved: <https://toronto.citynews.ca/2021/05/06/homebound-seniors-still-waiting-for-covid-19-vaccine/>

¹³¹ Tikkanen, Osborn, Mossialos, Djordjevic, Wharton. "International Health Care System Profiles: England." *The Commonwealth Fund*. Retrieved: <https://www.commonwealthfund.org/international-health-policy-center/countries/england>

¹³² Baraniuk, Chris. "Covid-19: How the UK vaccine rollout delivered success, so far." *bmj* 372 (2021).

¹³³ Reuters. "Moderna says UK deal will supply COVID-19 vaccine from March". November 17, 2020. Retrieved: <https://www.reuters.com/article/us-health-coronavirus-uk-moderna-idUSKBN27X1V2>

¹³⁴ NDTV. "UK Approves Moderna's COVID Vaccine, To Purchase Another 10 Million Doses". January 8, 2021. Retrieved: <https://www.ndtv.com/world-news/britain-approves-modernas-covid-19-vaccine-to-purchase-another-10-million-doses-2349744>

¹³⁵ BBC. "Covid-19: England gets third jab as Moderna rollout begins" April 13, 2021. Retrieved: <https://www.bbc.com/news/uk-56727510>

¹³⁶ Office for National Statistics. "Coronavirus (COVID-19 Latest Insights)". July 30, 2021. Retrieved: <https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/articles/coronavirus-covid19/latestinsights>

¹³⁷ NHS England. "COVID-19 Vaccination Statistics." July 18, 2021. Retrieved: <https://www.england.nhs.uk/statistics/wp-content/uploads/sites/2/2021/07/COVID-19-weekly-announced-vaccinations-22-July-2021.pdf>

¹³⁸ Department of Health and Social Care. "UK COVID-19 vaccine delivery plan." January 13, 2021. Retrieved: <https://www.gov.uk/government/publications/uk-covid-19-vaccines-delivery-plan/uk-covid-19-vaccines-delivery-plan>

¹³⁹ Baraniuk, Chris. "Covid-19: How the UK vaccine rollout delivered success, so far." *bmj* 372 (2021).

¹⁴⁰ The Financial Times. "How the UK boosted its vaccine manufacturing capacity." February 10, 2021. Retrieved: <https://www.ft.com/content/662ab296-2aef-4179-907c-5dba5c355d86>

¹⁴¹ BBC. "Covid-19: Vaccine rollout in England extends to 44-year-olds". April 26, 2021. Retrieved: <https://www.bbc.com/news/uk-56880376>

¹⁴² NHS England. "COVID-19 Vaccination Statistics". May 2, 2021. Retrieved: <https://www.england.nhs.uk/statistics/wp-content/uploads/sites/2/2021/05/COVID-19-weekly-announced-vaccinations-06-May-2021.pdf>

¹⁴³ BBC. "Covid vaccine: How many people in the UK have been vaccinated so far?" 2021. Retrieved: <https://www.bbc.com/news/health-55274833>

¹⁴⁴ The Economic Times. "COVID vaccination in UK: Second doses for over-50s to be accelerated amid concerns over Indian variant." May 15, 2021. Retrieved: <https://economictimes.indiatimes.com/news/international/world-news/covid-vaccination-in-uk-second-doses-for-over-50s-to-be-accelerated-amid-concerns-over-indian-variant/videoshow/82652493.cms?from=mdr>

¹⁴⁵ Lee, Dulcie. "COVID-19: More than half of the UK have a second jab". June 3, 2021. Retrieved: <https://www.bbc.com/news/uk-57346760>

¹⁴⁶ NHS England. "COVID-19 Vaccination Statistics." July 4, 2021. Retrieved: <https://www.england.nhs.uk/statistics/wp-content/uploads/sites/2/2021/07/COVID-19-weekly-announced-vaccinations-08-July-2021.pdf>

¹⁴⁷ Dyer, Clare. "Covid-19: Vaccination to become mandatory for care home staff and could extend to NHS." (2021).

