Research Article

Silent Voices of Immigrants and Refugees Battling with Mental Health and Addiction during COVID-19: A Follow- Up Population-Based Cohort Retrospective Study in Ontario, Canada

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Abstract

Background: Although the COVID-19 pandemic has affected all communities across Canada, immigrants and refugees have shouldered a disproportionate burden of the disease. This health disparity is not surprising, given their structurally marginalized social and economic positions. Further, immigrants and refugees with chronic health conditions, such as mental health and addiction disorders (MH&A), may be particularly vulnerable to the pandemic's negative impacts due to the preexisting debilitating health conditions. There is limited information in this area. This study is a follow up to our first study that looked at the impact of COVID-19 on immigrants and refugee population living with MH&A over a year of COVID-19 (See DOI: 10.26502/acbr.50170393).

Methods: As our initial study only covered the first two waves of COVID-19, a follow up retrospective cohort was conducted using linked Ontario-based administrative databases to expand the timeframe. The differential impact of COVID-19 over the two years (March 31, 2020, to December 31, 2021) on immigrants and non-immigrants with and without MH&A were examined using multivariate regression while controlling for potential socioeconomic and health-related confounders (e.g., age, sex, income quintiles, living in deprived neighbourhoods, region of origin, region of residence in Ontario, comorbidities, and access to primary care).

Results: Our study included about 10.4 million Ontario residents aged 18 or older, of which 24% were identified as immigrants and 8.9% lived with MH&A. The average age of immigrants and non-immigrants living with MH&A was around 46 years with nearly 60% identifying as female. While both immigrants and non-immigrants with MH&A were more likely than those without MH&A to be impoverished and reside in socially deprived neighborhoods immigrants with MH&A were more socially disadvantaged than non-immigrant without MH&A (27.2% vs. 17.2%, Std diff=0.242; 31% vs. 23.3%, Std diff=0.175; 23.7%vs. 17%, Std diff=0.2=0.166). The prevalence of confirmed COVID-19 test results was significantly higher among immigrants than non-immigrants living with MH&A (17.7% vs. 9.5%). When we adjusted for potential confounders, immigrants living with MH&A were 52% more likely to be diagnosed with COVID19, over twice as likely to be hospitalized and be admitted to ICU, and 65% more likely to die from COVID-19 non-immigrants without MH&A.

Conclusion: Our study provides evidence that the intersection of immigration status and preexisting MH&A significantly influences COVID-19 adverse outcomes. It is crucial that COVID-19 recovery efforts and future crisis responses incorporate targeted upstream interventions and community based-support systems that address the specific needs of structurally and clinically marginalized populations.

Keywords: Immigrants; Refugees; COVID-19; Mental health & Addiction Disorders; Health inequities; Hospitalization; Mortality; Vaccination; Systemic barriers; Ontario Marginalization index; Canada;

1. Background

The COVID-19 pandemic has had far-reaching and profound effects on societies across the globe [1]. Although Canada is often celebrated for its diversity and inclusivity, the pandemic revealed a disheartening reality: disproportionate adverse consequences among its structurally marginalized populations. Immigrants, refugees and racialized Canadians have borne the brunt of the pandemic's adverse consequences with higher rates of COVID-19 cases, hospitalizations and deaths compared to non-immigrants and white Canadians [2-6]. Existing evidence shows that immigrants and refugees are more vulnerable to COVID-19 and its adverse effects due to preexisting and persistent socioeconomic disparities, such as low income, precarious employment, living and working in crowded spaces, immigration status, constrained social support, limited literacy of Canada's official languages, and limited or no access to available lifesaving health care services due to systemic stigma and discrimination [5-13].

