

**BRIEF REPORT**

# Protective effects of prior third dose mRNA vaccination in rural nursing home residents during SARS-CoV-2 outbreaks

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**Abstract**

**Background:** In Canada, mortality due to SARS-CoV-2 disproportionately impacted residents of nursing homes (NH). In November 2021, NH residents in the Canadian province of Manitoba became eligible to receive three doses of mRNA vaccine but coverage with three doses has not been universal. The objective of this study was to compare the protection from infection conferred by one, two, and three doses of COVID-19 mRNA vaccine compared to no vaccination among residents of nursing homes experiencing SARS-CoV-2 outbreaks.

**Methods:** Infection Prevention and Control reports from 8 rural nursing homes experiencing outbreaks of SARS-CoV-2 between January 6, 2022, and March 5, 2022, were analyzed. Attack rates and the number needed to vaccinate (NNV) were calculated.

**Results:** SARS-CoV-2 attack rate was 65% among NH residents not vaccinated, 58% among residents who received 1–2 doses of mRNA COVID-19 vaccine, and 28% among residents who had received 3 vaccine doses. The NNV to prevent one nursing home resident from SARS-CoV-2 infection during an outbreak was 3 for a vaccination with 3 doses and 14 for 1–2 doses of COVID-19 mRNA vaccine. The superiority of receiving the third dose was statistically significant compared to 1–2 doses (Chi-Squared,  $p < 0.00001$ ).

**Conclusions:** Nursing home residents who received three doses of COVID-19 mRNA vaccine were at lower risk of SARS-CoV-2 infection compared to those who received 1–2 doses. Our analyses lend support to the protective effects of the third dose of mRNA vaccine for NH residents in the event of a SARS-CoV-2 outbreak.

**KEYWORDS**

COVID-19 vaccines, disease outbreaks, mRNA vaccines, nursing homes, SARS-CoV-2

[Correction added after first online publication on August 30, 2022. Affiliations of Samuel Quan, Pamela H. Orr and Philip D. St John have been corrected.]

No funding was received. An abstract has been submitted for presentation to the Canadian Association on Gerontology.

## INTRODUCTION

In many countries, morbidity and mortality due to the SARS-CoV-2 viral illness have been high among older adults residing in communal living environments, such as Nursing Homes (NHs).<sup>1-5</sup> Accordingly, once COVID-19 vaccines became available in Canada, they were strategically prioritized for NH residents and healthcare providers.<sup>6</sup> In Canada, NHs are regulated residential facilities providing 24-h nursing care and health services to residents by healthcare personnel. In the province of Manitoba, NHs are not used for subacute, post-acute, or convalescent purposes. Most NH residents are women (67%), and 50% are over 85 years of age.<sup>7,8</sup>

To date, most studies on vaccine efficacy in NHs were performed prior to the emergence of the BA.2 variant of SARS-CoV-2 (Omicron) as the dominant strain, and before a third vaccine dose was recommended.<sup>2-5,9</sup> Moreover, many of these nursing home studies looked at primarily urban as opposed to rural NH populations.<sup>10,11</sup> This report analyzes the effect of prior vaccination of NH residents during recent outbreaks of SARS-CoV-2 in NHs in rural Manitoba, Canada. The dose-response effect of mRNA vaccine in protection from infection was compared.

## METHODS

Residents living in Manitoba NHs were offered up to three doses of an mRNA COVID-19 vaccine within weeks of qualifying based on recommendations from Canada's National Advisory Committee on Immunization.<sup>12</sup> The first dose of either Pfizer-BioNTech (Comirnaty) or Moderna (SpikeVax) vaccine became available for NH residents in Manitoba on January 29, 2021. A second dose of the same vaccine was recommended 21 days later for Pfizer-BioNTech (Comirnaty) vaccine recipients and 28 days later for Moderna (Spikevax) vaccine. The first two doses comprised the "primary series". A third dose was available as of Nov. 10, 2021, and was offered as a "booster" after an interval of  $\geq 6$  months post primary series. For those who qualified, vaccines were offered on an ongoing basis to NH residents and those who recently entered the NH. In the analysis, an NH resident was considered vaccinated with a vaccine dose if  $\geq 14$  days had elapsed since the last dose had been received.

Eight of 43 rural NHs in the southwest region of Manitoba experienced outbreaks of SARS-CoV-2 between January 6, 2022, and March 5, 2022. All eight facilities are not-for-profit and operated by the regional health authority. Throughout this time, there was a vaccine mandate for all healthcare providers working in NHs<sup>13</sup> and Omicron was the dominant circulating strain in the region.<sup>14</sup>

### Key points

- In the context of SARS-CoV-2 outbreaks in 8 different rural homes, the number needed to vaccinate to prevent one SARS-CoV-2 infection was 3 for 3 doses of mRNA COVID-19 vaccine and 14 for 1–2 doses of vaccine when infection rates in unvaccinated residents were used as the reference group.
- The outbreaks described occurred when the circulating variant of SARS-CoV-2 was the BA.2 Omicron variant providing evidence the original mRNA COVID-19 vaccines approved in late 2020 provide protection against this variant.

