# TITLE PAGE

Brief Communication

**Title: COVID-19 Vaccination Uptake among individuals with Immune-Mediated Inflammatory Diseases in Ontario, Canada between December 2020 and October 2021: A population-based analysis**

***Running head**: COVID-19 Vaccination among IMIDs*


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## ABSTRACT

### Objective:

We assessed COVID-19 vaccine uptake among individuals with immune-mediated inflammatory diseases (IMID) and the Ontario general population.

### Methods:

We studied all residents 16 years and older who were alive and enrolled in Ontario's universal health insurance plan as of December 14, 2020 when vaccination commenced (n=12,435,914). Individuals with rheumatoid arthritis (RA), ankylosing spondylitis (AS), psoriatic arthritis (PsA), psoriasis (PsO), and inflammatory bowel disease (IBD) were identified using established disease-specific case definitions applied to health administrative data. Vaccination status was extracted from the provincial COVaxON registry. Weekly cumulative proportions of first and second doses up until October 3, 2021 were expressed as the vaccinated percentage of each disease group, and compared to the general Ontario population, and stratified by age.

### Results:

By October 3, 2021, the cumulative percentage with at least one dose was 82.1% for the general population, 88.9% for RA, 87.4% for AS, 90.6% for PsA, 87.3% for PsO, and 87.0% for IBD. There was also a higher total cumulative percentage with two doses among IMIDs (83.8-88.2%) vs the general population (78.0%). The difference was also evident when stratifying by age. Individuals with IMIDs in the youngest age group initially had earlier uptake than the general population but remain the lowest age group with two doses (70.6% in the general population vs. 73.7-79.2% across IMID groups).

### Conclusion:

While implementation of COVID-19 vaccination programs has differed globally, these Canadian estimates are the first to reassuringly show higher COVID-19 vaccine uptake among individuals with IMIDs.


**N= 245 / 250**

Immune-mediated inflammatory diseases (IMIDs) comprise a clinically diverse group of conditions characterised by altered immune regulation causing chronic inflammation in targeted organs or systems. Immune dysregulation, immunosuppressant treatment and other risk factors including multimorbidity make IMIDs a potentially COVID-19 vulnerable population (1, 2). Despite the initial lack of safety and efficacy data on COVID-19 vaccines within this patient population (as patients with IMIDs were excluded from the first clinical trials), most professional organizations and regulatory bodies recommended IMIDs be prioritized for vaccination when vaccination programs commenced (3-6).

Despite a slow start in early 2021, Canada has had mostly successful provincial COVID-19 vaccination programs involving three vaccines: BNT162b2/Pfizer-BioNTech, mRNA-1273/Moderna, and ChAdOx1 nCoV-19/AstraZeneca/COVISHIELD. By summer 2021, there was enough vaccine supply in Canada to meet the needs of the entire population. As global vaccination campaigns are still underway, including efforts to commence third doses, it is unknown whether vaccine uptake (with initial two dose regimens) among individuals with IMIDs is comparable to the general population or whether delays in uptake have occurred. Vaccine hesitancy may be amplified among IMID populations, owing to potential vaccine efficacy and potential safety concerns that patients may have (e.g., concerns over local or systemic reactogenicity, disease worsening or flare(7), negative experiences from prior vaccines(8), and the changing guidance on immunosuppressive treatment adjustments(5, 9)). Therefore, we compared the COVID-19 vaccine uptake among individuals with IMIDs and the general population in Ontario (Canada's most populous province).

## METHODS

***Setting.*** Ontario is one of 10 provinces of Canada, representing 40% of the country's population. Ontario is also Canada's most ethnically diverse province, comprised of individuals with approximately 250 different ethnic origins, and 29% of the province's population identify as non-Caucasian(10).