However, immigrants and refugees are not a homogeneous population. Those with preexisting chronic health conditions, such as mental health and addiction disorders (MH&A), may be at higher risk of adverse COVID-19 health outcomes due to the debilitating nature of these conditions. Additionally, the pandemic has exacerbated pre-existing inequities in access to healthcare, notably mental health care. For instance, a study by Barker et al.[14] reported alarming disparities in access to post-partum psychiatric emergency mental health care, with immigrants being among the groups facing significant barriers. Moreover, COVID-19 public health guidelines, such as social distancing and self-isolation, combined with the closure of or limited access to essential mental health services, have worsened the mental health of individuals with preexisting conditions [15-19]. The pandemic has also further intensified digital technology inequity, a concept that has become increasingly vital during the pandemic. The widespread adoption of digital technologies, including virtual care, has posed significant challenges for structurally marginalized people in accessing critical health services, employment opportunities, and social involvement. These digital related inequities are particularly challenging for racialized immigrant communities, including new immigrants, refugees, and ethnic minorities [20]. Furthermore, empirical evidence shows that asylum seekers, refugees, and foreign-born migrants, often in precarious circumstances, have experienced heightened physical, mental, and socioeconomic consequences during the pandemic [21]. Likewise, the access to essential information and services, including vaccination, remains a challenge for these marginalized and vulnerable populations.

Extensive research highlights the impact of COVID-19 on structurally marginalized populations and individuals with preexisting MH&A issues separately. However, these studies often remain unidimensional, overlooking the compounded effects of social and clinical disadvantages simultaneously.

Our first retrospective cohort study over the first year of the pandemic attempted to fill this critical knowledge gap. To our knowledge, our previous study was among the first to explore COVID-19-related disparities among immigrants and refugees (called “immigrants” hereafter) living with MH&A. The study explored the issue across three groups: immigrants with MH&A, non-immigrants with MH&A and the general population which included both immigrants and

non-immigrants without MH&A. We found that immigrants with MH&A faced a higher risk of being diagnosed with and hospitalized for COVID-19 but lower risk of being admitted to ICU and dying within 60 days of diagnosis compared to the general population. On the contrary non-immigrants with MH&A were more likely to be hospitalized, admitted to ICU and die within 60 days of their diagnosis compared to the general population and immigrants with MH&A (for more information, please see the published manuscript DOI: 10.26502/acbr.50170393) [13].

Given that our initial study only covered the first two waves of COVID-19, we conducted a follow-up retrospective cohort study, over two years of the pandemic, to examine the impact across four groups: immigrants with MH&A, immigrants without MH&A, non-immigrants with MH&A, and non-immigrants without MH&A. We aimed to explore the long-term effects of COVID-19 pandemic on immigrants living with MH&A, recognizing the likelihood that their financial and social resources may have been depleted over time. Additionally, we recognized that their mental health may be further compromised by pandemic related anxiety and uncertainties, as well as the shift towards digital/virtual healthcare, replacing in-person care. Moreover, including immigrants without MH&A as a separate group allows us to distinguish the differential impact of COVID-19 on those with and without social and clinical disadvantages. Similar to our first study in this area, we used linked provincial administrative databases. In addition to socioeconomic and health-related variables (e.g., age, sex, neighborhood income, region of origin, length of stay, marginalization index, access to primary care) that were included in our first study, we included other relevant variables like individuals' regions of residence in Ontario, comorbidities other than MH&A, and use of COVID-19 vaccination. In this study, we hypothesized that the combination of immigration status and preexisting MH&A issues will significantly influence COVID-19 adverse outcomes. The specific study objectives were:

1. To compare COVID-19-related outcomes (vaccination rates, diagnoses, hospitalizations, ICU admissions, and mortality) among immigrants with MH&A to three comparison groups: immigrants without MH&A, and non-immigrants with and without MH&A.
2. To determine the influence of sociodemographic and healthcare-related variables (e.g., sex, age, immigration status, region of origin, region of residence in Ontario, neighborhood income quintile, neighborhood marginalization index, access to primary care) on COVID-19-related outcomes for immigrants with MH&A compared to the other three groups.

This follow-up study helps fill a crucial knowledge gap that is essential for planning and developing equity-driven social and health strategies that address the specific needs of individuals who are structurally marginalized by health and social systems during current and future crises.

2. Methods

2.1 Study Design & Setting

A population-based retrospective cohort study was created using several linked administrative health care databases at ICES (formerly known as Institute for Clinical Evaluative Sciences). The study period spanned from *March 31, 2020 to*

December 31, 2021, in Ontario, Canada (corresponding to COVID-19 wave 1-4 (Fe26, 2020- Dec 14, 2021), and the 16 days of the wave 5 (Dec15-Dec31, 2021)).

