Supplementary data

Risk of severe COVID-19-related outcomes among patients with cirrhosis: a population-based cohort study in Canada

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**Appendix A.** BC COVID-19 Cohort (BCC19C)

The BC COVID-19 Cohort (BCC19C) is a surveillance platform that integrates COVID-19 data with administrative health datasets (Table S1). The platform was established in 2020 in order to support the public health response to the COVID-19 pandemic. The BCC19C is a dynamic cohort in which COVID-19 datasets are updated daily and most administrative health datasets are updated weekly/monthly. The majority of the integrated datasets are population- based (cover all individuals in the province). Datasets are de-identified and linked together through a combination of probabilistic and deterministic matching algorithms, as described previously.[1](#_bookmark0)

The BCC19C is a collaboration between the Provincial Health Services Authority (PHSA), BC Centre for Disease Control (BCCDC), and the BC Ministry of health (MOH). The platform was established under BCCCDC’s public health mandate. This study was also reviewed and approved by the Behavioral Research Ethics Board at the University of British Columbia (H20-02097).

# Table S1. Data Sources integrated within the BC COVID-19 Cohort (BCC19C)

|  |  |
| --- | --- |
| **British Columbia Centre for Disease Control (BCCDC), Provincial Heath Services Authority (PHSA) and Regional Health Authority data sources:** | **Data Date Ranges:** |
| Integrated COVID-19 laboratory dataset (SARS-CoV2 tests from private/public labs) S1 | Jan,2020-onward |
| COVID-19 surveillance case data (information collected on all probable/confirmed cases as part of public health follow up) S2 | Jan,2020-onward |
| Provincial COVID-19 Monitoring Solution (critical and non-critical care hospital census  data) S3 | Jan,2020-onward |
| Provincial Immunizations Registry (COVID-19 vaccination data) S4 | Dec,2020-onward |
| Provincial Laboratory Information Solution (laboratory tests from private/public labs) S5 | Jan,2020-onward |
| Public Health Reporting Data warehouse (Influenza laboratory tests)S6 | Jan,2008-onward |
| Emergency department visits (hospital-based and community-based ambulatory care) | Mar,2020-onward |
| Ministry of Health (MoH) Administrative Data Sources: |  |
|  | **Data Date Ranges:** |
| Client Roster (CR) (registry of enrollment in the universal public health insurance plan including residential history) S7 | 2008/9-onward |
| Discharge Abstracts Database (DAD) (hospital discharge records) S8 | 2008/9-onward |
| Medical Services Plan (MSP) (physician diagnostic and billing data for services provided through universal public health insurance plan) S9 | 2008/9-onward |
| PharmaNet (Pharma) (prescription drugs dispensed from community pharmacies, includes medications covered by public and private insurance plans) S10 | 2008/9-onward |
| BC Vital Statistics (VS) (deaths registry) S11 | 2008/9-onward |
| National Ambulatory Care Reporting System (NACRS) (hospital-based and community- based ambulatory care) S12 | 2011/12–onward |
| Chronic Disease Registry S13 | 2008/9-2018/19 |
| 811 Calls (respiratory calls only) S14 | 2014-onward |
| Health System Matrix S15 | 2018/19-onward |
| Population Grouper Methodology S16 | 2008/9-onward |

**References (Data Sources)**

S1. British Columbia Centre for Disease Control [creator]. Integrated COVID-19 laboratory dataset (SARS- CoV2 tests from private/public labs). Public Health Reporting Data Warehouse, British Columbia Centre for Disease Control [publisher] (2020). 2021.

S2. British Columbia Centre for Disease Control [creator]. COVID-19 surveillance case data. British Columbia Centre for Disease Control [publisher]. (2020). 2021.

S3. Provincial Health Services Authority [creator]. Provincial COVID-19 Monitoring Solution. Provincial Health Services Authority [publisher]. (2020). 2021.

S4. Provincial Health Services Authority [creator]. Provincial Public Health Information Systems [publisher]. (2020). 2021.

S5. Provincial Health Services Authority [creator]. COVID-19 vaccination data. Provincial Immunizations Registry, Provincial Public Health Information Systems [publisher]. (2020). 2021.

S6. British Columbia Centre for Disease Control [creator]. Respiratory datamart, Public Health Reporting Data Warehouse, British Columbia Centre for Disease Control [publisher] (2020). 2021.

S7. British Columbia Ministry of Health [creator]. Client Roster (Client Registry System/Enterprise Master Patient Index). British Columbia Ministry of Health [publisher]. Data Extract. MOH (2020). 2021. https://www2.gov.bc.ca/gov/content/health/health-forms/online-services

S8. British Columbia Ministry of Health [creator]. Discharge Abstract Database (Hospital Separations). British Columbia Ministry of Health [publisher]. Data Extract. MOH (2020). 2021. https://www2.gov.bc.ca/gov/content/health/health-forms/online-services

S9. British Columbia Ministry of Health [creator]. Medical Services Plan (MSP) Payment Information File.

