ORIGINAL RESEARCH

# The COVID-19 Pandemic and Dementia: a Multijurisdictional Meta-Analysis of the Impact of the First Two Pandemic Waves on Acute Health-care Utilization and Mortality in Canada

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## ABSTRACT

### Background

Previous studies on the impact of the coronavirus disease 2019 (COVID-19) pandemic on persons living with dementia (PLWD) were mostly conducted in a single jurisdiction or focused on a limited number of outcomes. Our study estimates the impact of the first two pandemic waves on emergency department (ED) visits (all-cause/ambulatory care sensitive conditions), hospitalizations (all-cause/30-day readmissions), and all-cause mortality in four Canadian jurisdictions.

### Methods

Using administrative databases from Alberta, Ontario, Saskatchewan, and Quebec, we assembled two closed retrospective cohorts (2019/pre-pandemic control and 2020/pandemic) of PLWD aged 65+. Within community and nursing home settings, the rates of the above-mentioned outcomes in three pandemic periods (first wave, interim period, second wave) were compared to the corresponding pre-pandemic periods. We performed random effects meta-analyses on the provincial incident rate ratios.

### Results

Pre-pandemic and pandemic cohorts included 167,095 vs. 173,240 (community) and 93,374 vs. 92,434 (nursing home) individuals, respectively. During the first wave, community and nursing home populations experienced significant declines in the rates of all-cause ED visits (36% vs. 40%) and hospitalizations (25% vs. 22%), which persisted in the following periods in the community. These declines were greater for the rates of ambulatory care sensitive condition ED visits and 30-day readmissions. Mortality was 36% higher in nursing homes (first wave) and 13% higher in the community (second wave).

### Conclusions

It is key to prepare for future health crises and ensure that PLWD receive necessary care and services and do not have such a high mortality rate. Attention should be equally given to PLWD living in their homes and nursing homes.

**Key words:** dementia, health services research, COVID-19, pandemic preparedness, meta-analysis, emergency room visits, hospitalization, mortality

## INTRODUCTION

It is well known that persons living with dementia (PLWD) were severely affected by the coronavirus disease 2019 (COVID-19) pandemic.(1) Once infected, PLWD were highly vulnerable to the adverse outcomes(2) and experienced a higher mortality rate compared to individuals without dementia.(3) In addition, the pandemic led to disruptions in acute care services(4,5) and decreased access to community resources.(6) Moreover, triaging scarce medical resources among PLWD and other groups during the pandemic led to ethical conflicts.(7)

Although region-specific findings are available, the complexities of having a comprehensive portrait of the impact of the COVID-19 pandemic on PLWD across jurisdictions within countries hamper planning responses to public health emergencies at the national level.(8,9) Many countries, in fact, currently do not possess the essential capabilities required to promptly identify and address known vulnerabilities, including those related to PLWD.(10)

In countries such as the United States, Canada, and Australia, regional or local jurisdictions (states or provinces) devote resources to routinely collect administrative health data—generated during the administration of the health-care system for planning and reporting purposes.(11) While there is an increasingly recognized value of administrative health data in research, local health services planning, and clinical care,(12) these data are rarely used in a cross-jurisdictional way to inform federal policy or program development.(11) Merging datasets across jurisdictions could be an ‘unsurmountable’ challenge due to legal rules to share data,(13) governance, and architecture,(14) differences between datasets and coding systems,(15) availability of variables and indicators, and quality of data.(16) Meta-analyses of cross-jurisdictional population-based data could be an alternative and more effective way of providing federal estimates.(17) This method could help conduct retrospective assessments of the impact of health crises (such as the COVID-19 pandemic) across jurisdictions in order to raise awareness among government policy makers, health-care providers, PLWD and their care partners, and the general public, and plan for future emergencies.

The objective of this study was to estimate the overall impact of the first two waves of the COVID-19 pandemic on acute health-care utilization and all-cause mortality among both community-dwelling PLWD and those residing in nursing homes across four jurisdictions in Canada using meta-analysis methods.

## METHODS

### Design

A cross-jurisdictional meta-analysis study was conducted in four Canadian provinces (Alberta, Ontario, Saskatchewan, and Quebec). Within each province, we assembled two closed retrospective cohorts (one 2019 pre-pandemic/historical control and one 2020/pandemic) of persons aged 65 years and older living with dementia from administrative databases (see Appendix 1A).

In Alberta, data for this study were extracted from the Alberta Health Services Enterprise Data Warehouse with support provided by the Alberta Strategy for Patient Oriented Research Support Unit (AbSPORU). The study received research ethics board approval with a waiver of informed consent.

In Ontario, datasets are linked using unique encoded identifiers and analyzed at ICES. ICES is an independent, non-profit research institute whose legal status under Ontario’s health information privacy law allows it to collect and analyze health-care and demographic data, without consent, for health system evaluation and improvement.

In Saskatchewan, data provided by the Saskatchewan Ministry of Health and eHealth Saskatchewan were linked using unique, masked identifiers and analyzed at the Saskatchewan Health Quality Council (HQC). HQC is an independent organization, operating at arm’s-length from Government of Saskatchewan that reports on and seeks to accelerate improvement in the quality of health care across Saskatchewan through training and education, improvement initiatives, and research. The study received ethics board approval, without requiring consent from individuals.

Quebec’s contribution is part of the ongoing chronic disease surveillance mandate assigned to the Institut national de santé publique du Québec (INSPQ) by the provincial Minister of Health and Social Services. All surveillance activities under this mandate are approved by the provincial Public Health Ethics Committee. No informed consent was required.

We adapted a participatory research approach and ensured stakeholder engagement (PLWD, care partners, clinicians, and policy-makers) throughout the project.(18) Their experiential knowledge during the pandemic guided our research questions and analysis.

### Populations

We identified all older adults who met our age and dementia criteria on two index dates: March 3, 2019 (pre-pandemic cohort index date) and March 1, 2020 (pandemic cohort index date) (Figure 1). Dementia was ascertained using a validated algorithm which identifies a dementia index date as the earliest of any of the following three criteria (sensitivity of 79.3%, specificity of 99.1%): 1) one or more hospitalizations with a diagnosis of dementia (coded in any diagnostic position); or 2) at least three physician visits at least 30 days apart in a two-year period with a code for a dementia diagnosis; or 3) one or more prescriptions of medications specific to dementia (cholinesterase inhibitors, memantine—where available).(19) These criteria were applied within a five-year look-back period to ascertain prevalent cases. We subsequently stratified each cohort by residence: living permanently in a nursing home(20) vs. living in a community setting (all other dwellings).