¹⁴⁸ Stokel-Walker, Chris. "Covid-19: The countries that have mandatory vaccination for health workers." *bmj* 373 (2021).

¹⁴⁹ Bernal, Jamie Lopez, Nick Andrews, Charlotte Gower, Julia Stowe, Chris Robertson, Elise Tessier, Ruth Simmons et al. "Early effectiveness of COVID-19 vaccination with BNT162b2 mRNA vaccine and ChAdOx1 adenovirus vector vaccine on symptomatic disease, hospitalisations and mortality in older adults in England." *MedRxiv* (2021).

¹⁵⁰ Vasileiou, E., Simpson, C. R., Shi, T., Kerr, S., Agrawal, U., Akbari, A., ... & Sheikh, A. (2021). Interim findings from first-dose mass COVID-19 vaccination roll-out and COVID-19 hospital admissions in Scotland: a national prospective cohort study. *The Lancet*, 397(10285), 1646-1657.

¹⁵¹ Public Health England. "Monitoring of the early impact and effectiveness of COVID-19 vaccine in England" February 22, 2021. Retrieved: <https://www.gov.uk/government/publications/phe-monitoring-of-the-effectiveness-of-covid-19-vaccination>

¹⁵² Public Health England. "Monitoring of the early impact and effectiveness of COVID-19 vaccine in England". March, 2021. Retrieved: <https://www.gov.uk/government/publications/phe-monitoring-of-the-effectiveness-of-covid-19-vaccination>

¹⁵³ Lee, Dulcie. "Covid-19: More than half of UK adults have had second jab". June 3, 2021. Retrieved: <https://www.bbc.com/news/uk-57346760>

¹⁵⁴ Roxby, Philippa. "Covid: NHS plans booster jab for those 50 and over before winter". BBC News. July 1, 2021. Retrieved: <https://www.bbc.com/news/health-57667987>

¹⁵⁵ Tikkanen, Osborn, Mossialos, Djordjevic, Wharton. "International Health Care System Profile: Israel". June 5, 2020. Retrieved: <https://www.commonwealthfund.org/international-health-policy-center/countries/israel>

¹⁵⁶ Rosen, B., Waitzberg, R. & Israeli, A. "Israel's rapid rollout of vaccinations for COVID-19". *Isr J Health Policy Res* 10, 6 (2021). <https://doi.org/10.1186/s13584-021-00440-6>

¹⁵⁷ Government of Israel. "Data Dashboard". 2021. Retrieved: https://datadashboard.health.gov.il/COVID-19/general?utm_source=go.gov.il&utm_medium=referral

¹⁵⁸ Rosen, B., Waitzberg, R. & Israeli, A. "Israel's rapid rollout of vaccinations for COVID-19". *Isr J Health Policy Res* 10, 6 (2021). <https://doi.org/10.1186/s13584-021-00440-6>

¹⁵⁹ Our World In Data. "Israel: Confirmed COVID-19 Cases by Age Group". July 24, 2021. Retrieved: <https://ourworldindata.org/grapher/israel-covid-19-cases-by-age?stack-Mode=absolute&time=latest>

¹⁶⁰ Choi Y, Stall NM, Maltsev A, et al. "Lessons Learned from Israel's Vaccine Rollout. Science Briefs of the Ontario COVID-19 Science Advisory Table." 2021;2(9). <https://doi.org/10.47326/ocsat.2021.02.09.1.0>

¹⁶¹ Regev, Dana. "The secrets to Israel's coronavirus vaccination success". January 11, 2021. Retrieved: <https://www.politico.eu/article/israel-coronavirus-vaccine-success-secret/>

¹⁶² Rosen, B., Waitzberg, R. & Israeli, A. "Israel's rapid rollout of vaccinations for COVID-19". *Isr J Health Policy Res* 10, 6 (2021). <https://doi.org/10.1186/s13584-021-00440-6>

¹⁶³ Rosen, Bruce, Ruth Waitzberg, and Avi Israeli. "Israel's rapid rollout of vaccinations for COVID-19." *Israel journal of health policy research* 10, no. 1 (2021): 1-14.