British Columbia Ministry of Health [publisher]. Data Extract. MOH (2020). 2021.https://www2.gov.bc.ca/gov/content/health/health-forms/online-services

S10. British Columbia Ministry of Health [creator]. PharmaNet. British Columbia Ministry of Health [publisher]. Data Extract. MOH (2020). 2021. https://www2.gov.bc.ca/gov/content/health/health-forms/online-services

S11. BC Vital Statistics Agency [creator]. Vital Statistics Deaths. BC Vital Statistics Agency [publisher]. Data Extract. BC Vital Statistics Agency (2020). 2021. https://www2.gov.bc.ca/gov/content/health/health- forms/online-services

S12. British Columbia Ministry of Health [creator]. National Ambulatory Care Reporting System. British Columbia Ministry of Health [publisher]. Data Extract. MOH (2020). 2021. https://www2.gov.bc.ca/gov/content/health/health-forms/online-services

S13. British Columbia Ministry of Health [creator]. Chronic Disease Registry. British Columbia Ministry of Health [publisher]. Data Extract. MOH (2020). 2020.

https://www2.gov.bc.ca/gov/content/health/health-forms/online-services

S14. British Columbia Ministry of Health [creator]. 811 calls. British Columbia Ministry of Health [publisher].

Data Extract. MOH (2020). 2021. https://www2.gov.bc.ca/gov/content/health/health-forms/online-services

S15. British Columbia Ministry of Health [creator]. Health System Matrix. British Columbia Ministry of Health [publisher]. Data Extract. MOH (2020). 2021.

https://www2.gov.bc.ca/gov/content/health/health-forms/online-services

S16. British Columbia Ministry of Health [creator]. Population Grouper Methodology. British Columbia Ministry of Health [publisher]. Data Extract. MOH (2020). 2021.

https://www2.gov.bc.ca/gov/content/health/health-forms/online-services

# Appendix B. Definitions for comorbidity variables derived from administrative datasets

**Administrative data sources:**

1. Chronic disease registry (CDR)5 – Available information includes diagnosis date(s)
2. Medical Services Plan (MSP)1 – ICD-9 billing/diagnostic codes.
3. Discharge Abstract Database (DAD)3 – DAD1 contains ICD-9 coded hospitalization data and DAD2 contains ICD-10 coded hospitalization data.
4. National Ambulatory Care Reporting System (NACRS)4 – Contains ICD-10 coded diagnostic codes.
5. PharmaNet2 – Each medication is identified with a drug identification number (DINPIN).
6. Canadian Census (2016)
7. Provincial Immunization Registry

# All comorbidities were identified according to the information extracted from CDR, with the following exceptions:

1. **Cirrhosis**
   * MSP ICD-9 diagnostic codes: starting with 4562; exact codes 4560, 4561, 56723, 5722, 5724, 5712, 5728,

5715, 7895, 07044, 5713

* + DAD1 ICD-9-CM diagnostic codes: starting with 4562; exact codes 4560, 4561, 56723, 5722, 5723, 5724, 5712, 5728, 5715, 7895, 07044, 5713
  + DAD2/NACRS ICD-10-CA diagnostic codes: starting with K703; exact codes: I850, K652, K721, K729, K766, K767, K7460, K7469, R18, I98.20, I98.3, K704

# Cancer (ever)

Any occurrence of “lymphoma”, “metastatic cancer”, and “solid tumor without metastasis” groups of Elixhauser comorbidity index[3](#_bookmark2).

# Chronic kidney disease

As per “renal failure” group of Elixhauser comorbidity index3.

# Diabetes (DM)

Diabetes status as per CDR; classified as:

|  |  |
| --- | --- |
|  | DM requiring insulin: PharmaNet DINPINs 1934074, 1959220, 2024284, 586714, 2024233, 446564,  612227, 1934112, 612197, 632651, 632686, 1986085, 1986805, 1986813, 2025256, 1959239, 2024268, |
|  | 587737, 2024225, 446572, 612235, 1934066, 646148, 2024241, 446580, 612278, 1934090, 2024403, |
|  | 2241310, 2415089, 2403447, 795879, 2024217, 1959212, 2025248, 889121, 2024446, 1962639, 2024292, |
|  | 1962655, 2024306, 1962663, 2024322, 1962647, 2024314, 889091, 889105, 889113, 2466864, 644358, |
|  | 733075, 2024276, 513644, 2275872, 514551, 552275, 612170, 1985949, 2022249, 2275864, 514535, |
|  | 612162, 612359, 2244353, 2245397, 2377209, 2460416, 2460424, 2460408, 2265435, 2265443, 2467879, |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2467887, | 2474875, | 2412829, | 2271842, | 2245689, | 2276410, | 2251930, | 2444844, | 2294338, | 2444852, |
| 2461528, | 2441829, | 2493373, | 2478293, | 2279479, | 2279460, | 2279487, | 2294346, | 2229704, | 2469901, |
| 2229705, | 2469898, | 2233562, | 2241283, | 2403412, | 2469871, | 2439611, | 2470152, | 2240294, | 2240295, |

2403420, 2240297, 2403439, 632694, 650935, 1986821, 2022230, 552259, 614416, 1985957, 1985981,

612189, 552267, 628301, 723789, 1985930, 446610, 612219, 612200, 446599, 612243, 1934104, 446602,

612251, 1934082, 773654, 1985973, 632678, 1985965, 5894, 6009, 274119, 274127, 275409, 275417,

275425, 539201, 539244, 542911, 542938, 542946, 546348, 554820, 648094, 999717, 1986791,

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 45230001, | 45230002, | 45230003, |  | 45230004, | 45230005, | 45230006, | 45230007, | 45230008, | 45230009, |
| 45230010, | 45230011, | 45230012, |  | 45230013, | 47450001, | 47450002, | 47450003, | 47450004, | 47450005, |
| 47450006, | 47450007, | 66123203, |  | 66124134, | 66124135, | 66124225, | 66124582, | 45230014, | 45230015, |

45230016, 46340034, 46340035, 46340036, 46340037, 47450008, 47450009.