2.2 Data Sources

The study cohort was created by linking the following provincial databases:

- *Immigration, Refugees and Citizenship Canada Permanent Resident database (IRCC)* contains demographic characteristics of landed immigrants and refugees in Canada since 1985.
- *Canadian Institute for Health Information Discharge Abstract Database (CIHI DAD)* provides detailed diagnostic and procedural information for all inpatient hospital admissions in Canada.
- *National Ambulatory Care Reporting System (NACRS)* captures information on patient visits to hospitals and community-based ambulatory care: day surgery, outpatient clinics and emergency departments.
- *Ontario Mental Health Reporting System (OMHRS*) database includes individuals receiving inpatient adult mental health services in Ontario.
- *Ontario Health Insurance Plan (OHIP)* identifies physician billing claims and specialties for all services provided by fee-for-service physicians in Ontario.
- *Registered Persons Database (RPDB)* contains the age, sex, and postal code of all Ontario residents eligible for OHIP.
- *The Ontario Drug Benefit (ODB)* database includes claims for prescription drugs under the Ontario Drug Benefit program and services provided to long-term care (LTC) residents.
- *Primary Care Population (PCPOP)* is an ICES-derived dataset that includes all individuals in Ontario who are alive and eligible for health insurance at a given time.
- *The Client Agency Program Enrolment (CAPE)* records the enrolment of an individual with a specific family physician and group in recognized programs, including primary care Patient Enrolment Models (PEM). The PEM structure is based on various compensation models for primary care providers including incentives and bonuses. This models include: 1) Family Health Group [FHG] and Comprehensive Care Model [CCM] which are primarily an enhanced fee-for-service model,2) Family Health Team [FHT] which is primarily a capitation-based model using interprofessional teams, 3) Non-FHT like Family Health Organization (FHO) and Family Health Network (FHN) which are primarily capitation-based, 4) Other PEM such as Community Health Group, Group Health Center, Rural Northern Physician Group (RNPGA)), 5) Traditional fee-for-service (TFFS) for physicians not participating in any of the above-mentioned models), and 6) No Care [22-23].
- *Ontario Marginalization Index (ON-Marg-2016)* is a geographically based index developed using Census data to measure the extent of marginalization across Ontario. It consists of four major dimensions that are believed to underpin marginalization: residential instability (family structure, ownership, and occupancy), material deprivation (income, education, lone-parent families, housing quality), dependency (workforce eligibility, proportion of the population aged 65+ and under 15), and ethnic concentration (recent immigrants and visible minorities) [24-25]. The index is determined by linking individuals' postal codes, using the Postal Code Conversion File, to data from the 2016 Canadian Census.

- *COVID-19 Integrated Testing Data (C19INTGR)* is a comprehensive dataset created by ICES that includes all available COVID-19 diagnostic lab results in Ontario. This dataset incorporates data from Ontario Laboratories Information System (OLIS), distributed testing laboratories, Public Health CCM, and Ontario COVID-19 Vaccine Data (COVaxON) which includes information on COVID-19 vaccination events. All indicators are as of the index date (March 31, 2020), with various look-back periods. These datasets were linked using unique encoded identifiers and analyzed at ICES.

2.3 Study Population

The study cohort included Ontario residents aged 18 or older who were alive on March 31, 2020 and eligible for OHIP for the entire study period. Immigrants were defined based on inclusion in the IRCC database. MH&A cases were identified using a previously validated ICES algorithm, which looks at the presence of billing and diagnosis codes in available databases. We considered *someone as having MH&A disorders if they had more than one diagnosis code '300' outpatient claims (i.e. Neuroses and Personality Disorders: Anxiety neurosis, hysteria, neurasthenia, obsessive compulsive neurosis, reactive depression) or have at least one non-300 diagnosis code MHA-related outpatient claim or MHA-related NACRS ED visit or MHA-related DAD/OHMRS hospitalization in the one year before the study index date* (i.e., March 31, 2020). We excluded anyone living in Ontario rural areas, as most immigrants live in urban areas, and anyone residing in a long-term care facility, as there was evidence that the trajectory of COVID-19 infections was different in long-term facilities compared to the community. We then divided our study cohort into four groups: 1) immigrants with MH&A, 2) immigrants without MH&A, 3) non-immigrants with MH&A, and 4) non-immigrants without MH&A.