### Why does this paper matter?

Reporting on the impact prior mRNA COVID-19 vaccination of nursing home residents has during facility outbreaks on the reduction in SARS-CoV-2 infection rates in the less well-studied rural population is important to help clinicians, policy makers, residents, and families understand the benefits of the ongoing efforts to manage the pandemic.

Infection Prevention and Control reports, collected at the facility level were used for the analyses. This study was approved by the Health Research Ethics Board of the University of Manitoba (File No. HS25462/H2022:137). The reference group consisted of those who were not vaccinated. They were compared to those who had received 1–2 doses, and those who had received 3 doses of vaccine. The outcome of interest was SARS-CoV-2 infection, determined by positive nasopharyngeal polymerase chain reaction (PCR) tests, and defined as "cases" in the reporting data. Nasopharyngeal PCR tests were administered to those who were positive for signs and symptoms of COVID-19, and those who were in close contact with cases. Nasopharyngeal swabs for PCR testing were not obtained from asymptomatic residents who were not identified as close contacts. We calculated the viral infection attack rate with 95% confidence intervals (95%CI), vaccine effectiveness (i.e., attributable risk among the exposed), and the number needed to vaccinate to prevent one SARS-CoV-2 infection (NNV). The NNV is defined as the inverse of the absolute risk reduction

( $=1/ARR$ ). The ARR was calculated as the attack rate for the reference group (not vaccinated) minus the attack rate for a given vaccine group (1–2, or three doses). Chi-square for trend was performed using StatCalc within Epi Info™ 7 to examine if there was a dose–response effect.

## RESULTS

Eight facilities in the rural health region experienced outbreaks of SARS-CoV-2 between January 6, 2022 and March 5, 2022. A total of 416 residents resided in the eight rural NHs included in the study. The NHs ranged in size from 20 to 100 residents. At the time of the outbreaks, most NH residents ( $n = 362$ , 87%) had received three doses (primary series and a booster dose) of a COVID-19 mRNA vaccine. Very few had received a single dose of vaccine and were therefore analyzed with those who had received two doses. Fifteen residents (3.6%) were not vaccinated.

A total of 135 residents (32%) became infected. Figure 1 shows the percentage of those with an infection for each of the eight nursing homes. Table 1 summarizes combined number of residents, number of resident infections, and attack rates by vaccination status. Vaccine effectiveness for prevention of infection was 11%

for 1–2 doses and 57% for three doses. When compared to unvaccinated, NNV was 14 for 1–2 doses, and 3 for 3 doses.

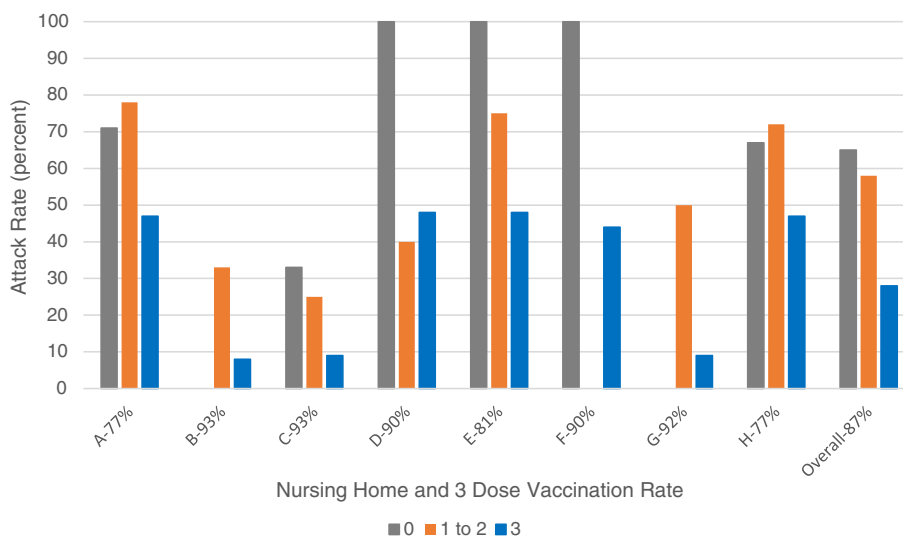
There was a graded relationship between an increased number of vaccine doses and decreased risk of infection ( $p < 0.0001$  for chi-square for trend). Vaccine effectiveness was 55% and NNV was 3 when comparing three doses versus 1–2 doses.