In Ontario, the COVID-19 immunization program involved a three-phased distribution plan (11). Phase one (December 2020 – March 2021) prioritized the limited vaccine supply for residents and staff in long-term care and retirement homes, health care workers, adults ages 80 years and older, and indigenous adults. Ontario had initially followed the manufacturers' recommended dosing schedules (i.e., a 21-day interval for BNT162b2 and a 28-day interval for mRNA-1273), but in late January 2021 extended the interval to 35-42 days (12). In early March, Ontario adopted the National Advisory Committee on Immunization (NACI) recommendation - the scientific body advising Health Canada on vaccinations – to delay administration of the second dose by up to 16 weeks (13). As vaccine supply and capacity to administer vaccines increased, the immunization program expanded to include additional priority populations over time. Phase two (April – June 2021) prioritized adults aged 55 and older (in decreasing age group increments), high-risk congregate settings (such as shelters, group homes), high density 'hot spot' regions (in large urban cities), certain essential caregivers, people unable to work from home, and individuals with certain health conditions. Specifically, provincial eligibility for immunocompromising health conditions or medications commenced May 3-6, before expanding to all adults aged 18 years and older on May 18. In June, the interval between doses was shortened due to increased supply. Eligibility for Phase three (July 2021 and beyond) involved the remaining individuals 12 years and older. To encourage vaccine uptake, the provincial government announced a COVID-19 vaccine passport

system on September 1 that came into effect September 22 2021. With the exception of children under 12 and those with accepted medical exemptions, all individuals must provide proof of identification and vaccination to access certain businesses and settings. Throughout Phase three, additional levers and mandates were announced by provincial and federal levels of government and employers targeting specific sectors/settings.

In the early vaccine distribution (Phase one – up to March 2021), vaccines were distributed directly within high-risk settings (e.g., hospitals, congregate care homes). For Phase two (April – June 2021), for the most part, early eligibility enabled residents to book appointments based on availability of vaccine supply/capacity. Therefore, simply being eligible for booking did not ensure all eligible individuals received vaccines during their time period of eligibility (as appointments could occur weeks after time of booking). Vaccine booking appointments were available at mass vaccination centres, selected pharmacies, and subsequently primary care clinics. Walk-ins (without appointments) were also available at some of these sites if supply was available, and via community pop-up walk-in clinics, and mobile units.

***Study Population.*** We studied all residents 16 and older who were alive and actively enrolled in the Ontario Health Insurance Plan (OHIP) on December 14, 2020 when the immunization program began. Individuals meeting this criteria formed the general population group for this study. From within the general population group, individuals with rheumatoid arthritis (RA), ankylosing spondylitis (AS), psoriatic arthritis (PsA), psoriasis (PsO), inflammatory bowel disease (IBD) were identified using established disease-specific case definitions applied to health administrative data (Supplementary Table 1). These case definitions were comprised of hospital and billing data that require multiple healthcare contacts for the condition of interest and based on validation studies

(14-16). These population-based cohorts have been extensively used for previous research purposes (17-20).

***Vaccination status.*** Vaccination status was extracted between December 2020 and October 3, 2021. We obtained information regarding COVID-19 vaccination status, including vaccine product, date of administration, and dose number from COVaxON, a centralized COVID-19 vaccine registry in Ontario. COVaxON also captures COVID-19 vaccine doses for Ontario residents that are administered out of province (regardless of the vaccine product) when residents provide proof to public health units. Dose administration date was used to determine the dose number as well as the dose interval (e.g. number of days from first to second dose). Among individuals who received their first dose, we also ascertained the number of individuals who were at least 40 days overdue for their second dose to determine the potential vaccine drop-outs, which is defined (according to the World Health Organization) as the proportion of people who received at least one dose of a COVID-19 vaccine but did not receive a second dose yet (9).

***Analysis.*** Descriptive statistics were used to characterize COVID-19 vaccines (all vaccine products and by product type) by dose, stratified by IMID diagnoses and the general population. The weekly cumulative percentage of individuals with one dose and two doses (separately determined) up until the end of study period (October 3, 2021) is expressed as the vaccinated proportion of each population. Age-specific estimates were separately determined. Analyses were conducted using SAS Version 9.4 (SAS Institute Inc., Cary, NC). This study was approved by a privacy impact assessment at ICES (www.ices.on.ca) where all analyses were performed. The use

of the data in this project was authorized under section 45 of Ontario's Personal Health Information Protection Act, which does not require review by a Research Ethics Board.