2.4 Study outcomes and variables

The main outcome measure was ***COVID-19 diagnosis***, defined as having *at least one positive lab result in OLIS between March 31, 2020, and December 31, 2021*. Secondary outcomes included **hospitalizations, ICU admissions, mortality due to COVID-19, and COVID-19 vaccinations.** Hospitalizations and ICU admissions attributed to COVID-19 were identified *as positive SARS-CoV-2 tests within 14 days before or three days after hospital admission*. Additionally, COVID-19 mortality was defined *as death within 30 days after a positive SARS-CoV-2 test result or within seven days post-mortem*. Vaccination was defined *as receiving at least one dose during the study period*.

We also examined individual and system-level factors, including sociodemographic and clinical characteristics: age, sex, immigration category, years since arrival in Canada, region of origin (East Asia & the Pacific, Europe & Central Asia, Latin America & the Caribbean, Middle East & North Africa, North America, South Asia, Sub-Saharan Africa, Western Europe), region of residence in Ontario (Central East, Central South, Central West, East, North, Toronto, South West), neighborhood income quintile (1 – lowest income to 5 – highest income), Ontario Marginalization Index (categorized into quintiles from 1 – most deprived to 5– least deprived), primary care provider status, primary care patient enrollment model (PEM), and number of comorbidities. We used the John-Hopkins ADG system to categorize the comorbidities in our cohort. The version of the program used is The Johns Hopkins ACG® System Version 10.0. Aggregated Diagnosis

Groups (ADGs) were derived. The ADG algorithm compiles 32 different diagnoses, with duration, severity, etiology, diagnostic certainty and expected need for specialty care, and used to understand comorbidities.

2.5 Ethical Review:

Ethics approval was obtained through ICES, an independent, not-for-profit corporation, that is a prescribed entity under section 45 of Ontario's Personal Health Information Protection Act (PHIPA). Section 45 authorizes ICES to collect personal health information, without consent, for the purpose of analysis or compiling statistical information with respect to the management of, evaluation or monitoring of, the allocation of resources to or planning for all or part of the health system. Projects conducted under section 45, by definition, do not require review by a Research Ethics Board. This project was conducted under section 45 and approved by ICES' Privacy and Legal Office. All methods were carried out in accordance with relevant guidelines and regulations. The datasets were linked using unique encoded identifiers and analyzed at ICES.

2.6 Analysis:

Descriptive statistics, including means, medians, and standard deviation (SD) were used for continuous variables, and proportions for categorical variables, to outline the baseline characteristics of the study population across four subgroups. Standard differences (Std diff) were calculated for each variable to assess differences between subgroups, with a Std diff >0.1 indicating statistically significant variation in characteristics across subgroups.

All COVID 19 outcomes were treated as binary variable (Yes/No) and logistic regression was used to determine adjusted odds ratios (AORs) with 95% confidence intervals (CIs). Our regression models compared *immigrants with and without MH&A and non-immigrants with MH&A to non-immigrants without MH&A*, while adjusting for covariates identified from the descriptive analysis where Std diff >0.1. These covariates included age, sex, income quintile (substituted for Ontario Marginalization Index due to high correlation), years since arrival in Canada, region of residence in Ontario, primary care model, and number of co-morbidities.

3. Results

Our cohort **(Figure 1)** comprised 10,356,878 Ontario residents aged 18 or older of which 2,496,963 (24.1%) were identified as immigrants, and 7,859,915 (75.9%) were identified as Canadian-born/long-term residents of Canada (*referred to from here on as "non-immigrants"*). About 8.9% of immigrants and 13.3% of non-immigrants were identified as having mental health and addiction (MH&A) disorders according to the study's definition. Among immigrants with MHA, 4.9% suffered from substance use issues compared to 9.9% of the non-immigrants with MH&A.