* + DM treated without insulin: Any record lacking the aforementioned DINPINs.

# Immunosuppression

Based on Sundaram et al. 2020[4](#_bookmark3). Includes any occurrence in DAD/NACRS of:

* + Antibody- or leukocyte-related immune disorders: ICD-10: D80 - D84, D89.8, D89.9 / ICD-9: 279
  + Neutropenia - ICD-10: D70 / ICD-9: 288.0
  + Abnormality of leukocytes - ICD-10: D71, D72 / ICD-9: 288.1, 288.2
  + Splenomegaly - ICD-10: D73.0 - D73.2 / ICD-9: 289.4 or 289.5
  + Asplenia - ICD-10: Q890 / ICD-9: 759.0
  + Sickle cell syndrome - ICD-10: D570 - D572; D57.8 / ICD-9: 282.6
  + Transplant: Organ or tissue replaced by transplant - ICD-9 (MSP): V42; Transplanted organ and tissue status - ICD-10: Z94
  + AIDS/HIV – As per “AIDS/HIV” group of Elixhauser comorbidity index3.

# Injection Drug Use[5](#_bookmark4)

Diagnosis age between 11 and 65:

* + MSP ICD-9 diagnostic codes: starting with 292, 970, 3040, 3041, 3042, 3044, 3045, 3046, 3047, 3048,

3049, 3054, 3055, 3056, 3057, 3059, 6483, 7960, 9621, 9650, 9658, 9663, 9664, 9670, 9684, 9685, 9694,

9696, 9697, 9698, 9699, E8500, V6542; exact code V6542

* + DAD1 ICD-9-CM diagnostic codes: starting with 292, 970, 3040, 3041, 3042, 3044, 3045, 3046, 3047,

3048, 3049, 3054, 3055, 3056, 3057, 3059, 6483, 7960, 9621, 9650, 9658, 9663, 9664, 9670, 9684, 9685,

9694, 9696, 9697, 9698, 9699, E8500, V6542; exact code V6542

* + DAD2/NACRS ICD- 10-CA diagnostic codes: starting with F11, F13, F14, F15, F19, R781, R782, T387, T400, T401, T402, T403, T404, T405, T406, T408, T409, T412, T423, T424, T425, T426, T427, T428, T436, T438, T439, T507; exact codes: R781, R782, T387, T400, T401, T402, T403, T404, T405, T406, T408, T409, T412, T423, T424, T425, T426, T427, T428, T436, T438, T439, T507
  + NACRS complaint codes: starting with 751, 753

# Alcohol Misuse[6](#_bookmark5)

* + MSP ICD-9 diagnostic codes: starting with 291, 303, 3050, 3575, 4255
  + DAD1 ICD-9-CM: starting with 291, 303, 3050,3575, 4255
  + DAD2/NACRS ICD-10-CA: starting with F10, E244, G312, G621, G721, I426, Z502, Z714.

# Schizophrenia and psychotic disorders[7](#_bookmark6)

2 MSP occurrences, or 1 DAD, or 1 NACRS

* MSP ICD-9 diagnostic codes: starting with 295, 2988, 2989, 2970, 2972, 2971, 2973, 2978, 2979
* DAD1 ICD-9-CM: starting with 295, 2988, 2989, 2970, 2972, 2971, 2973, 2978, 2979
* DAD2/NACRS ICD-10-CA: starting with F20, F21, F22, F23, F24, F25, F28, F29.

# Intellectual and developmental disabilities

# ICD-9

# 317 = Mild Mental Retardation (MR).

# 318 = Moderate, severe, and profound MR.

# 319 = Unspecified MR.

# 299 = Autism and other psychoses with origin specific to childhood.

# 758.0 - 758.3 = Chromosomal Anomalies (includes Down's, Patau's and Edward's syndromes).

# 759.81 - 759.89 = Other and unspecified congenital anomalies (includes Fragile X and Prader-Willi syndromes).

# 760.71 = Alcohol affecting fetus or newborn via placenta or breast milk (Fetal Alcohol Syndrome (FAS)).

# ICD-10

# F70.0, F70.1, F70.8, F70.9 = Mild mental retardation;

# F71.0, F71.1, F71.8, F71.9 = Moderate mental retardation;

# F72.0, F72.1, F72.8, F72.9 = Severe mental retardation;

# F73.0, F73.1, F73.8, F73.9 = Profound mental retardation;

# F78.0, F78.1, F78.8, F78.9 = Other mental retardation;

# F79.0, F79.1, F79.8, F79.9 = Unspecified mental retardation;

# F84.0, F84.1, F84.3, F84.4, F84.5, F84.8, F84.9 = Pervasive developmental disorders;

# P04.3 = Fetus and newborn affected by maternal use of alcohol (this excludes fetal alcohol syndrome = Q86.0);

# Q86.0, Q86.1, Q86.2, Q86.8 = Congenital malformation syndromes due to known exogenous causes, not elsewhere classified;

# Q87.0, Q87.1, Q87.2, Q87.3, Q87.5, Q87.8 = Other specified congenital malformation syndromes affecting multiple systems;