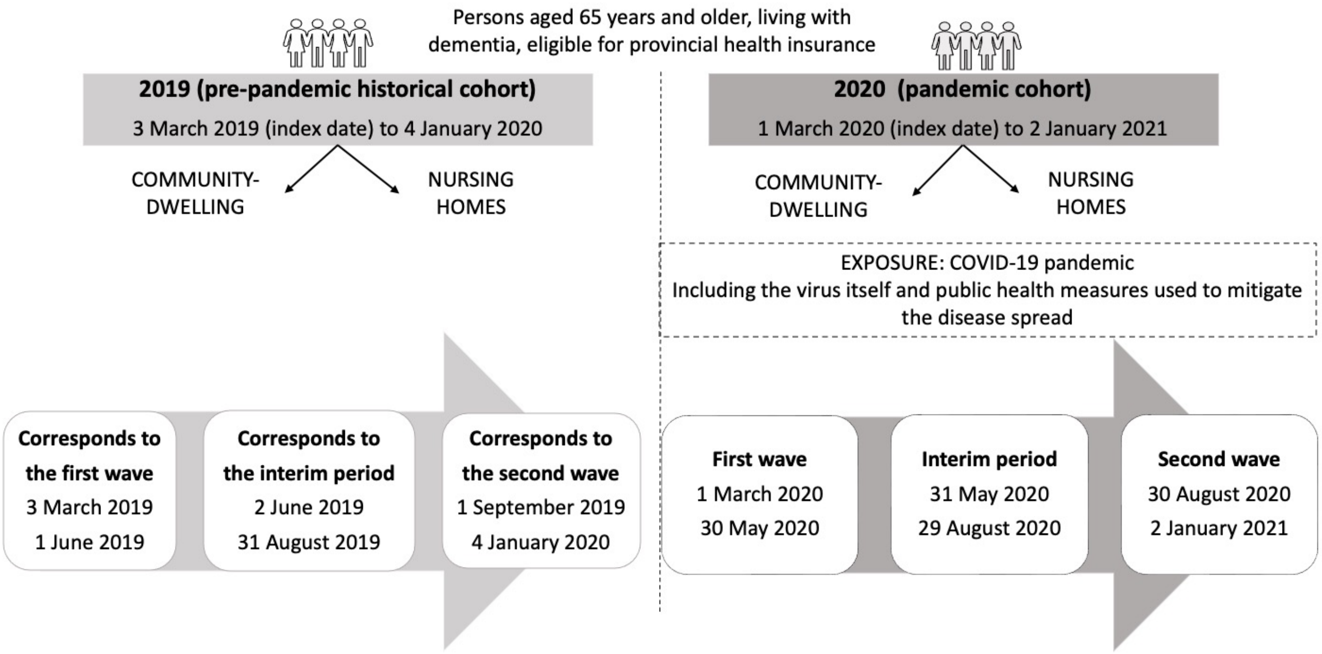

FIGURE 1. Study design and cohort creation

Individuals were followed from the index date until cohort exit including whichever came first for: end of the cohort-period (January 4, 2020 for the pre-pandemic cohorts and January 2, 2021 for the pandemic cohorts), admission to a nursing home (for community dwelling population), or death.

## Descriptive Characteristics of the Cohorts

We described each cohort at the index date. Age was reported as mean and proportions in age categories (65 to 74 yrs, 75 to 84, 85+). Male or female sex was reported as percentages. Time (yrs) from historical dementia case ascertainment to study index date was reported as a mean. The Charlson Comorbidity Index was calculated using a two-year look-back period from the index date when using hospitalization data.(21) We retained 16 individual indicator variables (excluding dementia), categorized the Charlson Comorbidity Index as 0, 1, 2+, and provided the mean score for the cohorts. Residential neighborhood characteristics included urbanicity (urban: ≥10,000 inhabitants; rural: <10,000 inhabitants), Statistical Area Classification (type 1=Urban area to type 7=Rural or remote area),(22) and Pampalon material and social deprivation indices based on geographic area (quintile 1=least deprived to quintile 5=most deprived).(23) The Ontario Marginalization Index material deprivation and residential instability dimensions were used in Ontario instead of Pampalon indices. We used standardized differences to compare clinical and sociodemographic characteristics of PLWD in pre-pandemic and pandemic cohorts within each province, where differences greater than 0.10 indicate an imbalance.(24) We tabulated the pooled numerical descriptive summaries of the four provinces.

## Exposure

The exposure was the COVID-19 pandemic, including the virus itself and public health measures used to mitigate the disease spread. We used three exposure time periods: first wave, interim period, and second wave (dates are shown in Figure 1).

## Outcome Measures

We measured all-cause emergency department (ED) visits, ambulatory care sensitive conditions (ACSC) ED visits,(25,26) all-cause hospital admissions, 30-day hospital readmissions, and all-cause mortality (see Appendix 1B for definitions). Outcomes were measured from the index date until the cohort exit, as described above.

## Meta-analysis

We adapted a two-step meta-analytic approach proposed for the analysis of nested level-1 (individuals) data with a small level-2 (provinces) sample size.(17)

Step 1 included calculating province-specific estimates. To allow an evaluation of the impact of the first two waves of the pandemic, each province analyzed their data in the three pandemic periods and corresponding periods in the pre-pandemic cohort. Rates were calculated as the number of outcomes during each period over person-weeks at risk (defined as the numbers of weeks from the index date until the end of the follow-up, by period). Acute care use outcomes were measured using an autoregressive correlation structure to account for the repeated measures, and negative binomial regression generalized estimating equations to adjust for censoring due to death or nursing home admission (for the community-dwelling population).(27) Mortality was measured using a Poisson model. We used an interaction term (*) between the cohort (2020 pandemic, 2019 pre-pandemic) and the period (first wave, interim period, and second wave) to compare between cohorts. The regression equation was as follows: Log(Outcome(μ)) = intercept + βkperiod* cohort + log(person weeks). Incidence rate ratios (IRR) and 95% confidence intervals (CI) were calculated. SAS 9.4 (SAS Institute Inc. Cary, NC) software was used for these analyses.(28)

Step 2 included random-effects meta-analyses to pool the province-level estimates ("pre-calculated effect-size data").(29) To calculate the CIs around the pooled (average) effects, we used Knapp-Hartung adjustment, which is preferable when few estimates of varying sample size and precision are available (i.e., N=4 provinces) to reduce the chance of false positives.(30) A Restricted Maximum Likelihood estimator was used to estimate the variance of the underlying distribution of true effect sizes (tau squared = $\tau^2$ ).(31) The $I^2$ statistic was reported as an expression of the inconsistency of provincial results depending on the precision of effect sizes.(32) We used the following packages in R statistical software (R Foundation for Statistical Computing; https://www.r-project.org/foundation/): 'meta' package (general package for meta-analysis)(33) including metagen function for generic inverse variance meta-analysis,(29) and 'tidyverse' package for data visualization.(34)

The results of this study are reported in accordance with the Reporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement.(35)

### Ethics Approval

The study was approved by the McGill University Institutional Research Ethics Board in the province of Quebec (Study IRB Number A07-E46-20B), the University of Calgary Conjoint Health Research Ethics Board (REB21-0482), and the University of Saskatchewan Biomedical Research Ethics Board (Bio-REB 2186). In Ontario, the use of the data in this project is authorized under section 45 of Ontario's Personal Health Information Protection Act (PHIPA) and does not require review by a Research Ethics Board.

## RESULTS

Figure 2 shows the derivation of pre-pandemic (2019) and pandemic (2020) cohorts using the provincial cohorts and the total numbers of PLWD included from all four provinces. In the community, a total of 167,095 and 173,240 PLWD were included in the pre-pandemic and pandemic cohorts, respectively. In the nursing home setting, the pre-pandemic cohort included 93,374 PLWD, while the pandemic cohort included 92,434 PLWD in total. Based on standardized differences, characteristics of PLWD were similar between 2019 and 2020 cohorts within each province and setting. Individuals were similar across provinces in general (apart from higher mean disease duration in Ontario, higher proportions of rural population in Saskatchewan, and higher proportions of individuals with two or more comorbidities in Quebec). Table 1 shows baseline characteristics of the pre-pandemic and pandemic cohorts in the community and nursing homes.