¹⁶⁴ Our World In Data. "Israel Vaccination Impact". July 24, 2021. Retrieved: <https://ourworldindata.org/vaccination-israel-impact>

¹⁶⁵ Hendrix, Rubin, Bruillard. "Israel's ahead-of-the-world vaccine rollout offers hope for

countries lagging behind". February 28, 2021. Retrieved: https://www.washingtonpost.com/world/middle_east/israel-coronavirus-vaccine-research-studies/2021/02/28/3ba3c3f2-7526-11eb-9489-8f7dacd51e75_story.html

¹⁶⁶ Kellman, Laurie. "Israel celebrates 5 millionth coronavirus vaccination". March 8, 2021. Retrieved: <https://www.ctvnews.ca/health/coronavirus/israel-celebrates-5-millionth-coronavirus-vaccination-1.5337844>

¹⁶⁷ Rosen, Dine, Davidovitch. "Lessons In COVID-19 Vaccination From Israel" March 18, 2021. Retrieved: <https://www.healthaffairs.org/doi/10.1377/hblog20210315.476220/full/>

¹⁶⁸ Our World In Data. "Israel Vaccination Impact". July 24, 2021. Retrieved: <https://ourworldindata.org/vaccination-israel-impact>

¹⁶⁹ Schraer, Rachel. "Covid: 'Israel may be reaching herd immunity'". April 14, 2021. <https://www.bbc.com/news/health-56722186>

¹⁷⁰ Tal, Howard, Carey. "Israel to offer third Covid-19 vaccine dose to people over 60". CNN News. July 30, 2021. Retrieved: <https://www.cnn.com/2021/07/30/middleeast/israel-covid-booster-shot-intl/index.html>

¹⁷¹ Mallapaty, Smriti. "Vaccines are curbing COVID: Data from Israel show drop in infections." *Nature* (2021).

¹⁷² Rossman, H., Shilo, S., Meir, T. et al. "COVID-19 dynamics after a national immunization program in Israel". *Nat Med* 27, 1055–1061 (2021). <https://doi.org/10.1038/s41591-021-01337-2>

¹⁷³ Tikkanen, Osborn, Mossialos, Djordevic, Wharton. "International Health Care Sys-

tem Profiles: United States. The Common Wealth Fund. June 5, 2020: Retrieved <https://www.commonwealthfund.org/international-health-policy-center/countries/unit-ed-states>

¹⁷⁴ Pfizer. "Pfizer and Biontech to Supply the United States With 100 Million Additional Doses of Covid-19 Vaccine". February 12, 2021. Retrieved; <https://www.pfizer.com/news/press-release/press-release-detail/pfizer-and-biontech-supply-united-states-100-million>

¹⁷⁵ Finch, Hannah. "Where the moderna vaccine is being made". March 13, 2021. Retrieved: <https://www.business-live.co.uk/technology/moderna-vaccine-being-made-20278092>

¹⁷⁶ Kansteiner, Fraiser. "Moderna eyes beefed-up vaccine production with the help of U.S.-brokered manufacturing talks: report". April 15, 2021. Retrieved: <https://www.fiercepharma.com/manufacturing/moderna-eyes-new-vaccine-production-partner-government-brokered-talk-report>

¹⁷⁷ Centers for Disease Control and Prevention. "COVID-19 Data Tracker". 2021. Retrieved: <https://covid.cdc.gov/covid-data-tracker/#vaccinations>

¹⁷⁸ Kaur, Harmeet. "How the effort to vaccinate the elderly is going in some states". December 31, 2021. Retrieved: <https://www.cnn.com/2020/12/31/health/how-states-are-getting-vaccine-to-elderly-trnd/index.html>

¹⁷⁹ Khazan, Olga. "The one areas of the U.S COVID-19 strategy seems to be working." February 22, 2021. <https://www.theatlantic.com/politics/archive/2021/02/america-vaccination-speed-europe-better/618094/>