# Q89.8 = Other specified congenital malformations;

# Q90.0, Q90.1, Q90.2, Q90.9 = Down's syndrome;

# Q91.0, Q91.1, 91.2, Q91.3, 91.4, Q91.5, 91.6, Q91.7 = Edward's syndrome and Patau's syndrome;

# Q93.0, Q93.1, Q93.2, Q93.3, Q93.4, Q93.5, Q93.6, Q93.7, Q93.8, Q93.9 = Monosomies and deletions from the autosomes, not elsewhere classified; and

# Q99.2 = Fragile X chromosome

# Income 8,9

The dissemination area-level after-tax income was obtained from the Postal Code Conversion File Plus Version 7A/7D for BC.8 This variable is generated by Statistics Canada using administrative data sources and captures household size to generate a per-person equivalent measure.2

# Vaccination status10

# Not vaccinated: Individual has not received any vaccine dose by collection date.

# Partially vaccinated: At least 14 days have passed since first dose inoculation and collection date.

# Vaccinated: No less than 14 days have passed since second dose and collection date.10

# References (definitions)

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**Appendix C.** Supplementary results

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| **Table S2.** Factors associated with COVID-19-related hospitalization in multivariable logistic regression\* analysis among confirmed adult cases during 2021, ages 18-49, BC COVID-19 Cohort (n=115,874) | | | | | |
| **Parameter** | **Levels** | **AOR** | **LCI** | **UCI** | **p-value** |
| **Sex** (ref. Female) | Male | 1.05 | 0.97 | 1.14 | 0.257 |
| **Asthma** |  | 1.00 | 0.90 | 1.12 | 0.992 |
| **Chronic obstructive pulmonary disease** | | 2.88 | 1.82 | 4.56 | < .001 |
| **Cirrhosis** |  | 3.73 | 2.70 | 5.15 | < .001 |
| **Chronic kidney disease** |  | 2.49 | 2.02 | 3.06 | < .001 |
| **Diabetes mellitus** (DM, ref. non-diabetic) | DM - Non-insulin dependent | 2.22 | 1.82 | 2.70 | < .001 |
|  | DM - Insulin dependent | 3.85 | 2.97 | 4.99 | < .001 |
| **Heart failure** |  | 2.11 | 1.36 | 3.29 | < .001 |
| **Hypertension** |  | 1.79 | 1.53 | 2.10 | < .001 |
| **Injection drug use** |  | 2.58 | 2.28 | 2.92 | < .001 |
| **Alcohol misuse** |  | 1.62 | 1.42 | 1.84 | < .001 |
| **Immunosuppression** |  | 2.08 | 1.74 | 2.48 | < .001 |
| **Alzheimer/dementia** |  | 3.27 | 0.58 | 18.46 | 0.181 |
| **Schizophrenia and psychotic disorders** | | 2.17 | 1.83 | 2.57 | < .001 |
| **Multiple sclerosis** |  | 5.61 | 3.05 | 10.30 | < .001 |
| **Rheumatoid arthritis** |  | 1.91 | 1.30 | 2.82 | 0.001 |
| **Obesity** |  | 1.88 | 1.57 | 2.26 | < .001 |
| **Weight loss** |  | 1.47 | 1.10 | 1.96 | 0.009 |
| **Intellectual and developmental disabilities** | | 2.10 | 1.33 | 3.31 | 0.002 |
| **Cancer, lymphoma** |  | 1.67 | 1.30 | 2.16 | < .001 |
| **Cancer, metastatic** |  | 1.14 | 1.00 | 1.31 | 0.046 |
| **Variant of concern** (ref. non-VOC) | Delta | 2.86 | 2.37 | 3.46 | < .001 |
|  | Alpha | 1.66 | 1.34 | 2.06 | < .001 |
|  | Beta | 1.39 | 0.19 | 10.15 | 0.747 |
|  | Gamma | 2.98 | 2.41 | 3.68 | < .001 |
|  | Not sequenced | 1.47 | 1.21 | 1.78 | < .001 |
|  | Omicron | 2.22 | 1.48 | 3.32 | < .001 |
| **Vaccination status** (ref. unvaccinated) | Partially vaccinated | 0.49 | 0.43 | 0.56 | < .001 |
|  | Vaccinated | 0.15 | 0.13 | 0.18 | < .001 |
| **Income** (quintiles - ref. 1st) | 2nd | 0.87 | 0.77 | 0.97 | 0.014 |
|  | 3rd | 0.78 | 0.69 | 0.88 | < .001 |
|  | 4th | 0.67 | 0.59 | 0.76 | < .001 |
|  | 5th | 0.67 | 0.58 | 0.77 | < .001 |
|  | Missing/unknown | 0.66 | 0.55 | 0.79 | < .001 |
| **Health** **authority** (ref. Fraser) | Interior | 1.05 | 0.93 | 1.17 | 0.454 |
|  | Northern | 1.72 | 1.51 | 1.96 | < .001 |
|  | Vancouver Coastal | 0.81 | 0.72 | 0.90 | < .001 |
|  | Vancouver Island | 1.03 | 0.87 | 1.21 | 0.746 |
|  | Missing/unknown | 0.55 | 0.20 | 1.48 | 0.235 |
| AOR: adjusted odds ratio; LCI: lower confidence interval; UCI: upper confidence interval. | | | | |  |
| \*Parkinsonism was removed from model due to zero counts. | | |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Table S3.** Factors associated with COVID-19-related hospitalization in multivariable logistic regression analysis among confirmed adult cases during 2021, ages 50-69, BC COVID-19 Cohort (n=37,435) | | | | | |
| **Parameter** | **Levels** | **AOR** | **LCI** | **UCI** | **p-value** |
| **Sex** (ref. Female) | Male | 1.58 | 1.45 | 1.71 | < .001 |
| **Asthma** |  | 1.20 | 1.07 | 1.34 | 0.001 |
| **Chronic obstructive pulmonary disease** | | 1.81 | 1.55 | 2.10 | < .001 |
| **Cirrhosis** |  | **2.55** | **1.96** | **3.31** | < .001 |
| **Chronic kidney disease** |  | 2.47 | 2.17 | 2.80 | < .001 |
| **Diabetes mellitus** (DM, ref. non-diabetic) | DM - Non-insulin dependent | 1.40 | 1.25 | 1.56 | < .001 |
|  | DM - Insulin dependent | 3.24 | 2.75 | 3.82 | < .001 |
| **Heart failure** |  | 1.50 | 1.21 | 1.86 | < .001 |
| **Hypertension** |  | 1.36 | 1.24 | 1.48 | < .001 |
| **Injection drug use** |  | 1.89 | 1.62 | 2.19 | < .001 |
| **Alcohol misuse** |  | 1.36 | 1.17 | 1.57 | < .001 |
| **Immunosuppression** |  | 1.89 | 1.59 | 2.26 | < .001 |
| **Alzheimer/dementia** |  | 1.77 | 1.02 | 3.10 | 0.044 |
| **Schizophrenia and psychotic disorders** | | 1.51 | 1.22 | 1.87 | < .001 |
| **Multiple sclerosis** |  | 2.03 | 1.10 | 3.76 | 0.024 |
| **Parkinsonism** |  | 2.24 | 0.96 | 5.22 | 0.061 |
| **Rheumatoid arthritis** |  | 1.12 | 0.88 | 1.43 | 0.353 |
| **Obesity** |  | 1.72 | 1.46 | 2.02 | < .001 |
| **Weight loss** |  | 1.44 | 1.17 | 1.77 | < .001 |
| **Intellectual and developmental disabilities** | | 2.25 | 1.44 | 3.52 | < .001 |
| **Cancer, lymphoma** |  | 1.43 | 1.01 | 2.01 | 0.042 |
| **Cancer, metastatic** |  | 1.73 | 1.43 | 2.08 | < .001 |
| **Variant of concern** (ref. non-VO ) | Delta | 4.26 | 3.58 | 5.06 | < .001 |
|  | Alpha | 1.97 | 1.62 | 2.39 | < .001 |
|  | Beta | 0.93 | 0.20 | 4.31 | 0.923 |
|  | Gamma | 3.97 | 3.27 | 4.83 | < .001 |
|  | Not sequenced | 1.38 | 1.16 | 1.65 | < .001 |
|  | Omicron | 2.55 | 1.66 | 3.90 | < .001 |
| **Vaccination status** (ref. unvaccinated) | Partially vaccinated | 0.54 | 0.47 | 0.61 | < .001 |
|  | Vaccinated | 0.13 | 0.12 | 0.15 | < .001 |
| **Income** (quintiles - ref. 1st) | 2nd | 0.75 | 0.67 | 0.84 | < .001 |
|  | 3rd | 0.73 | 0.65 | 0.82 | < .001 |
|  | 4th | 0.64 | 0.56 | 0.72 | < .001 |
|  | 5th | 0.57 | 0.50 | 0.65 | < .001 |
|  | Missing/unknown | 1.03 | 0.84 | 1.27 | 0.749 |
| **Health** **authority** (ref. Fraser) | Interior | 1.14 | 1.02 | 1.28 | 0.023 |
|  | Northern | 1.70 | 1.50 | 1.94 | < .001 |
|  | Vancouver Coastal | 1.09 | 0.98 | 1.22 | 0.101 |
|  | Vancouver Island | 1.40 | 1.20 | 1.63 | < .001 |
|  | Missing/unknown | 0.36 | 0.08 | 1.50 | 0.159 |
| AOR: adjusted odds ratio; LCI: lower confidence interval; UCI: upper confidence interval. | | | | |  |