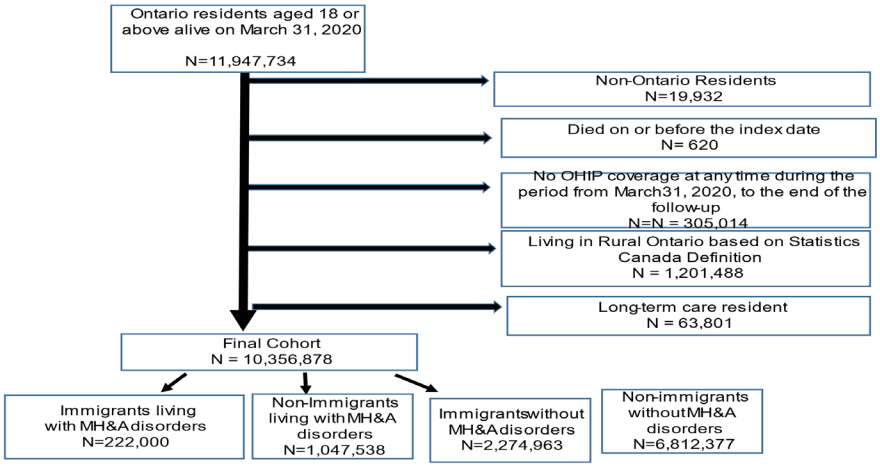

Figure 1: Study Cohort flow chart including immigrant and non-immigrant populations with and without MH&A in Ontario, Canada.

Table 1 illustrates the sociodemographic and healthcare-related characteristics for each of the four study subgroups. The average age of immigrants and non-immigrants living with MH&A disorders was notably younger than that of non-immigrants without MH&A (45.9 vs. 49.6, Std diff=0.217; 46.3 vs. 49.6, Std diff=0.179 respectively). Additionally, a significantly higher proportion of immigrants and non-immigrants with MH&A lived in low-income, highly marginalized, and residentially unstable neighborhoods compared to non-immigrants without MH&A. However, a considerably larger proportion of immigrants with MH&A lived in low-income and ethnically diverse neighborhoods than non-immigrants with MH&A (27.2% vs. 21.7%, Std diff=0.128; 58.1% vs. 21.1%, Std diff=0.818, respectively). Furthermore, a significantly higher proportion of immigrants with MH&A resided in Toronto and Central West compared to non-immigrants with MH&A (35% vs. 19.8%, Std diff=0.347; 28.6% vs. 17.9%, Std diff=0.255, respectively).

Most immigrants with and without MH&A were admitted to Canada under the Economy category (48% vs. 42%, respectively) and the Family category (35% vs. 34%, respectively). A markedly higher proportion of immigrants with MH&A were admitted to Canada as refugees compared to immigrants without MH&A (21.4% vs. 15.9%, Std diff=0.14). The average length of stay for immigrants with MH&A was significantly higher than for immigrants without MH&A (17.9 vs. 16.6 years, Std diff=0.14).

The most common region of origin for immigrants with MH&A was Europe and Central Asia (32.7%), followed by South Asia (23.9%), East Asia and Pacific (17.2%), Latin America and the Caribbean (15.1%), and Sub-Saharan Africa (8.6%).

Table 1: Participants Sociodemographic characteristics by immigration status

	Group 1	**Group 2**	**Group 3**	**Group 4**	**Standardized Difference**			
Categories	**Immigrants and refugees living with MH&A N= 222,000**	**Canadian-born /long-term residents living with MH&A N= 1,047,538**	**Immigrants and refugees without MH&A N=2,274,963**	**Canadian-born/long-term residents without a history of MH&A N=6,812,377**	**Gr1 vs. Gr2**	**Gr1 vs. Gr3**	**Gr1 vs. Gr4**	**G2 vs. G4**
Age								
Mean (SD)	45.9 (15.0)	46.3 (18.2)	46.9 (15.9)	49.6 (19.1)	0.023	0.061	0.217	0.179
Median (Q1-Q3)	45 (34-56)	45 (31-60)	46 (35-57)	50 (33-64)	0.006	0.042	0.206	0.176
18-24 - n (%)	16,631 (7.5)	141,348 (13.5)	148,794 (6.5)	745,029 (10.9)	0.197	0.037	0.119	0.078
25-44 - n (%)	90,072 (40.6)	368,530 (35.2)	931,007 (40.9)	2,123,990 (31.2)	0.111	0.007	0.197	0.085
45-64 - n (%)	91,069 (41.0)	352,993 (33.7)	874,311 (38.4)	2,248,370 (33.0)	0.152	0.053	0.167	0.015
65-74 - n (%)	16,090 (7.2)	108,487 (10.4)	193,271 (8.5)	954,423 (14.0)	0.11	0.046	0.221	0.112
75+ - n (%)	8,138 (3.7)	76,180 (7.3)	127,580 (5.6)	740,565 (10.9)	0.159	0.092	0.28	0.126
Sex								
Female - n (%)	1,26,354 (56.9)	5,98,015 (57.1)	1,176,551 (51.7)	34,20,727 (50.2)	0.003	0.105	0.135	0.138
Male - n (%)	95,646 (43.1)	4,49,523 (42.9)	1,098,412 (48.3)	33,91,650 (49.8)	0.003	0.105	0.135	0.138
Income quintile								
1 (lowest) - n (%)	60,374 (27.2)	227,296 (21.7)	567,811 (25.0)	1,172,332 (17.2)	0.128	0.051	0.242	0.114
2 - n (%)	46,965 (21.2)	212,820 (20.3)	494,596 (21.7)	1,308,632 (19.2)	0.021	0.014	0.048	0.028
3 - n (%)	44,877 (20.2)	200,839 (19.2)	475,152 (20.9)	1,366,503 (20.1)	0.026	0.017	0.004	0.022
4 - n (%)	39,771 (17.9)	195,646 (18.7)	420,755 (18.5)	1,409,624 (20.7)	0.02	0.015	0.07	0.051
5 (highest)-n (%)	29,571 (13.3)	208,583 (19.9)	312,857 (13.8)	1,542,945 (22.6)	0.178	0.013	0.245	0.067