**RESULTS**

Our study population comprised 12,435,914 individuals in the general population, and 138,304 (1.1%) individuals with RA, 28,509 (0.2%) with AS, 17,646 (0.1%) with PsA, 182,319 (1.5%) with PsO, and 108,792 (0.9%) with IBD. The age compositions of each population are presented in Supplementary Table S2; The RA cohort had the highest percentage (63.4%) of individuals 60 years and older (vs. 29.6% for the general population).

By October 3 2021, the cumulative percentage with at least one dose was 82.1% (95% CI 82.0%-82.1%) for the general population, 88.9% (95% CI 88.7%-89.0%) for RA, 87.4% (95% CI 87.0%-87.7%) for AS, 90.6% (95% CI 90.2%-91.1%) for PsA, 87.3% (95% CI 87.2%-87.5%) for PsO, and 87.0% (95% CI 86.8%-87.2%) for IBD (Figure 1, Table 1). By the end of the study period, higher cumulative percentages with at least one dose were identified across all age-specific groups for IMIDs compared to the general population (Supplementary Figure S1). Overall, older age groups had earlier uptake than younger age groups (corresponding with eligibility criteria). Within age groups, individuals with IMIDs in the youngest age group initially had earlier uptake than the general population of the same age (corresponding with eligibility criteria where younger individuals with IMIDs become eligible before the general population age group). However, as eligibility for health conditions followed older age eligibility, individuals with IMIDs in the older age groups did not have earlier uptake of first doses although they ultimately ended up with a higher percentage vaccinated by the end of study period.

By October 3 2021, there was a higher total cumulative percentage with two doses among individuals with IMIDs (83.8-88.2%) versus the general population [77.9% (95% CI 77.9%-77.9%)], Figure 2, Table 1. The difference between the IMID and general population groups was also evident when stratifying by age groups. Across age groups, individuals with IMIDs that were 60-79 years achieved the highest coverage with two doses, ranging from 89.2% (95% CI 89.0%-89.4%) for RA to 91.8% (95% CI 91.2%-92.4%) for PsA (Supplementary Figure S2). By October 3 2021, individuals aged 16 to 39 years were the lowest age group with two doses [cumulative percent of 70.6% (95% CI 70.5%-70.6%) in the general population versus 73.7-79.2% in IMIDs].

Among those vaccinated, the majority of individuals (70.9-73.1%) received BNT162b2 vaccines (Table 1). The median interval between first and second doses ranged between 60-71 days for BNT162b2, 53-61 days for mRNA-1273, and 71-74 days for ChAdOx1 nCoV-19 (Supplementary Table S3). Among those eligible for a second dose but have failed to complete the two-dose series by October 3, 2021, a slightly higher percentage of individuals were identified among those who received mRNA-1273 as their first dose (3-4% for mRNA-1273 vs. 2% for BNT162b2).

## DISCUSSION

COVID-19 vaccines have brought tremendous promise to help manage the pandemic and ensuring high COVID-19 vaccine uptake among patients with IMIDs has been a priority for most COVID-19 immunization programs. However, the vaccination uptake among this group was previously unknown. We conducted a population-based study to analyze vaccine uptake among individuals with IMIDs and the general population in one province in Canada. Our study reveals

higher COVID-19 vaccine uptake among individuals with IMIDs, surpassing the general population vaccination uptake of 78% with two doses as of October 2021.

The World Health Organization named vaccine hesitancy - the reluctance or refusal to vaccinate - as a threat to global health (21) and early studies on the acceptance of COVID-19 vaccines among individuals with IMIDs raised varied concerns that could contribute to additional vaccine hesitancy and thus lower uptake of COVID-19 vaccines in this patient population (3, 7, 8, 22). While vaccine hesitancy varies considerably with nationality(23), and the implementation of COVID-19 immunization programs has also differed globally, a higher percentage of Ontario residents with IMIDs received COVID-19 vaccines in comparison to the general population. Therefore, for the most part, vaccine hesitancy did not appear to be increased among individuals with IMIDs. The earlier/faster uptake of COVID-19 vaccines among IMIDs is largely reflective of these individuals meeting earlier eligibility requirements through their their advanced age, IMID diagnosis, pre-existing comorbidities, or use of immunosuppressive therapies. Yet, despite Ontario having sufficient available supply and time to vaccinate the entire population, there is a subset of the IMID population that remains unvaccinated. Moreover, there is a difference between availability and accessibility of vaccines and individuals with IMIDs are disproportionately impacted with disabilities that can make accessibility of vaccination more challenging. Our study also identified a lower vaccine uptake in younger individuals including those with IMIDs. Reasons are unknown, but this may be due to perceived lower risk, busier schedules, and/or clinical factors (e.g., some patients might wait for a disease flare to resolve, some patients may be on prednisone and wait for a lower dose in order to have an effective vaccine response). While this study did not address which patient subgroups have lower vaccine uptake, a recent study by Vieira Rezende et al identified concurrent malignancy, certain comorbidities, and concurrent use of anti-rheumatic