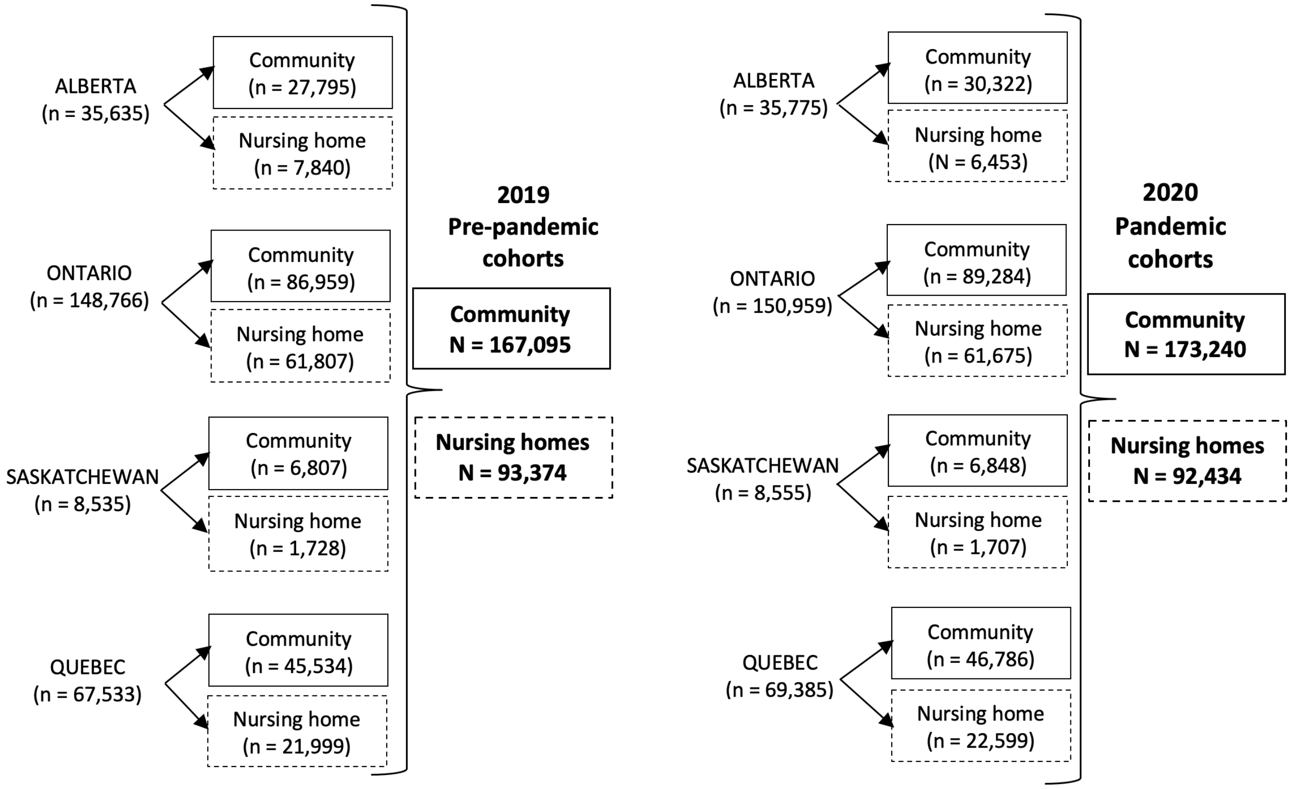

FIGURE 2. Assembling 2019 pre-pandemic and 2020 pandemic cohorts from four provinces

Rates of outcomes during 2019 pre-pandemic and 2020 pandemic periods in four Canadian provinces by location of residence were shown in Table 2. The results of the meta-analyses for each outcome by period are presented in Figure 3A (community) and 3B (nursing home). Additional provincial and cross-provincial results are available

TABLE 1.
Baseline characteristics of pre-pandemic (2019) and pandemic (2020) cohorts in four provinces

| | *Community-Dwelling Population* | | *Nursing Home Population* | |
|---|---|---|---|---|
| | *2019 Cohort* | *2020 Cohort* | *2019 Cohort* | *2020 Cohort* |
| Total N | 167,095 | 173,240 | 93,374 | 92,434 |
| Female N (%) | 100,171 (59.9%) | 103,497 (59.7%) | 63,424 (67.9%) | 62,640 (67.8%) |
| Number of years since dementia diagnosis ascertainment mean | 2.7 | 2.7 | 3.3 | 3.3 |
| Age at index date mean | 82.4 | 82.4 | 85.3 | 85.4 |
| Age category N (%) | | | | |
| 65 to 74 | 28,052 (16.8%) | 29,245 (16.9%) | 10,166 (10.9%) | 10,239 (11.1%) |
| 75 to 84 | 69,669 (41.7%) | 72,208 (41.7%) | 28,854 (30.9%) | 28,594 (30.9%) |
| 85+ | 69,374 (41.5%) | 71,787 (41.4%) | 54,354 (58.2%) | 53,601 (58.0%) |
| Charlson Comorbidity Index (CCI)[a] N (%) | | | | |
| No hospitalization during two-year look back period (CCI was not calculated) | 78,525 (47.0%) | 82,709 (47.7%) | 46,043 (49.3%) | 45,680 (49.4%) |
| 0 | 40,533 (24.3%) | 41,678 (24.1%) | 19,985 (21.4%) | 19,892 (21.5%) |
| 1 | 11,948 (7.2%) | 12,454 (7.2%) | 6,484 (6.9%) | 6,001 (6.5%) |
| 2+ | 36,089 (21.6%) | 36,399 (21.0%) | 20,862 (22.3%) | 20,861 (22.6%) |
| CCI mean (for whom CCI were calculated) | 2.0 | 2.0 | 1.9 | 1.9 |
| Rural residence N (%) | | | | |
| Urban | 126,234 (75.5%) | 129,965 (75.0%) | 79,327 (85.0%) | 78,539 (85.0%) |
| Rural | 40,176 (24.1%) | 42,447 (24.5%) | 13,429 (14.3%) | 13,273 (14.3%) |
| missing | 685 (0.4%) | 828 (0.5%) | 618 (0.7%) | 622 (0.7%) |
| Statistical Area Classification type N (%) | | | | |
| 1 (Census metropolitan area) | 122,535 (73.3%) | 127,342 (73.5%) | 68,682 (73.6%) | 68,367 (74.0%) |
| 2 (Census agglomeration with at least one census tract) | 4,819 (2.9%) | 5,037 (2.9%) | 2,443 (2.6%) | 2,306 (2.5%) |
| 3 (Census agglomeration having no census tracts) | 14,952 (8.9%) | 15,266 (8.8%) | 8,401 (9.0%) | 8,037 (8.7%) |
| 4 (Strong metropolitan influenced zone) | 8,086 (4.8%) | 8,277 (4.8%) | 4,625 (5.0%) | 4,641 (5.0%) |
| 5 (Moderate metropolitan influenced zone) | 10,398 (6.2%) | 10,712 (6.2%) | 5,831 (6.2%) | 5,807 (6.3%) |
| 6 (Weak metropolitan influenced zone) | 4,977 (3.0%) | 5,227 (3.0%) | 2,546 (2.7%) | 2,468 (2.7%) |
| 7 (No metropolitan influenced zone) | 793 (0.5%) | 784 (0.5%) | 292 (0.3%) | 277 (0.3%) |
| missing | 535 (0.3%) | 595 (0.3%) | 554 (0.6%) | 531 (0.6%) |
| Pampalon Material Deprivation Index[b] N (%) | | | | |
| 1 (least deprived) | 31,500 (18.9%) | 33,048 (19.1%) | 16,384 (17.5%) | 16,483 (17.8%) |
| 2 | 29,354 (17.6%) | 30,541 (17.6%) | 15,938 (17.1%) | 15,828 (17.1%) |
| 3 | 29,110 (17.4%) | 30,342 (17.5%) | 15,619 (16.7%) | 15,446 (16.7%) |
| 4 | 30,284 (18.1%) | 31,186 (18.0%) | 16,463 (17.6%) | 16,338 (17.7%) |
| 5 (most deprived) | 29,787 (17.8%) | 30,881 (17.8%) | 17,431 (18.7%) | 17,235 (18.6%) |
| missing | 17,060 (10.2%) | 17,242 (10.0%) | 11,539 (12.4%) | 11,104 (12.0%) |
| Pampalon Social Deprivation Index[c] N (%) | | | | |
| 1 (least deprived) | 21,799 (13.0%) | 23,333 (13.5%) | 8,014 (8.6%) | 7,968 (8.6%) |
| 2 | 24,083 (14.4%) | 25,204 (14.5%) | 11,070 (11.9%) | 11,141 (12.1%) |
| 3 | 27,561 (16.5%) | 28,813 (16.6%) | 14,133 (15.1%) | 13,865 (15.0%) |
| 4 | 32,874 (19.7%) | 33,749 (19.5%) | 20,301 (21.7%) | 20,248 (21.9%) |
| 5 (most deprived) | 43,718 (26.2%) | 44,899 (25.9%) | 28,317 (30.3%) | 28,108 (30.4%) |
| missing | 17,060 (10.2%) | 17,242 (10.0%) | 11,539 (12.4%) | 11,104 (12.0%) |