¹⁸⁰ The Center for Disease Control and Prevention. "How COVID-19 Vaccines get to you." 2020. Retrieved: <https://www.cdc.gov/coronavirus/2019-ncov/vaccines/distributing.html>

¹⁸¹ AARP. "When Can Older Americans Expect to Get a COVID-19 Vaccine?". July 16, 2021. Retrieved: <https://www.aarp.org/health/conditions-treatments/info-2020/coronavirus-vaccine-distribution.html>

¹⁸² Feed, Cubanski, Ochleng, Neuman. "Vaccinating Older Adults in the US Against COVID-19: A Work in Progress". February 25, 2021. Retrieved: <https://www.kff.org/coronavirus-covid-19/issue-brief/vaccinating-older-adults-in-the-us-against-covid-19-a-work-in-progress/>.

¹⁸³ Khazan, Olga. "The one areas of the U.S COVID-19 strategy seems to be working." February 22, 2021. <https://www.theatlantic.com/politics/archive/2021/02/america-vaccination-speed-europe-better/618094/>

¹⁸⁴ Center for Disease Control. "COVID-19 Data Tracker". 2021. Retrieved: <https://covid.cdc.gov/covid-data-tracker/>

¹⁸⁵ New York Times. "COVID-19 Tracker". 2021. Retrieved: [nytimes.com/live/2021/03/18/world/covid-19-coronavirus](https://www.nytimes.com/live/2021/03/18/world/covid-19-coronavirus)

¹⁸⁶ BBC. "Johnson & Johnson vaccine paused over rare blood clots". April 13, 2021. Retrieved: <https://www.bbc.com/news/world-us-canada-56733715>

¹⁸⁷ BBC. "US lifts pause on Johnson & Johnson Vaccine". April 24, 2021. Retrieved: <https://www.bbc.com/news/world-us-canada-56865562>

¹⁸⁸ Center for Disease Control. "COVID-19 Data Tracker". 2021. Retrieved: <https://covid.cdc.gov/covid-data-tracker/>

¹⁸⁹ Financial Times. "The US vaccine effect: rapid rollout starts to bear fruit". March 17, 2021. Retrieved: <https://www.ft.com/content/78bb-2c9c-9795-4a0c-860b-eeede85fdb9b7>

¹⁹⁰ The Globe and Mail. "Thanks to a coming boost to Canada's vaccine supply, pandemic victory is finally in sight" June 10, 2021. Retrieved: <https://www.theglobeandmail.com/opinion/editorials/article-thanks-to-a-coming-boost-to-canadas-vaccine-supply-pandemic-victory-is/>

¹⁹¹ McPhillips, Diedre. "3 states have already reached Biden's new vaccination goal, but vaccine hesitancy may make it challenging for others". May 11, 2021. Retrieved: <https://www.cnn.com/2021/05/05/health/us-coronavirus-wednesday/index.html>

¹⁹² Center for Disease Control. "COVID-19 Data Tracker". 2021. Retrieved: <https://covid.cdc.gov/covid-data-tracker/>

¹⁹³ Diamond, Dan. "A tipping point': Government officials, health groups move to require coronavirus vaccines for workers". July 26, 2021. <https://www.washingtonpost.com/health/2021/07/26/mandatory-vaccinations-urged-health-workers/>

¹⁹⁴ Tikkanen, Osborn, Mossialos, Djordjevic, Wharton. "International Health Care System: Denmark". June 5, 2021. Retrieved: <https://www.commonwealthfund.org/international-health-policy-center/countries/denmark>

¹⁹⁵ Danish Health Authority. "Vaccination Against COVID-19, Target Groups". 2021. Retrieved: <https://www.sst.dk/en/English/Corona-eng/Vaccination-against-COVID-19/Target-groups>

¹⁹⁶ Our World in Data. "Share of People Fully Vaccinated Against COVID-19 by Age, Denmark". July 2021. Retrieved: <https://ourworldindata.org/grapher/covid-fully-vaccinated-by-age?country=~DNK>

¹⁹⁷ Danish Health Authority. "Vaccination against COVID-19". June 7, 2021. Retrieved: <https://www.sst.dk/en/english/corona-eng/vaccination-against-covid-19>