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| **Table S4**. Factors associated with COVID-19-related hospitalization in multivariable logistic regression analysis among confirmed adult cases during 2021, ages ≥70, BC COVID-19 Cohort (n=9,200) | | | | | |
| **Parameter** | **Levels** |  |  |  |  |
| **Sex** (ref. Female) | Male | 1.40 | 1.27 | 1.55 | < .001 |
| **Asthma** |  | 1.04 | 0.90 | 1.19 | 0.618 |
| **Chronic obstructive pulmonary disease** | | 1.73 | 1.49 | 2.01 | < .001 |
| **Cirrhosis** |  | **1.68** | **1.07** | **2.64** | 0.023 |
| **Chronic kidney disease** |  | 1.85 | 1.65 | 2.07 | < .001 |
| **Diabetes mellitus** (DM, ref. non-diabetic) | DM - Non-insulin dependent | 1.17 | 1.04 | 1.31 | 0.01 |
|  | DM - Insulin dependent | 2.05 | 1.68 | 2.50 | < .001 |
| **Heart failure** |  | 1.56 | 1.34 | 1.82 | < .001 |
| **Hypertension** |  | 1.13 | 1.01 | 1.28 | 0.037 |
| **Injection drug use** |  | 0.85 | 0.46 | 1.58 | 0.612 |
| **Alcohol misuse** |  | 1.56 | 1.24 | 1.96 | < .001 |
| **Immunosuppression** |  | 1.93 | 1.51 | 2.47 | < .001 |
| **Alzheimer/dementia** |  | 1.74 | 1.33 | 2.28 | < .001 |
| **Schizophrenia and psychotic disorders** | | 1.89 | 1.32 | 2.71 | < .001 |
| **Multiple sclerosis** |  | 2.12 | 0.82 | 5.45 | 0.12 |
| **Parkinsonism** |  | 2.31 | 1.46 | 3.65 | < .001 |
| **Rheumatoid arthritis** |  | 1.55 | 1.23 | 1.96 | < .001 |
| **Obesity** |  | 1.08 | 0.81 | 1.43 | 0.602 |
| **Weight loss** |  | 1.57 | 1.27 | 1.93 | < .001 |
| **Intellectual and developmental disabilities** | | 1.33 | 0.58 | 3.05 | 0.5 |
| **Cancer, lymphoma** |  | 1.56 | 1.16 | 2.09 | 0.004 |
| **Cancer, metastatic** |  | 1.30 | 1.06 | 1.59 | 0.011 |
| **Variant of concern** (ref. non-VOC) | Delta | 2.65 | 2.16 | 3.26 | < .001 |
|  | Alpha | 1.11 | 0.88 | 1.40 | 0.369 |
|  | Beta | 1.62 | 0.45 | 5.85 | 0.459 |
|  | Gamma | 1.93 | 1.50 | 2.49 | < .001 |
|  | Not sequenced | 0.92 | 0.76 | 1.11 | 0.384 |
|  | Omicron | 2.20 | 1.41 | 3.43 | < .001 |
| **Vaccination status** (ref. unvaccinated) | Partially vaccinated | 0.64 | 0.56 | 0.74 | < .001 |
|  | Vaccinated | 0.20 | 0.17 | 0.23 | < .001 |
| **Income** (quintiles - ref. 1st) | 2nd | 0.74 | 0.64 | 0.85 | < .001 |
|  | 3rd | 0.69 | 0.60 | 0.80 | < .001 |
|  | 4th | 0.70 | 0.60 | 0.83 | < .001 |
|  | 5th | 0.61 | 0.52 | 0.72 | < .001 |
|  | Missing/unknown | 0.97 | 0.71 | 1.32 | 0.847 |
| **Health** **authority** (ref. Fraser) | Interior | 1.29 | 1.12 | 1.47 | < .001 |
|  | Northern | 1.54 | 1.28 | 1.84 | < .001 |
|  | Vancouver Coastal | 1.25 | 1.09 | 1.45 | 0.002 |
|  | Vancouver Island | 0.96 | 0.77 | 1.18 | 0.675 |
|  | Missing/unknown | 0.39 | 0.11 | 1.40 | 0.148 |