[a] Based on hospital episode and excluding dementia.
[b] Ontario used Ontario Marginalization Index (Material deprivation).
[c] Ontario used Ontario Marginalization Index (Residential instability).

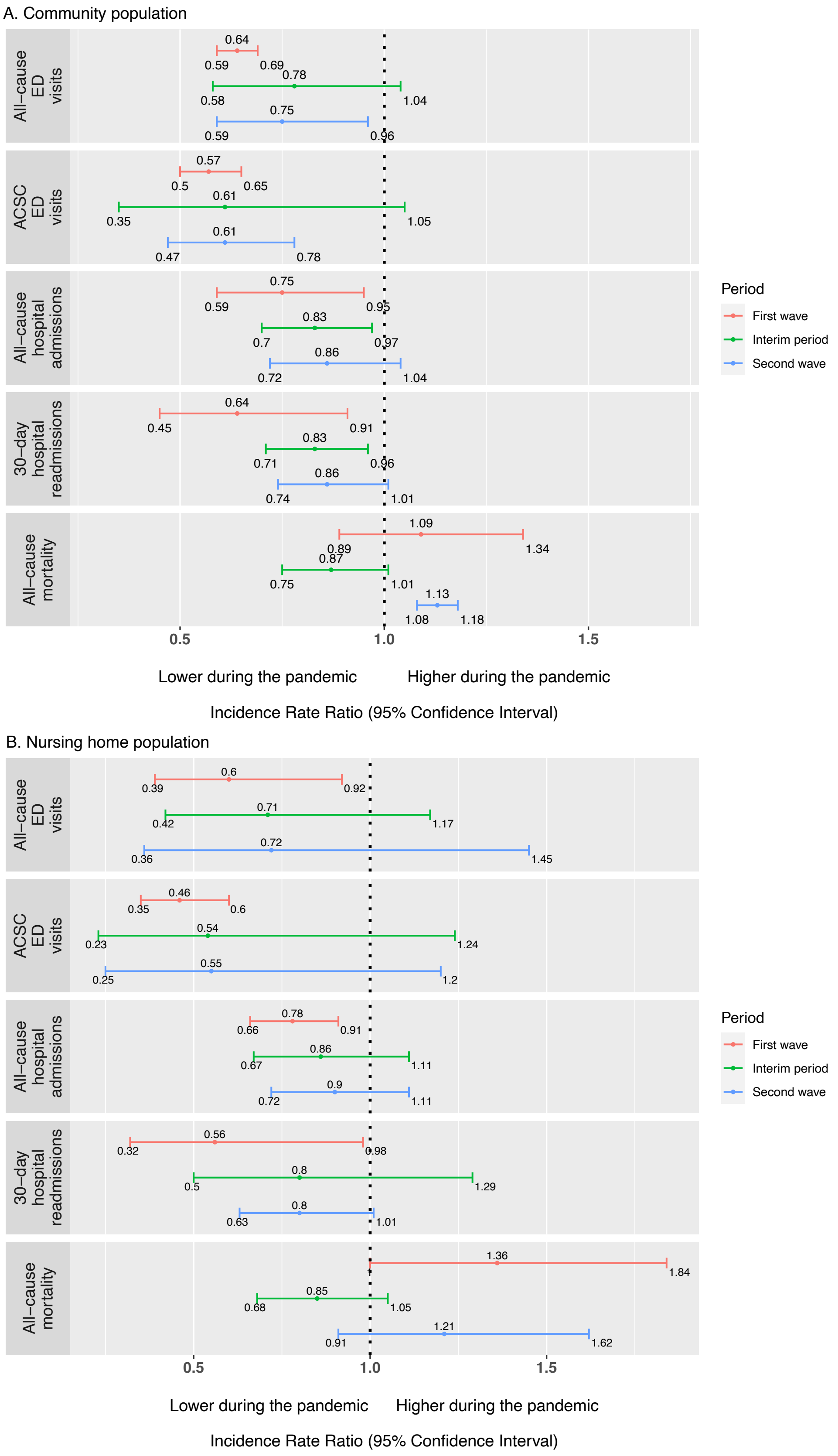

FIGURE 3. Pooled outcomes in four Canadian provinces; pandemic cohorts were compared to pre-pandemic cohorts (reference) across three periods; Saskatchewan data did not contribute to all-cause and ACSC ED visits in both community and nursing home populations as well as 30-day hospital readmissions in nursing home population.
ED = emergency department; ACSC = ambulatory care sensitive conditions.

in Appendices 2A and 2B. Statistically significant changes (reduction or increase) in the probability of each outcome during the pandemic periods compared to pre-pandemic periods (reference) were reported as percentages.

## All-Cause and ACSC ED Visits

In the community, compared to the corresponding pre-pandemic periods, PLWD experienced a 36% (IRR=0.64 [0.59–0.69]) and 25% (IRR=0.75 [0.59–0.96]) lower rate of ED visits during the first and second waves, respectively. Among persons living in nursing homes, we observed a 40% (IRR=0.60 [0.39–0.92]) lower rate of ED visits in the first wave.

In the community, the rates of ACSC ED visits were 43% (IRR=0.57 [0.50–0.65]) lower in the first wave and 39% (IRR=0.61 [0.47–0.78]) lower in the second wave. In the nursing home setting, during the first pandemic wave, rates of ACSC ED visits were 54% (IRR=0.46 [0.35–0.60]) lower than the corresponding pre-pandemic periods.

## All-Cause and 30-Day Hospital Admissions

The rates of all-cause hospitalizations fell by 25% (IRR=0.75 [0.59–0.95]) during the first wave and 17% (IRR=0.83 [0.70–0.97]) during the interim period in the community. In nursing homes, the rate fell by 22% (IRR=0.78 [0.66–0.91]) in the first wave.