¹⁹⁸ Danish Health Authority. "Vaccination Against COVID-19, Target Groups". 2021. Retrieved: <https://www.sst.dk/en/English/Corona-eng/Vaccination-against-COVID-19/Target-groups>

¹⁹⁹ Naomi O'Leary. "How Denmark plans to finish vaccinating by June 27". February 22, 2021. Retrieved: <https://www.irishtimes.com/news/world/europe/covid-19-how-denmark-plans-to-finish-vaccinating-by-june-27th-1.4492192>

²⁰⁰ Medical Express. "Norway, Denmark reserves AstraZeneca vaccine for under-65s". February 4, 2021. Retrieved: <https://medicalxpress.com/news/2021-02-norway-denmark-reserve-astrazeneca-vaccine.html>

²⁰¹ The Local. "What is Denmark's current schedule for Covid-19 vaccination?". March 1, 2021. Retrieved: <https://www.thelocal.dk/20210301/what-is-denmarks-current-schedule-for-covid-19-vaccination/>

²⁰² Boffey, Daniel. "Austria and Denmark to work with Israel on future Covid jabs, saying EU 'too slow'". March 2, 2021. Retrieved: [theguardian.com/world/2021/mar/02/austria-and-denmark-to-work-with-israel-on-future-covid-jabs-saying-eu-too-slow](https://www.theguardian.com/world/2021/mar/02/austria-and-denmark-to-work-with-israel-on-future-covid-jabs-saying-eu-too-slow)

²⁰³ The Global and Mail. EU's Vaccine Shortages prompt countries to seek outside supplies. March 4, 2021.

²⁰⁴ BBC. "AstraZeneca vaccine: Denmark stops rollout completely". April 14, 2021. <https://www.bbc.com/news/world-europe-56744474#:~:text=Denmark%20has%20ceased%20giving%20the,vaccination%20programme%20by%20several%20weeks>.

²⁰⁵ Sydsgaard, Lehto. "'We need time': Nordic caution keeps AstraZeneca shots on hold". March 19, 2021. Retrieved: <https://www.reuters.com/article/us-health-coronavirus-denmark-astrazenec/denmark-to-decide-on-astrazeneca-vaccine-next-week-health-agency-idUSKBN2BB1CU>".

²⁰⁶ The Journal. "Denmark announces plans to reopen society once all over 50s vaccinated". March 23, 2021. Retrieved: <https://www.thejournal.ie/denmark-reopening-covid-5389008-Mar2021/>

²⁰⁷ BBC. "AstraZeneca vaccine: Denmark stops rollout completely". April 14, 2021. Retrieved: <https://www.bbc.com/news/world-europe-56744474#:~:text=Denmark%20has%20ceased%20giving%20the,vaccination%20programme%20by%20several%20weeks>.

²⁰⁸ The Local. "What is Denmark's current schedule for Covid-19 vaccination?". March 1, 2021. Retrieved: <https://www.thelocal.dk/20210301/what-is-denmarks-current-schedule-for-covid-19-vaccination/>

²⁰⁹ Associated Press. "Denmark pauses AstraZeneca vaccine jabs to probe blood clots". March 11, 2021. Retrieved: <https://www.peacearchnews.com/news/denmark-pauses-astrazeneca-vaccine-jabs-to-probe-blood-clots/>

²¹⁰ Reuters. "Denmark cuts Johnson & Johnson COVID-19 vaccine from program: reports". May 3, 2021. Retrieved: <https://globalnews.ca/news/7828928/denmark-johnson-johnson-covid-vaccine/>

²¹¹ The Local. "Denmark sends a new optional vaccination scheme out to consultation". May 10, 2021. <https://www.thelocal.dk/20210510/denmark-to-launch-new-optional-vaccination-scheme-next-week-minister/>

²¹² Outbreak News Today. "Denmark: Of the target groups, 94.9 percent received the first COVID-19 vaccination". June 6, 2021. Retrieved: <http://outbreaknewstoday.com/denmark-of-the-target-groups-94-9-percent-received-the-first-covid-19-vaccination-79447/>