therapies, as characteristics potentially associated with COVID-19 vaccine hesitancy among adults with IMIDs(7). Ongoing monitoring, and identifying characteristics associated with lower vaccine uptake and reducing potential inequities are warranted.

Strengths of our study include the population-based nature of our data with near complete capture of COVID-19 vaccines in a central repository. Additional public health measures such as a vaccine passport requirement has also likely encouraged reporting of vaccines administered out-of-province. Our findings are also likely generalizable to other provinces and territories in Canada which have had a similar overall uptake in COVD-19 vaccines.

The data presented herein may differ from other sources for various reasons, including differing data extract times and methodologies for processing COVaxON data. Moreover, we acknowledge that populations are dynamic (e.g., individuals move away) and we have only studied closed population-based cohorts who were alive and eligible for vaccination when the COVID-19 immunization program commenced. In Ontario, COVID-19 vaccines were freely available to anyone meeting eligibility requirements, irrespective of whether they were Ontario residents with publicly-funded healthcare coverage. Therefore, the totality of vaccines distributed in Ontario exceeds the results presented herein.

In conclusion, our study provides encouraging Canadian data regarding a high uptake of COVID-19 vaccines among individuals with IMIDs. However, the relatively lower uptake in younger individuals should be considered for novel targeted interventions. Ongoing surveillance of COVID-19 vaccines, including the safety and effectiveness of COVID-19 vaccines among

patients with IMIDs remains a priority to reduce the morbidity related to COVID-19/SARSCoV-2 infection among this priority population.

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## LIST OF TABLES & FIGURES



## SUPPLEMENTARY MATERIALS

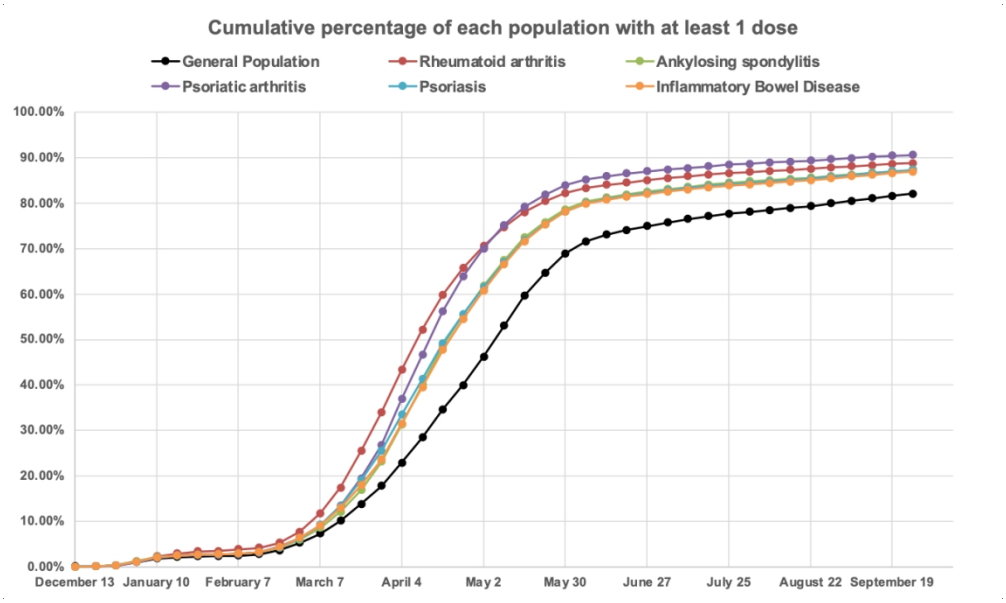


Figure 1. Cumulative percentage of each population with at least one dose by October 3 2021