In the community, the rates of 30-day rehospitalizations fell by 36% (IRR=0.64 [0.45–0.91] and 17% (IRR=0.83 [0.71–0.96] during the first wave and interim period, respectively. In nursing homes, during the first wave, the rates were up to 44% (IRR=0.56 [0.32–0.98]) lower than the corresponding pre-pandemic periods.

## All-Cause Mortality

On average, among the community-dwelling population, the all-cause mortality rate was 13% (IRR=1.13 [1.08–1.18]) higher in the second wave compared to the corresponding pre-pandemic period. In nursing homes, we found 36%

TABLE 2.
Rates of outcomes during pre-pandemic and pandemic periods in four Canadian provinces

| *Outcome* *Rate per 100 person-week* | *ALBERTA* | | | | | | *ONTARIO* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *2019* | | | *2020* | | | *2019* | | | *2020* | | |
| | *P1* | *P2* | *P3* | *P1* | *P2* | *P3* | *P1* | *P2* | *P3* | *P1* | *P2* | *P3* |
| Community-dwelling population living with dementia | | | | | | | | | | | | |
| All-cause ED visits | 2.44 | 2.28 | 2.18 | 1.49 | 1.86 | 1.68 | 1.64 | 1.72 | 1.62 | 0.95 | 1.32 | 1.27 |
| ACSC ED visits | 0.49 | 0.44 | 0.41 | 0.28 | 0.32 | 0.28 | 0.25 | 0.25 | 0.25 | 0.13 | 0.17 | 0.17 |
| All-cause hospital admissions | 1.01 | 0.88 | 0.89 | 0.68 | 0.80 | 0.76 | 0.91 | 0.87 | 0.93 | 0.68 | 0.83 | 0.87 |
| 30-day hospital readmissions | 0.16 | 0.14 | 0.14 | 0.09 | 0.12 | 0.12 | 0.13 | 0.12 | 0.12 | 0.09 | 0.12 | 0.11 |
| All-cause mortality | 0.24 | 0.22 | 0.23 | 0.23 | 0.21 | 0.31 | 0.21 | 0.20 | 0.25 | 0.24 | 0.22 | 0.27 |
| Nursing home population living with dementia | | | | | | | | | | | | |
| All-cause ED visits | 1.27 | 1.29 | 1.23 | 0.88 | 1.06 | 1.09 | 0.88 | 0.82 | 0.76 | 0.43 | 0.54 | 0.56 |
| ACSC ED visits | 0.35 | 0.32 | 0.30 | 0.19 | 0.27 | 0.25 | 0.16 | 0.14 | 0.13 | 0.06 | 0.07 | 0.08 |
| All-cause hospital admissions | 0.62 | 0.61 | 0.66 | 0.51 | 0.58 | 0.60 | 0.67 | 0.63 | 0.62 | 0.46 | 0.49 | 0.55 |
| 30-day hospital readmissions | 0.07 | 0.07 | 0.07 | 0.04 | 0.07 | 0.07 | 0.08 | 0.09 | 0.07 | 0.04 | 0.05 | 0.06 |
| All-cause mortality | 0.93 | 0.84 | 1.07 | 1.34 | 1.13 | 1.76 | 0.58 | 0.51 | 0.61 | 0.80 | 0.50 | 0.66 |

| *Outcome* *Rate per 100 person-week* | *SASKATCHEWAN* | | | | | | *QUEBEC* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *2019* | | | *2020* | | | *2019* | | | *2020* | | |
| | *P1* | *P2* | *P3* | *P1* | *P2* | *P3* | *P1* | *P2* | *P3* | *P1* | *P2* | *P3* |
| Community-dwelling population living with dementia | | | | | | | | | | | | |
| All-cause ED visits | NA | NA | NA | NA | NA | NA | 2.86 | 2.60 | 2.71 | 1.84 | 1.91 | 1.79 |
| ACSC ED visits | NA | NA | NA | NA | NA | NA | 0.33 | 0.25 | 0.29 | 0.20 | 0.16 | 0.17 |
| All-cause hospital admissions | 1.00 | 0.87 | 0.88 | 0.68 | 0.75 | 0.74 | 0.92 | 0.80 | 0.84 | 0.80 | 0.73 | 0.76 |
| 30-day hospital readmissions | 0.07 | 0.09 | 0.11 | 0.03 | 0.07 | 0.09 | 0.12 | 0.12 | 0.11 | 0.09 | 0.10 | 0.10 |
| All-cause mortality | 0.38 | 0.37 | 0.46 | 0.42 | 0.33 | 0.43 | 0.18 | 0.15 | 0.17 | 0.23 | 0.17 | 0.21 |
| Nursing home population living with dementia | | | | | | | | | | | | |
| All-cause ED visits | NA | NA | NA | NA | NA | NA | 2.63 | 2.37 | 2.3 | 1.55 | 1.65 | 1.51 |
| ACSC ED visits | NA | NA | NA | NA | NA | NA | 0.37 | 0.27 | 0.28 | 0.17 | 0.16 | 0.15 |
| All-cause hospital admissions | 0.46 | 0.36 | 0.43 | 0.29 | 0.50 | 0.38 | 1.08 | 0.99 | 0.92 | 0.92 | 0.87 | 0.86 |
| 30-day hospital readmissions | 0.03 | s | 0.04 | s | s | 0.04 | 0.15 | 0.16 | 0.15 | 0.11 | 0.14 | 0.12 |
| All-cause mortality | 0.59 | 0.58 | 0.63 | 0.73 | 0.53 | 0.81 | 0.68 | 0.59 | 0.64 | 1.21 | 0.54 | 0.75 |

2019 cohort: P1: Corresponds to the first wave (3 March to 1 June 2019). P2: Corresponds to the interim period (2 June to 31 August 2019). P3: Corresponds to the second wave (1 September 2019 to 4 January 2020)
2020 cohort: P1: First wave (1 March to 30 May 2020). P2: Interim period (31 May to 29 August 2020). P3: Second wave (30 August 2020 to 2 January 2021)
ACSC = Ambulatory Care Sensitive Conditions, ED = Emergency Department, s = Supressed, NA = not available.

(IRR=1.36 [1.00–1.84]) higher all-cause mortality in the first wave.

## DISCUSSION

We estimated the impact of the first two waves of the COVID-19 pandemic on acute care utilization and all-cause mortality among PLWD across four Canadian jurisdictions in both community and nursing home settings. During the first wave, community and nursing home populations experienced significant declines in the rates of all-cause ED visits and hospitalizations, which persisted in the following periods in the community. The first wave declines were greater for the rates of ED visits for ambulatory care sensitive conditions and 30-day readmissions. All-cause mortality rates increased in both the community and nursing homes. In addition, some of the statistically insignificant results showed estimates above 10%, which might be clinically significant.(36)

Our results confirmed that PLWD experienced disruption in essential health services, particularly a decreased ED use, as it was the case for the general population.(37) Decrease in ED visits and hospitalizations could be explained by the reluctance of PLWD living in the community and their care partners to seek support due to the fear of potential consequences (e.g., COVID-19 infection), a phenomenon observed among the general population.(37) As most hospitals had visitor restriction policies,(38) PLWD might have been afraid of being hospitalized without an accompanying care partner or dying alone.(37) In addition, in the early part of the pandemic, nursing home staff avoided transfers to congested acute care settings,(39) which may explain reductions in ED visits and hospitalizations. Future studies should investigate whether the decrease in ED visits and hospitalizations is linked with suboptimal outcomes during this period and potential long-term health consequences.