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| **Table S5.** Factors associated with COVID-19-related ICU admission in multivariable logistic regression\* analysis among confirmed adult hospitalization cases during 2021, ages 18-49, BC COVID-19 Cohort (n=2,691) | | | | | |
| **Parameter** | **Levels** | **AOR** | **LCI** | **UCI** | **p-value** |
| **Sex** (ref. Female) | Male | 1.60 | 1.33 | 1.94 | < .001 |
| **Asthma** |  | 1.10 | 0.86 | 1.41 | 0.446 |
| **Chronic obstructive pulmonary disease** | | 0.99 | 0.41 | 2.38 | 0.977 |
| **Cirrhosis** |  | **2.90** | **1.65** | **5.09** | < .001 |
| **Chronic kidney disease** |  | 1.83 | 1.22 | 2.75 | 0.004 |
| **Diabetes mellitus** (DM, ref. non-diabetic) | DM - Non-insulin dependent | 1.50 | 1.02 | 2.21 | 0.04 |
|  | DM - Insulin dependent | 1.49 | 0.92 | 2.44 | 0.107 |
| **Heart failure** |  | 2.01 | 0.91 | 4.45 | 0.085 |
| **Hypertension** |  | 1.17 | 0.85 | 1.61 | 0.35 |
| **Injection drug use** |  | 0.86 | 0.65 | 1.14 | 0.285 |
| **Alcohol misuse** |  | 1.31 | 0.98 | 1.74 | 0.067 |
| **Immunosuppression** |  | 0.85 | 0.56 | 1.27 | 0.423 |
| **Schizophrenia and psychotic disorders** | | 0.51 | 0.34 | 0.76 | 0.001 |
| **Multiple sclerosis** |  | 1.31 | 0.34 | 5.08 | 0.694 |
| **Rheumatoid arthritis** |  | 2.18 | 1.01 | 4.71 | 0.047 |
| **Obesity** |  | 2.15 | 1.49 | 3.10 | < .001 |
| **Weight loss** |  | 0.95 | 0.52 | 1.72 | 0.863 |
| **Intellectual and developmental disabilities** | | 1.19 | 0.64 | 2.21 | 0.589 |
| **Cancer, lymphoma** |  | 0.92 | 0.32 | 2.66 | 0.884 |
| **Cancer, metastatic** |  | 0.89 | 0.51 | 1.58 | 0.697 |
| **Variant of concern** (ref. non-VOC) | Delta | 1.51 | 0.97 | 2.35 | 0.068 |
|  | Alpha|Beta\*\* | 1.18 | 0.71 | 1.96 | 0.521 |
|  | Gamma | 1.84 | 1.13 | 2.99 | 0.014 |
|  | Not sequenced | 1.08 | 0.69 | 1.70 | 0.734 |
|  | Omicron | 0.26 | 0.03 | 2.07 | 0.203 |
| **Vaccination status** (ref. unvaccinated) | Partially vaccinated | 0.50 | 0.35 | 0.72 | < .001 |
|  | Vaccinated | 0.35 | 0.20 | 0.61 | < .001 |
| **Income** (quintiles - ref. 1st) | 2nd | 1.11 | 0.85 | 1.44 | 0.433 |
|  | 3rd | 1.03 | 0.78 | 1.37 | 0.81 |
|  | 4th | 1.04 | 0.78 | 1.40 | 0.774 |
|  | 5th | 0.94 | 0.68 | 1.29 | 0.695 |
|  | Missing/unknown | 1.08 | 0.71 | 1.63 | 0.731 |
| **Health** **authority** (ref. Fraser) | Interior | 1.29 | 0.99 | 1.67 | 0.06 |
|  | Northern | 1.27 | 0.95 | 1.69 | 0.107 |
|  | Vancouver Coastal | 1.13 | 0.87 | 1.48 | 0.36 |
|  | Vancouver Island | 1.28 | 0.87 | 1.89 | 0.204 |
|  | Missing/unknown | 1.41 | 0.13 | 14.69 | 0.776 |
| AOR: adjusted odds ratio; LCI: lower confidence interval; UCI: upper confidence interval. | | | | |  |
| \*Alzheimer/dementia and Parkinsonism were removed from model due to zero counts. | | | | |  |
| \*\*VOC: Alpha and Beta were collapsed together due to low counts. | | |  |  |  |