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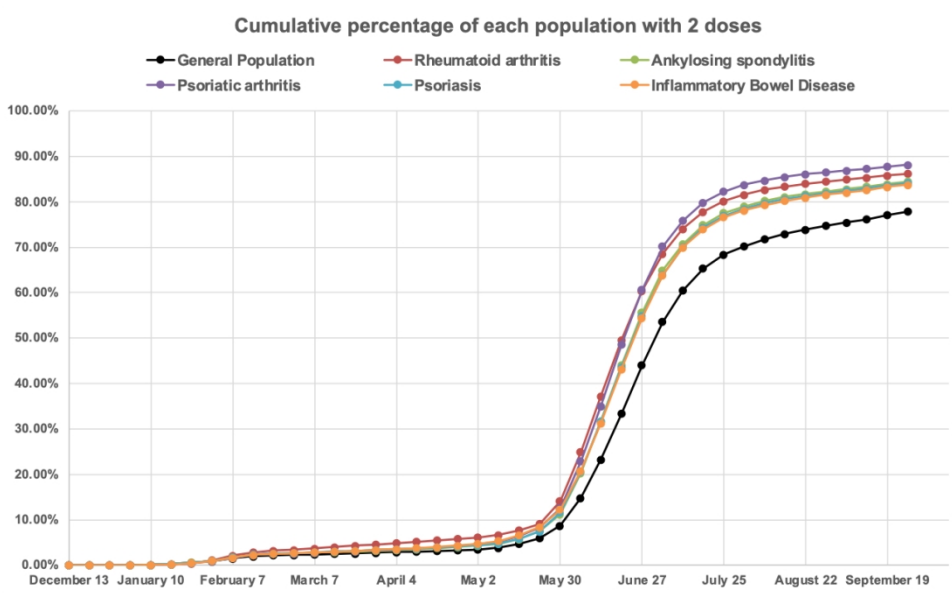


Figure 2. Cumulative percentage of each population with two doses by October 3 2021

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**Table 1. Overall Summary of First and Second Vaccine Doses Administered to the Study Population as of October 3 2021**

| Any vaccine type | General Population N=12,435,914 | RA N=138,304 | AS N=28,509 | PsA N=17,646 | PsO N=182,319 | IBD N=108,792 |
|---|---|---|---|---|---|---|
| **Received at least 1 dose, n (%)** | 10,208,667 (82.1%) | 122,893 (88.9%) | 24,911 (87.4%) | 15,995 (90.6%) | 159,220 (87.3%) | 94,613 (87.0%) |
| Vaccine Product of 1st Dose[1], n (%) | | | | | | |
| BNT162b2 | 7,384,130 (72.3%) | 89,816 (73.1%) | 17,650 (70.9%) | 11,361 (71.0%) | 113,523 (71.3%) | 67,535 (71.4%) |
| mRNA-1273 | 1,958,127 (19.2%) | 23,225 (18.9%) | 4,564 (18.3%) | 2,746 (17.2%) | 28,655 (18.0%) | 17,604 (18.6%) |
| ChAdOx1 nCoV-19 | 862,543 (8.4%) | 9,831 (8.0%) | 2,689 (10.8%) | 1,886 (11.8%) | 17,011 (10.7%) | 9,456 (10.0%) |
| **Received two doses, n (%)** | 9,694,968 (78.0%) | 119,198 (86.2%) | 24,082 (84.5%) | 15,556 (88.2%) | 153,521 (84.2%) | 91,187 (83.8%) |
| Interval between two doses (days), median (IQR) | 60 (44-76) | 70 (54-83) | 64 (50-78) | 67 (54-79) | 65 (50-79) | 64 (49-78) |
| **Individuals at least 40 days overdue for 2nd dose[2], n (%)** | 237,665 (2.4%) | 2,280 (1.9%) | 412 (1.7%) | 256 (1.6%) | 2,827 (1.8%) | 1,724 (1.9%) |

[1] In total, the vaccine type was another product or unknown vaccine product in 3,867 individuals.
[2] Potential vaccine dropouts who failed to compete the 2 dose series.