Increased mortality rates in nursing homes might be attributed to more frequent outbreaks among PLWD living in collective settings. One in three Canadian nursing homes experienced an outbreak during the first wave, and 37% of nursing home residents infected with COVID-19 died from the virus.(40) Our results for mortality rates are consistent with the international literature showing higher mortality in both community(5,41,42) and nursing home dementia populations.(41-43) Nursing home staffing challenges and unpreparedness, low COVID-19 preparedness at the government level(44) and lack of resources(39,45) were raised worldwide.

In addition to the international attention that has been placed on nursing homes, our results also showed that PLWD living in the community experienced not only a prolonged disruption in health services but also an important increased mortality. These disruptions in health services may have contributed to deteriorations in health among PLWD.(46) Indeed, a meta-analysis of the studies investigating the first wave or first year of the pandemic showed 25% increased mortality among PLWD without COVID-19 infection.(47)

This study has some limitations regarding the design and use of administrative data. First, issues related to study design included a short time window, pandemic waves hitting different provinces at different times, and larger provinces (Ontario and Quebec) dominating estimates. The clinical and statistical heterogeneity might be explained by variations in the timing of pandemic waves as we established the study periods based on provinces with larger populations. Second, given the design and the use of administrative data, causal inferences are impossible. Third, data were not available for specific outcomes in some small provinces, which likely had very little effect on the pan-Canadian rates.

Nevertheless, our study had important strengths. The administrative databases are population-based as they include individuals eligible for health insurance across provincial single-payer health systems, with minor exceptions.(48) The four provinces in our study capture 76% of the Canadian population.(49) This study quantified the impact of the COVID-19 pandemic at a national level using advanced methods to combine data across several jurisdictions. It provided a comprehensive portrait of the disruptions of services and increased mortality for PLWD in both nursing home and community settings, which were often examined separately in the international literature.

## CONCLUSION

In this paper, we demonstrated a meta-analytical method to pool population-based data from four Canadian jurisdictions as an alternative and more effective way of providing federal estimates. In Canada, PLWD in both community and nursing home settings experienced lower rates of acute care use and greater mortality during the first two waves of the COVID-19 pandemic. The extent to which these results can be attributed to issues with access to health-care services or COVID-19 outbreaks, as well as the federal and jurisdictional initiatives/interventions that were put in place, need further investigation to inform care of PLWD during future emergencies. Our findings underscore the need to develop a nationwide federal emergency action plan specific to vulnerable populations, such as PLWD, while sustaining accessible and equitable health-care services for those who live in both community and nursing home settings.

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## CONFLICT OF INTEREST DISCLOSURES

We have read and understood the *Canadian Geriatrics Journal*'s policy on disclosing conflicts of interest and declare that we have none. The analyses, conclusions, opinions, and statements expressed herein are solely those of the authors and do not reflect those of the funding or data sources; no endorsement is intended or should be inferred. This study is based in part on data provided by Alberta Health and Alberta Health Services. The interpretation and conclusions contained herein are those of the researchers and neither the Government of Alberta nor Alberta Health Services express any opinion in relation to this study. The interpretation and conclusions contained herein do not necessarily represent those of the Government of Quebec or the Minister of Health and Social Services. The interpretation and conclusions contained herein do not necessarily represent those of the Government of Saskatchewan, the Saskatchewan Ministry of Health, or eHealth Saskatchewan.

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## APPENDIX 1A. Health administrative databases used in the present study in four Canadian provinces

*Ontario Databases*

**National Ambulatory Care Reporting System (NACRS):** Compiled by the Canadian Institute for Health Information (CIHI) and contains clinical (diagnoses and procedures), demographic, and administrative information for all patient visits made to hospital- and community-based ambulatory care centres (emergency departments (ED), day surgery units).

**Canadian Institute for Health Information Discharge Abstract Database (CIHI DAD):** Compiled by the CIHI and contains clinical (diagnoses and procedures/interventions), demographic, and administrative information for all admissions to acute care hospitals.

**Ontario Health Insurance Plan Physician Claims Database (OHIP):** Claims database contains information on inpatient and outpatient services provided to Ontario residents eligible for the province's publicly funded health insurance system by fee-for-service health care practitioners (primarily physicians) and "shadow billings" for those paid through non-fee-for-service payment plans.

**Ontario Registered Persons Database (RPDB):** The RPDB provides basic demographic information (e.g., birth date, sex, death date, if applicable) on anyone who has received a health card number in Ontario.

**Ontario Drug Benefit Database (ODB):** Database contains prescription medication claims for those covered under the provincial drug program, including: all nursing home residents, those aged 65 years and older, patients receiving services under the Ontario Home Care program, those receiving social assistance, and residents eligible for specialized drug programs.

**Continuing Care Reporting System Long-term Care Database (CCRS-LTC)(1) — Resident Assessment Instrument–Minimum Data Set (CCRS RAI-MDS 2.0)(2):** The CCRS-LTC database is compiled by the CIHI and comprises all mandatory clinical assessments performed on nursing home residents in Ontario.
The CCRS collects and reports data from the RAI-MDS 2.0©. This standardized clinical assessment was developed by interRAI, a not-for-profit international research network committed to improving care for people with complex medical needs.
The RAI-MDS 2.0 assessment instrument is designed to be used in hospital-based and residential continuing care. Along with administrative, demographic and resource utilization data, the RAI MDS 2.0 data is submitted to the CCRS-LTC and made available across Canada for planning and monitoring care, understanding populations, improving quality and allocating resources.

*Alberta Databases*

**National Ambulatory Care Reporting System (NACRS):** Same as above

**Canadian Institute for Health Information Discharge Abstract Database (CIHI DAD):** Same as above.

**Practitioner Claims (AB Practitioner Claims):** Practitioner Claims database contains information on fee for services provided to Alberta residents with Alberta Health Care Insurance Plan coverage in inpatient and outpatient settings. Physicians paid through alternative payment plans submit 'shadow billing' claims in place of real claims. Data includes elements such as date of claim, location, physician specialty, up to 3 ICD-9 diagnosis codes, Alberta Schedule of Medical benefits code and amount claimed.

**Pharmaceutical Information Network (PIN):** Captures nearly all drug dispensations from community pharmacies in Alberta, regardless of insurance coverage or age of recipients. Most Long-Term care facilities have drugs dispensed from community pharmacies and are captured in PIN however some go through other pharmacies (e.g., hospital pharmacies) and do not get captured in PIN. Its impact is considered to be small since the dementia definition also relies on diagnosis codes.

**Alberta Continuing Care Information System (ACCIS):** Continuing care stays including long-term care, designated supportive living and home-living. Earliest data: January 1, 2012.

**Resident Assessment Instrument–Minimum Data Set (RAI-MDS):** Same as above. A comprehensive assessment that is used to identify the preference, needs and strengths of residents of nursing homes and patients in continuing care hospitals; it also provides a snapshot of the services they receive.

*Saskatchewan Databases*

**National Ambulatory Care Reporting System (NACRS):** Same as above. 50% of population from two urban areas.

**CIHI Discharge Abstract Database (CIHI DAD):** Same as above.

**Medical Services Billing (MSB):** Saskatchewan physician's services database. Fee-for services, but salaried physicians are required to shadow bill. Has data on physician services: date of service, location of service, diagnostic code, service provided.