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| **Table S6.** Factors associated with COVID-19-related ICU admission in multivariable logistic regression analysis among confirmed adult hospitalization cases during 2021, ages 50-69, BC COVID-19 Cohort (n=3,273) | | | | | |
| **Parameter** | **Levels** | **AOR** | **LCI** | **UCI** | **p-value** |
| **Sex** (ref. Female) | Male | 1.3 | 1.11 | 1.52 | 0.001 |
| **Asthma** |  | 0.99 | 0.81 | 1.22 | 0.931 |
| **Chronic obstructive pulmonary disease** | | 1.33 | 1.02 | 1.74 | 0.032 |
| **Cirrhosis** |  | **1.73** | **1.16** | **2.58** | 0.007 |
| **Chronic kidney disease** |  | 1.19 | 0.95 | 1.48 | 0.124 |
| **Diabetes mellitus** (DM, ref. non-diabetic) | DM - Non-insulin dependent | 1.27 | 1.04 | 1.55 | 0.02 |
|  | DM - Insulin dependent | 1.64 | 1.26 | 2.14 | < .001 |
| **Heart failure** |  | 1.16 | 0.82 | 1.63 | 0.412 |
| **Hypertension** |  | 0.98 | 0.83 | 1.15 | 0.777 |
| **Injection drug use** |  | 0.79 | 0.6 | 1.04 | 0.09 |
| **Alcohol misuse** |  | 0.94 | 0.72 | 1.23 | 0.653 |
| **Immunosuppression** |  | 1.52 | 1.13 | 2.05 | 0.006 |
| **Alzheimer/dementia** |  | 0.69 | 0.23 | 2.04 | 0.506 |
| **Schizophrenia and psychotic disorders** | | 0.6 | 0.41 | 0.9 | 0.013 |
| **Multiple sclerosis** |  | 0.18 | 0.02 | 1.46 | 0.108 |
| **Parkinsonism** |  | 0.42 | 0.05 | 3.79 | 0.441 |
| **Rheumatoid arthritis** |  | 1.01 | 0.64 | 1.6 | 0.951 |
| **Obesity** |  | 1.75 | 1.32 | 2.32 | < .001 |
| **Weight loss** |  | 0.9 | 0.62 | 1.3 | 0.559 |
| **Intellectual and developmental disabilities** | | 0.89 | 0.39 | 2.03 | 0.79 |
| **Cancer, lymphoma** |  | 1.38 | 0.77 | 2.46 | 0.283 |
| **Cancer, metastatic** |  | 0.93 | 0.66 | 1.31 | 0.658 |
| **Variant of concern** (ref. non-VOC ) | Delta | 1.73 | 1.22 | 2.45 | 0.002 |
|  | Alpha|Beta\* | 1.24 | 0.84 | 1.83 | 0.274 |
|  | Gamma | 1.58 | 1.07 | 2.32 | 0.02 |
|  | Not sequenced | 1.21 | 0.85 | 1.72 | 0.284 |
|  | Omicron | 1.56 | 0.62 | 3.94 | 0.347 |
| **Vaccination status** (ref. unvaccinated) | Partially vaccinated | 0.73 | 0.58 | 0.93 | 0.012 |
|  | Vaccinated | 0.4 | 0.29 | 0.54 | < .001 |
| **Income** (quintiles - ref. 1st) | 2nd | 1.09 | 0.88 | 1.35 | 0.415 |
|  | 3rd | 1.06 | 0.85 | 1.33 | 0.583 |
|  | 4th | 1.09 | 0.86 | 1.38 | 0.468 |
|  | 5th | 0.86 | 0.67 | 1.12 | 0.267 |
|  | Missing/unknown | 1.19 | 0.8 | 1.78 | 0.38 |
| **Health** **authority** (ref. Fraser) | Interior | 1.08 | 0.87 | 1.33 | 0.5 |
|  | Northern | 0.92 | 0.72 | 1.18 | 0.506 |
|  | Vancouver Coastal | 0.91 | 0.74 | 1.13 | 0.409 |
|  | Vancouver Island | 1.26 | 0.94 | 1.69 | 0.127 |
|  | Missing/unknown\*\* | NA | NA | NA | 0.961 |
| AOR: adjusted odds ratio; LCI: lower confidence interval; UCI: upper confidence interval. | | | | | |
| \*VOC: Alpha and Beta were collapsed together due to low counts. | | | |  |  |
| \*\*Undetermined due to low cell counts | |  |  |  |  |