²¹³ Statens Serum Institute. "Vaccination". 2021. Retrieved: <https://experience.arcgis.com/experience/1c7ff08f-6cef4e2784df7532d16312f1>

²¹⁴ Bastías, Gabriel et al. "Health care reform in Chile." CMAJ : Canadian Medical Association journal = journal de l'Association médicale canadienne vol. 179,12 (2008): 1289-92. doi:10.1503/cmaj.071843

²¹⁵ Cox et al. "Rebuilding the Broken Health Contract in Chile". April 25, 2021. The Lancet. Retrieved: [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(20\)30228-2/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30228-2/fulltext)

²¹⁶ Roman-Urrestarazu, A., Yang, J.C., Ettelt, S. et al. "Private health insurance in Germany and Chile: two stories of co-existence, segmentation and conflict". *Int J Equity Health* 17, 112 (2018). <https://doi.org/10.1186/s12939-018-0831-z>

²¹⁷ Diaz-Cerda, Veronica. "How Chile became and unlikely winner in the COVID-19 vaccine race". February 10, 2021. *The Conversation*. Retrieved: <https://theconversation.com/how-chile-became-an-unlikely-winner-in-the-covid-19-vaccine-race-154614>

²¹⁸ Kiry, Jen. "How Chile built one of the world's most successful vaccination campaigns." March 10, 2021. *Vox News*. Retrieved: <https://www.vox.com/22309620/chile-covid-19-vaccination-campaign>

²¹⁹ Ibid.

²²⁰ Ibid.

²²¹ John Bartlett. "Chile Emerges as global leader in COVID inoculations with pragmatic strategy". February 28, 2021. *The Guardian*. Retrieved: <https://www.theguardian.com/global-development/2021/feb/28/chile-covid-inoculations-vaccines-strategy>

²²² *The Economist*. "Vaccination going well in Chile why not its neighbors?". 2021. Retrieved: <https://www.economist-com.proxy1.lib.uwo.ca/the-americas/2021/03/06/vaccination-is-going-well-in-chile-why-not-its-neighbours>

²²³ Ministerio de Salud. "Mass Vaccination Schedule Against COVID-19". 2021. Retrieved: <https://www.minsal.cl/calendario-de-vacunacion-masiva-contracovid-19/>

²²⁴ ITTV. "Covid vaccine: Chile's jab rollout is

world-leading - so why are its hospitals struggling?". April 8, 2021. Retrieved: <https://www.itv.com/news/2021-04-08/covid-vaccine-chiles-jab-rollout-is-world-leading-so-why-are-its-hospitals-struggling>

²²⁵ France 24. "China's Coronavac 80% effective at preventing Covid deaths: Chile results". April 16, 2021. Retrieved: <https://www.france24.com/en/live-news/20210416-china-s-coronavac-80-effective-at-preventing-covid-deaths-chile-results>

²²⁶ Sample and Holmes "Israel and Chile both led on Covid jabs, so why is one back in lockdown?". April 6, 2021. <https://www.theguardian.com/world/2021/apr/06/israel-and-chile-both-led-on-covid-jabs-so-why-is-one-back-in-lockdown>

²²⁷ Taylor, Luke. "Spike in cases in Chile is blamed on people mixing after first vaccine shot". April 20, 2021. Retrieved: <https://www.bmj.com/content/373/bmj.n1023>

²²⁸ The BBC. "Covid-19 pandemic: Chile capital locks down despite mass vaccination". June 11, 2021. <https://www.bbc.com/news/world-latin-america-57436861>

²²⁹ Gale, Jason. "Subcovac's vaccine efficacy inferior to Pfizer shot in Chile study." July 1, 2021. Retrieved: <https://www.bloomberg.com/news/articles/2021-07-08/china-made-vaccine-found-inferior-to-pfizer-shot-in-chile-study>