**Person Health Registration System (PHRS):** Health Services Number, for the purpose of health system management and provider payment. It was used to identify anyone who had health insurance and was thus eligible to use any of the health services in a given year. PHRS was also used to identify the following: Age, sex, Pampalon deprivation Index, Urban/rural location.

**Prescription Drug Database:** The Prescription Drug Database is the prescription claims database of the Drug Plan and Extended Benefits Branch of the Ministry of Health. The Prescription Drug Plan Database includes information about dispensations to all individuals regardless of the source of funding for the costs (i.e., public or private insurance, out of pocket). Saskatchewan has access to the same prescription drug data as every other province; however, at the time of this study, Health Quality Council did not have access to it Defined Daily Dosage variable.

**CCRS RAI-MDS 2.0:** Same as above.

| *Quebec Databases* |
|---|
| **Maintenance et exploitation des données pour l'étude de la clientèle hospitalière (Med-Écho):** Database contains clinical and administrative personal information related to the care and services provided to a person admitted or registered for day surgery in a Quebec hospital. For each hospital stay, it contains the date of admission, and discharge, diagnoses, place of origin, and discharge destination. |
| **Quebec Integrated Chronic Disease Surveillance System (QICDSS) [In French : Système intégré de surveillance des maladies chroniques du Québec (SISMACQ)] :** Quebec linked population-based health administrative database. The QICDSS database links 5 health administrative databases that cover: patient demographics, health care, health care services utilization (fee-for-service medical consultation, hospitalization, prescription drug use) and deaths. The QISDSS was developed to allow chronic diseases surveillance. This dataset covers 99% of the 65+ population of Quebec. The following variables and algorithms were available in the database: 1) For each person: date of birth and death, sex, small-area level socioeconomic status (Pampalon index of material deprivation), small-area level measure of rurality; 2) For each medical service billing: the date of the service, the service provider (identification number and specialty) and the location of service delivery; 3) For each hospital stay: the date of admission, and discharge, the diagnoses, provenance and discharge destination, alternate level of care status; 4) For each dispensed drug: date of dispensation and name. |
| Surveillance of major neurocognitive disorders in Quebec focuses on cases identified from the QICDSS matching five files (the first four QICDSS files are used to identify cases of major neurocognitive disorders), namely: 1) The registration file of persons insured for health insurance (le fichier d'inscription des personnes assurées à l'assurance maladie FIPA), which provides information on demographic data as well as on periods of eligibility for health insurance; 2) The fee-for-service physician billing file, which lists all medical acts billed by physicians; 3) The MED-ÉCHO hospitalization file (maintenance and use of data for the study of hospital patients), which lists all hospitalizations as well as the associated main and secondary diagnoses; 4) The pharmaceutical services file, which lists the drugs claimed, as well as the periods of eligibility for drug insurance, for persons insured by the public drug insurance plan; 5) Vital Events Registry Death File.<br>It should be noted that the pharmaceutical services file only includes medications prescribed and reimbursed by the public prescription drug insurance plan for people who benefit from it. All community-dwelling people aged 65 and over are generally eligible for prescription drug insurance and the vast majority utilize this coverage (90% of the entire population, either community-dwelling or institutionalized). Among community-dwelling people aged 40 to 64, 35 to 40% of the whole Quebec population are members of the prescription drug insurance plan. |
| **Quebec does not participate in the CCRS. Algorithm to identify the 65+ community[a] vs. nursing home population in the provincial administrative database in Quebec(3):** A person is defined as institutionalized if they have encountered one of the following three situations: 1) Identified as institutionalized in the pharmaceutical services file; 2) Had a hospital admission of which the type of origin or the type of destination was being in a nursing home; 3) Received a medical service paid on a fee-for-service basis in a public or private long-term accommodation for the elderly. In situations where more than one of these three criteria were met, it was the earliest date that was considered the institutionalization date. All individuals were considered alive and living in the community before their institutionalization date. All other members of the cohort who met none of these criteria were considered to be living in the community throughout their follow-up time. |

[a] The term community means residence with or without home care services including, but not limited to, private home, retirement home, and assisted living.

## APPENDIX 1B. Operational definitions for study outcomes censored for death and nursing home admission (for community-dwelling population)

**All-cause ED visits:** Rate of ED visits during the week among persons with dementia. Numerator: Total number ED visits (unscheduled, not a transfer from another ED and with or without a subsequent hospital admission) during the week.
Denominator: Total person-weeks among persons with a diagnosis of dementia on the 1st day of the week in community.

**Ambulatory care sensitive condition (ACSC) ED visits-older population definition (Codes adapted from Godard-Sebillotte *et al*.,(4) Grunier *et al*.,(5):** Among ED visits identified above, include ED visits for ACSC (older population definition) coded as the main problem (DX10CODE1). Use ICD-10 codes for hospitalizations for ACSC (older population definition). Among hospital admissions, include those with a most-responsible diagnosis (DX10CODE1) for the following:

***Include all conditions for the general population definition: CIHI and Godard-Sebillotte et al.*(4): angina** (ICD-10: I20, I23.82, I24.0, I24.8, I24.9) unless the record also indicates a cardiac procedure was performed); **asthma** (ICD-10: J45); **heart failure and pulmonary edema** (ICD-10: I50, J81, unless the record also indicates a cardiac procedure was performed-see below for codes); **chronic obstructive pulmonary disease (COPD)** (ICD-10: J41, J42, J43, J44, J47); **acute lower respiratory infection** (only when a diagnosis of J44 is also present in any diagnostic position other than most-responsible diagnosis): J10.0, J11.0, J12-J16, J18, J20, J21, J22); **diabetes** (ICD-10: E10.0, E10.1, E10.63, E10.64, E10.9, E11.0, E11.1, E11.63, E11.64, E11.9, E13.0, E13.1, E13.63, E13.64, E13.9, E14.0, E14.1, E14.63, E14.64, E14.9); **hypertension** (ICD-10: I10.0, I10.1, I11) unless the record also indicates that a cardiac procedure was performed); **epilepsy-grand mal status and other epileptic convulsions** (ICD-10: G40, G41); **CCI intervention codes for cardiac procedures (used to exclude records as noted above):** 1HA58, 1HA80, 1HA87, 1HB53, 1HB54, 1HB55, 1HB87, 1HD53, 1HD54, 1HD55, 1HH59, 1HH71, 1HJ76, 1HJ82, 1HM57, 1HM78, 1HM80, 1HN71, 1HN80, 1HN87, 1HP76, 1HP78, 1HP80, 1HP82, 1HP83, 1HP87, 1HR71, 1HR80, 1HR84, 1HR87, 1HS80, 1HS90, 1HT80, 1HT89, 1HT90, 1HU80, 1HU90, 1HV80, 1HV90, 1HW78, 1HW79, 1HX71, 1HX78, 1HX79, 1HX80, 1HX83, 1HX86, 1HX87, 1HY85, 1HZ53 (except 1HZ53LAKP), 1HZ54, 1HZ55 (except 1HZ55LAKP), 1HZ56, 1HZ57, 1HZ59, 1HZ80, 1HZ85, 1HZ87, 1IF83, 1IJ50, 1IJ54GQAZ, 1IJ55, 1IJ57, 1IJ76, 1IJ80, 1IJ86, 1IK50, 1IK57, 1IK80, 1IK87, 1IN84, 1LA84, 1LC84, 1LD84, 1YY54LANJ, 1YY54LAFS, 1YY54LANM