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| **Table S7.** Factors associated with COVID-19-related ICU admission in multivariable logistic regression analysis among confirmed adult hospitalization cases during 2021, ages ≥70, BC COVID-19 Cohort (n=2,582) | | | | | |
| **Parameter** | **Levels** | **AOR** | **LCI** | **UCI** | **p-value** |
| **Sex** (ref. Female) | Male | 1.40 | 1.16 | 1.69 | < .001 |
| **Asthma** |  | 1.07 | 0.83 | 1.37 | 0.627 |
| **Chronic obstructive pulmonary disease** | | 1.08 | 0.83 | 1.39 | 0.578 |
| **Cirrhosis** |  | **1.72** | **0.91** | **3.27** | 0.096 |
| **Chronic kidney disease** |  | 0.98 | 0.79 | 1.20 | 0.813 |
| **Diabetes mellitus** (DM, ref. non-diabetic) | DM - Non-insulin dependent | 1.05 | 0.85 | 1.31 | 0.642 |
|  | DM - Insulin dependent | 1.44 | 1.05 | 1.97 | 0.024 |
| **Heart failure** |  | 0.74 | 0.56 | 0.96 | 0.025 |
| **Hypertension** |  | 0.71 | 0.57 | 0.88 | 0.002 |
| **Injection drug use** |  | 2.15 | 0.86 | 5.37 | 0.103 |
| **Alcohol misuse** |  | 0.67 | 0.45 | 1.01 | 0.058 |
| **Immunosuppression** |  | 1.58 | 1.09 | 2.28 | 0.015 |
| **Alzheimer/dementia** |  | 0.31 | 0.16 | 0.60 | < .001 |
| **Schizophrenia and psychotic disorders** | | 0.64 | 0.33 | 1.23 | 0.179 |
| **Multiple sclerosis** |  | 1.25 | 0.30 | 5.22 | 0.76 |
| **Parkinsonism** |  | 0.55 | 0.21 | 1.44 | 0.224 |
| **Rheumatoid arthritis** |  | 0.79 | 0.51 | 1.22 | 0.284 |
| **Obesity** |  | 2.18 | 1.40 | 3.40 | < .001 |
| **Weight loss** |  | 0.50 | 0.34 | 0.76 | < .001 |
| **Intellectual and developmental disabilities** | | 0.72 | 0.14 | 3.67 | 0.691 |
| **Cancer, lymphoma** |  | 1.21 | 0.76 | 1.94 | 0.423 |
| **Cancer, metastatic** |  | 1.18 | 0.85 | 1.65 | 0.328 |
| **Variant of concern** (ref. non-VOC) | Delta | 0.86 | 0.60 | 1.23 | 0.409 |
|  | Alpha|Beta\* | 0.25 | 0.78 | 1.80 | 0.418 |
|  | Gamma | 1.07 | 0.69 | 1.66 | 0.768 |
|  | Not sequenced | 0.98 | 0.69 | 1.38 | 0.895 |
|  | Omicron | 0.64 | 0.23 | 1.83 | 0.41 |
| **Vaccination status** (ref. unvaccinated) | Partially vaccinated | 0.59 | 0.46 | 0.78 | < .001 |
|  | Vaccinated | 0.58 | 0.43 | 0.78 | < .001 |
| **Income** (quintiles - ref. 1st) | 2nd | 0.89 | 0.69 | 1.15 | 0.384 |
|  | 3rd | 0.70 | 0.52 | 0.92 | 0.012 |
|  | 4th | 1.02 | 0.77 | 1.36 | 0.89 |
|  | 5th | 0.90 | 0.66 | 1.23 | 0.517 |
|  | Missing/unknown | 1.09 | 0.64 | 1.87 | 0.744 |
| **Health** **authority** (ref. Fraser) | Interior | 1.28 | 1.00 | 1.65 | 0.051 |
|  | Northern | 1.42 | 1.04 | 1.93 | 0.027 |
|  | Vancouver Coastal | 1.14 | 0.87 | 1.48 | 0.344 |
|  | Vancouver Island | 1.24 | 0.83 | 1.85 | 0.297 |
|  | Missing/unknown\*\* | NA | NA | NA | 0.967 |
| AOR: adjusted odds ratio; LCI: lower confidence interval; UCI: upper confidence interval. | | | | |  |
| \*VOC: Alpha and Beta were collapsed together due to low counts. | | |  |  |  |
| \*\*Undetermined due to low cell counts | |  |  |  |  |