²³⁰ Reuters. "Chile to give COVID-19 vaccine boosters for those inoculated with Sinovac". August 5, 2021. Retrieved: <https://www.reuters.com/world/americas/chile-give-covid-19-vaccine-boosters-those-inoculated-with-sinovac-2021-08-05/>

²³¹ *New York Times*. "How much herd immu-

nity is enough?". April 2, 2021. Retrieved: <https://www.nytimes.com/2020/12/24/health/herd-immunity-covid-coronavirus.html>

²³² Flether, Robson. "We probably won't reach herd immunity against COVID-19 any time soon, but it's OK, experts say". May 5, 2021. Retrieved: <https://www.cbc.ca/news/health/herd-immunity-threshold-canada-covid-1.6013685>

²³³ Aschwanden, Christie. "Five reasons why COVID-19 herd immunity is probabilitiy impossible". March 18, 2021. Retrieved: <https://www.nature.com/articles/d41586-021-00728-2>

²³⁴ Rubin, Rita. "Difficult to determine herd immunity threshold for COVID-19". August 25, 2021. Retrieved: <https://jamanetwork.com/journals/jama/fullarticle/2769704>

²³⁵ Aresnych, Alex. "Ontario's New Top Doctor Says An 'Endemic' Period Is Coming & Here's What That Means". June 24, 2021. Retrieved: <https://www.narcity.com/toronto/covid-19-will-become-an-endemic-in-ontario-in-the-fall-says-new-top-doctor>

²³⁶ The New York Times. "COVID-19 Doses". 2021. Retrieved: <https://www.nytimes.com/interactive/2020/us/covid-19-vaccine-doses.html>

²³⁷ Malik, MCFadden, Eldharake, Omer. "Determinants of COVID-19 vaccine acceptance in the US". September 1, 2020. Retrieved; [https://www.thelancet.com/journals/eclinm/article/PIIS2589-5370\(20\)30239-X/fulltext](https://www.thelancet.com/journals/eclinm/article/PIIS2589-5370(20)30239-X/fulltext)

²³⁸ Bloomberg. "UK finds greater vaccine

hesitancy in young people". July 2, 2021 Retrieved: <https://www.bloomberg.com/news/articles/2021-07-02/u-k-finds-greater-covid-19-vaccine-hesitancy-in-young-people>

²³⁹ Canadian Press, "Quebec Pharmacies to Administer COVID-19 Vaccines on March 15.

²⁴⁰ Canadian Press, "77 per cent of Montrealers over 60 Have Received COVID Vaccine or Have an Appointment."

²⁴¹ McGrath, "Here's Ontario's Phase 2 Vaccine Update."

²⁴² McGrath, "Here's Ontario's Phase 2 Vaccine Update

²⁴³ Rocha and Pelley. "Deaths, hospitalizations dropping amongst Canadians as COVID-19 vaccinations ramp up". April 26, 2021. Retrieved: <https://www.cbc.ca/news/health/vaccines-impact-covid-data-analysis-1.6000007>

²⁴⁴ Ibid.

²⁴⁵ William, Dan. "Israel, Austria, Denmark establish vaccine-supply alliance". March 5, 2021. Retrieved: [https://www.reuters.com/article/us-health-coronavirus-israel-vaccine-eur-idUSKBN2AW250#:~:text=JERUSALEM%20\(Reuters\)%20%2D%20Israel%2C,to%20contend%20with%20virus%20mutations.](https://www.reuters.com/article/us-health-coronavirus-israel-vaccine-eur-idUSKBN2AW250#:~:text=JERUSALEM%20(Reuters)%20%2D%20Israel%2C,to%20contend%20with%20virus%20mutations.)

²⁴⁶ Takser, Jean Paul. "Vaccine Ency: why can't Canada make COVID-19 doses at home?". April 28, 2021. Retrieved: <https://www.cbc.ca/news/politics/domestic-vaccine-manufacturing-canada-1.6004427>

²⁴⁷ Ibid.