***Plus, include the following:*** **hypotension** (ICD-10: I95.0, I95.1, I95.2, I95.8, I95.9); **dehydration (includes volume depletion, acute renal failure, hypokalemia, hyponatremia)** (ICD-10: E87.1, E86.0, E86.8, E87.6, N14.4, N17.0, N17.1, N17.2, N17.8, N17.9, N25.8, N25.9); **pneumonia** (ICD-10: J12, J13, J14, J15, A48.1, J16, J18, J69); **urinary tract infection** (ICD-10: N10, N11, N12, N13.6, N16.0, N16.1, N16.2, N16.4, N16.5, N15.8, N15.9, N20.2, N30.0, N30.1, N30.2, N33.0, N30.8, N30.9, N34.0, N35.1, N37, N39.0, N41.0, N41.1, N41.2, N41.3, N41.4, N41.8, N41.9, N51,); **constipation** (ICD-10: K56.4, K59.0); **skin ulcers** (ICD-10: L89.0, L89.1, L89.2, L89.3, L89.4, L89.5, L89.8, L89.9, L97, L97.0, L97.1, L97.2, L97.3, L97.4, L97.5, L97.8, L97.9, L98.4); **weight loss/adult failure to thrive** (ICD-10: R63.3, R63.4, R63.6, R63.8); **nutritional deficiency** (ICD-10: E40, E41, E42, E43, E44.0, E44.1, E45, E46, E55.0, E64.3)

**All-cause hospital admissions:** Rate of non-elective hospitalizations during the week among persons with dementia.
Numerator: Total number of hospital admissions during the week. Denominator: Total number of person-weeks among persons with a diagnosis of dementia on the 1st day of the week.

**30-day hospital readmissions:** Rate of 30-day hospital readmissions during the week among persons with dementia.
Numerator: Among acute care hospitalizations defined above, flag those with another hospitalization (based on the admission date) in the 30 days following the index admission. Note: Count the readmission based on the week it occurred (not the week of the initial hospital discharge).
Denominator: Total person-weeks among persons with a diagnosis of dementia on the 1st day of the week and who experienced a hospitalization in the past 30 days.

**Mortality:** Rate of deaths during the week among persons with dementia. Numerator: Total number of persons deceased during the week. Denominator: Total number of person-weeks among persons with a diagnosis of dementia on the 1st day of the week.

## APPENDIX REFERENCES

1. Canadian Institute for Health Information. Continuing care reporting system data users guide, 2018–2019. Ottawa, ON: CIHI. 2020.
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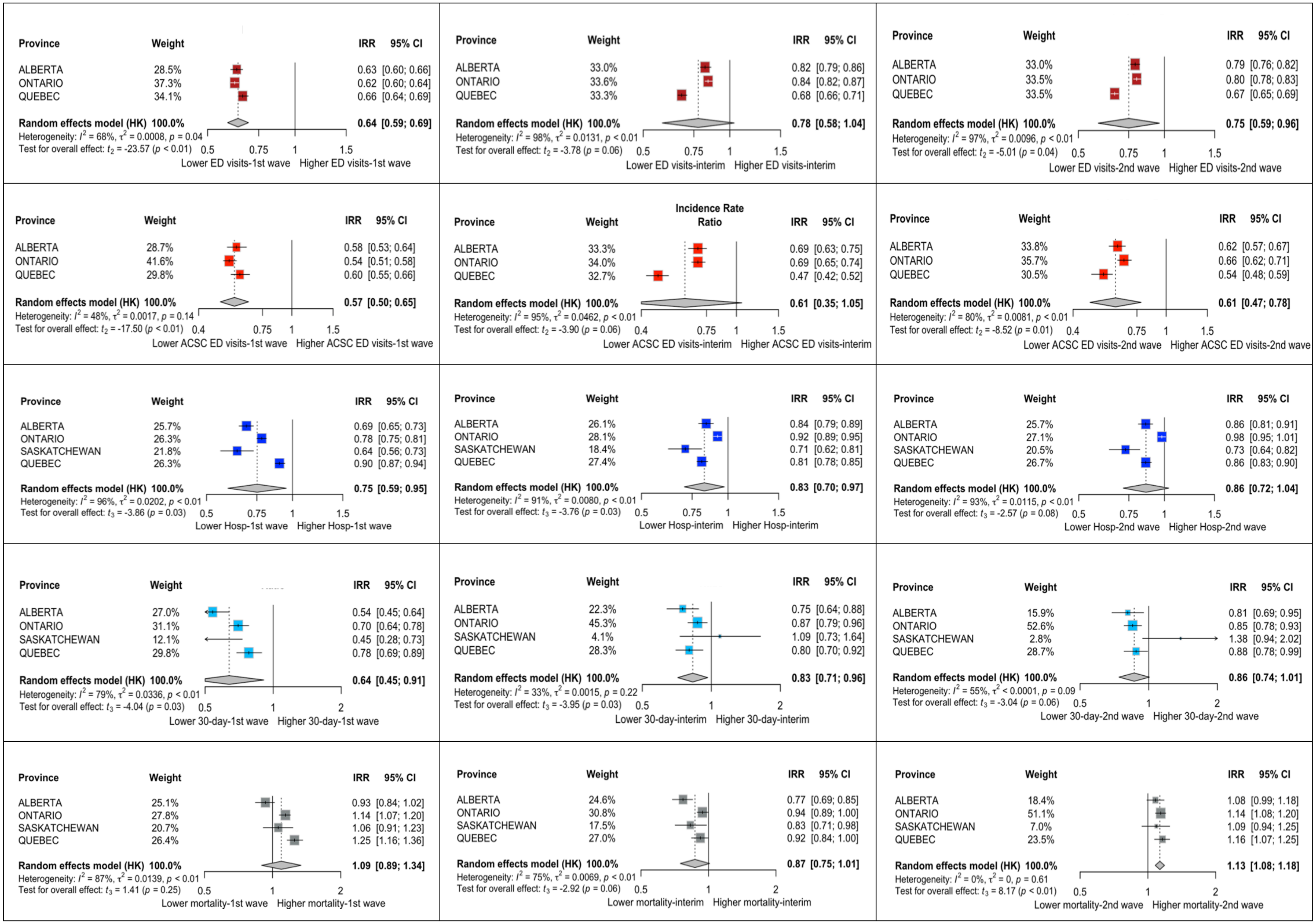
3. Godard-Sebillotte C, Sourial N, Hardouin M, Rochette L, Pelletier E, Gamache P, *et al*. Development of two hierarchical algorithms identifying the 65+ community dwelling population in the provincial administrative database in Quebec. CAHSPR Annual Conference. Halifax, NS2019.
4. Godard-Sebillotte C, Strumpf E, Sourial N, Rochette L, Pelletier E, Vedel I. Primary care continuity and potentially avoidable hospitalization in persons with dementia. *J Am Geriatr Soc*. 2021.
5. Gruneir A, Bell CM, Bronskill SE, Schull M, Anderson GM, Rochon PA. Frequency and pattern of emergency department visits by long-term care residents—a population-based study. *J Am Geriatr Soc.* 2010;58:510–17.

# APPENDIX 2A. Cross-provincial results from random-effects meta-analyses (Community population)



## APPENDIX 2B. Cross-provincial results from random-effects meta-analyses (Nursing Home population)