## DISCUSSION

We observed a clear gradient in the risk of SARS-CoV-2 infection among NH residents across the number of COVID-19 mRNA vaccine doses received. Reported SARS-CoV-2 infection was significantly lower among those who received three doses of COVID-19 mRNA vaccine when compared to those who received 1–2 doses. This is consistent with other literature demonstrating the effectiveness of the third dose of COVID-19 mRNA vaccine in NH residents.<sup>15,16</sup>

There are limitations to our analyses. Factors such as age, functional status, morbidity burden, and cognitive impairment were not available in our dataset, but may influence both vaccine receipt and the risk of infection. The population residing in NHs in Manitoba has high rates of cognitive impairment and morbidity because

**FIGURE 1** Percentage of nursing home residents with SARS-CoV-2 infection in each of the facilities, stratified by the number of COVID-19 vaccine doses received. Facilities A through D had more than 50 residents, while in E through H were 50 or fewer residents.



**TABLE 1** SARS-CoV-2 attack rate among nursing home residents who were not vaccinated, received 1 or 2 doses, or received 3 doses

	Not vaccinated	1–2 doses	3 doses
Total number of residents	23	31	362
Infected with COVID-19	15	18	102
Attack rate (95%CI)	65% (46%–85%)	58% (41%–75%)	28% (24%–33%)
Chi-square for trend	Chi-square for trend: 21.2, $p < 0.00001$		

functional impairment is a condition of admission.<sup>7,17</sup> There is the potential for selection bias; those who received their third dose must survive to receive and benefit from it. The factors leading to this differential survival may also influence the attack rate, potentially making the third dose appear more effective. This bias cannot be mitigated by the available data. Second, the results may not be generalizable to non-Canadian rural populations. Clinical characteristics, social factors, effects of urbanicity/rurality, and vaccination rates of residents, staff, and families may differ. Moreover, the use of NHs may vary between countries and some utilization patterns, such as using NHs for subacute care, would likely increase the risk of transmission of SARS-CoV-2 infection. Third, the results may be less applicable to future variants as they emerge over longer periods of time. Fourth, due to the lack of clinical details regarding the infections, we cannot comment on differences in severity of disease among residents with different numbers of vaccine doses. Since asymptomatic screening of all residents was not done, some infections may not have been detected in those who remained asymptomatic and were not close contacts of a positive case. Finally, the NNV findings should also be interpreted with some caution, since NNV is highly dependent upon the time horizon of the study period and the baseline risk of the outcome, which is high during an outbreak in congregate living settings.

Our study uniquely contributes to the literature as there are limited reports of rural populations and few studies that focus on NH outbreaks of the Omicron variant. There is also heterogeneity in the facility size and baseline risk of infection, demonstrating our findings should remain robust among smaller and larger sized NH. Our findings thereby provide real-world data that supports the provision of three doses of mRNA COVID-19 vaccine in NH residents to reduce viral transmission.

#### AUTHOR CONTRIBUTIONS

*Study concept and design:* Elizabeth S Rhynold, Philip D St John, P.H.Orr, Samuel Quan. *Acquisition of data:* Elizabeth S Rhynold. *Analysis and interpretation of data:* All authors. *Preparation of manuscript:* All authors.

#### ACKNOWLEDGMENTS

We would like to thank N Hargrove for statistical advice.

#### CONFLICT OF INTEREST

Dr. Rhynold is a member of the Manitoba COVID-19 Vaccine Medical Clinical Advisory Committee (no financial remuneration), a member of the Doctors Manitoba COVID-19 Vaccine Medical Advisory Committee (honorarium for time participating in committee

meetings), and an employee of the Prairie Mountain Health Region. As Interim Personal Care Home Medical Director has been part of the medical support to the Personal Care Home COVID-19 vaccination roll-out (no additional remuneration from the vaccination of residents). Dr. St John is a board member of Age and Opportunity (Manitoba), has received speaking fees from McMaster University and the Regional Geriatric Program of Eastern Ontario has research funding from the Canadian Institute for Health Research and consulting fees from the University Health Network/Toronto Rehabilitation Institute. Dr. Quan is a graduate student and resident trainee in the Geriatric Medicine and the Clinician Investigator Program at the University of Manitoba, and received scholarships from the CIHR Canada Graduate Scholarship (Master's), Tri-Agency Top-Up Award (Faculty of Graduate Studies, University of Manitoba), and the Dr. Hector Ma Award (Department of Internal Medicine, University of Manitoba). Dr. Singer is the Network Director of the Manitoba Primary Care Research Network (MaPCReN) and a Principal Investigator on research grants funded by IBM, Calian, Research Manitoba, CIHR, and PHAC. Dr. Orr and L. Labine have no conflicts to declare.

#### SPONSOR'S ROLE

This study received no funding or sponsorship.

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**How to cite this article:** Rhynold ES, Quan S, Orr PH, LaBine L, Singer A, St John PD. Protective effects of prior third dose mRNA vaccination in rural nursing home residents during SARS-CoV-2 outbreaks. *J Am Geriatr Soc*. 2022;1-5. doi:10.1111/jgs.17996