²⁴⁸ Djuric, Mickey. "Saskatoon lab builds

manufacturing facility for vaccines, including their own". February 3, 2021. Retrieved: <https://www.cbc.ca/news/canada/saskatchewan/video-intervac-vaccine-manufacturing-facility-phase-1-clinical-trial-1.5899559>

²⁴⁹ Marchildon and Boehm. "Why we do not have COVID-19 vaccine production in Canada and what we can do about it" March 31, 2021. Retrieved: <https://www.thestar.com/business/opinion/2021/03/31/why-we-do-not-have-covid-19-vaccine-production-in-canada-and-what-we-can-do-about-it.html>

²⁵⁰ McKie, Robin. "Is vaccinating against COVID-19 enough?" April 11, 2021. Retrieved: <https://www.theguardian.com/society/2021/apr/11/is-vaccinating-against-covid-enough-what-we-can-learn-from-other-countries>

²⁵¹ BBC. "COVID-19 pandemic: Chile capital locks down despite mass vaccination". June 11, 2021. Retrieved: <https://www.bbc.com/news/world-latin-america-57436861>

²⁵² Our world in data. "UK daily COVID-19 cases" 2021. Retrieved: <https://ourworldindata.org/grapher/uk-daily-new-covid-cases>

²⁵³ BBC. "Israel reimposes masks amid new virus fears". June 25, 2021. Retrieved: <https://www.bbc.com/news/world-middle-east-57594155>

²⁵⁴ CANImmunize. 2021. Retrieved: <https://www.canimmunize.ca/en/home>

²⁵⁵ Sali, David. "Ottawa's CANImmunize forecasts global demand for vaccination-tracking platform". June 10, 2021. Retrieved: <https://www.obj.ca/article/techopia/ottawas-canimmunize-forecasts-global-demand->

[vaccination-tracking-platform](#)

²⁵⁶ Huynh, Sava, and Hahn-Goldberg, "Mobile On-Site COVID-19 Vaccination of Naturally Occurring Retirement Communities by Neighbourhood Risk in Toronto."

²⁵⁷ Canadian Press, "Doctors, Caregivers Push for in-Home COVID-19 Vaccinations for Housebound Seniors."

²⁵⁸ Seidman, Lila. "Grass-roots groups are helping the homebound get vaccines. They're racing against the clock" March 30, 2021. Retrieved: <https://www.latimes.com/california/story/2021-03-30/grassroots-groups-race-to-vaccinate-homebound-seniors-left-behind>

²⁵⁹ Hernandez, David. "San Diego Firefighters Administer Vaccines in Nursing Homes". January 31, 2021. Retrieved: <https://www.latimes.com/california/story/2021-01-31/san-diego-firefighters-administer-vaccines-nursing-homes>

²⁶⁰ Huynh, Sava, and Hahn-Goldberg, "Mobile On-Site COVID-19 Vaccination of Naturally Occurring Retirement Communities by Neighbourhood Risk in Toronto."

²⁶¹ The National Institute on Ageing, Canadian Red Cross. "Closing the gaps: Advancing emergency preparedness, response, and recovery for older adults". December 2020. Retrieved: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/5fd2410d9db3cd0795e984ed/1607614734474/CRC_WhitePaper_EN.pdf

²⁶² Kirby, Jen. "How Chile built one of the most successful vaccination campaigns". Vox News. March 10, 2021. Retrieved: <https://www.vox.com/22309620/chile-covid-19-vaccination-campaign>

²⁶³ Aguilera, Ximena, Adrian P. Mundt, Rafael Araos, and Thomas Weitzel. "The story behind Chile's rapid rollout of COVID-19 vaccination." *Travel Medicine and Infectious Disease* (2021).

²⁶⁴ Rosen, Bruce, Ruth Waitzberg, and Avi Israeli. "Israel's rapid rollout of vaccinations for COVID-19." *Israel journal of health policy research* 10, no. 1 (2021): 1-14.

To learn more about the NIA visit our
website at www.ryerson.ca/nia
and follow us on twitter [@RyersonNIA](https://twitter.com/RyersonNIA)

NIA NATIONAL
INSTITUTE
ON AGEING 