Missing information - n (%)	442 (0.2)	2,354 (0.2)	3,792 (0.2)	12,341 (0.2)	0.006	0.008	0.004	0.01
Residential instability quintile								
0 Missing information - n (%)	812 (0.4)	7,109 (0.7)	5,692 (0.3)	36,819 (0.5)	0.043	0.021	0.026	0.018
1 (lowest) - n (%)	56,272 (25.3)	182,846 (17.5)	644,173 (28.3)	1,431,242 (21.0)	0.193	0.067	0.103	0.09
2 - n (%)	32,765 (14.8)	170,659 (16.3)	362,689 (15.9)	1,284,648 (18.9)	0.042	0.033	0.11	0.067
3 - n (%)	29,943 (13.5)	172,518 (16.5)	315,699 (13.9)	1,203,824 (17.7)	0.084	0.011	0.116	0.032
4 - n (%)	33,356 (15.0)	208,448 (19.9)	323,792 (14.2)	1,270,254 (18.6)	0.129	0.022	0.097	0.032
5 (highest)- n (%)	68,852 (31.0)	305,958 (29.2)	622,918 (27.4)	1,585,590 (23.3)	0.039	0.08	0.175	0.135
Missing information - n (%)	812 (0.4)	7,109 (0.7)	5,692 (0.3)	36,819 (0.5)	0.043	0.021	0.026	0.018
Deprivation quintile								
1 (lowest)- n (%)	44,782 (20.2)	242,280 (23.1)	462,018 (20.3)	1,745,840 (25.6)	0.072	0.003	0.13	0.058
2 - n (%)	41,701 (18.8)	205,141 (19.6)	449,830 (19.8)	1,463,389 (21.5)	0.02	0.025	0.067	0.047
3 - n (%)	39,920 (18.0)	182,938 (17.5)	428,759 (18.8)	1,252,468 (18.4)	0.014	0.022	0.01	0.024
4 - n (%)	42,277 (19.0)	185,552 (17.7)	440,069 (19.3)	1,154,987 (17.0)	0.034	0.008	0.054	0.02
5 (highest)- n (%)	52,508 (23.7)	224,518 (21.4)	488,595 (21.5)	1,158,874 (17.0)	0.053	0.052	0.166	0.112
Missing information - n (%)	812 (0.4)	7,109 (0.7)	5,692 (0.3)	36,819 (0.5)	0.043	0.021	0.026	0.018
Dependency quintile								
1 (lowest) - n (%)	86,588 (39.0)	265,492 (25.3)	900,740 (39.6)	1,718,578 (25.2)	0.296	0.012	0.298	0.003
2 - n (%)	50,198 (22.6)	216,470 (20.7)	511,966 (22.5)	1,378,668 (20.2)	0.047	0.003	0.058	0.011
3 - n (%)	34,061 (15.3)	190,754 (18.2)	345,730 (15.2)	1,251,459 (18.4)	0.077	0.004	0.081	0.004
4 - n (%)	27,560 (12.4)	177,470 (16.9)	294,134 (12.9)	1,186,329 (17.4)	0.128	0.015	0.141	0.013

5 (highest)- n (%)	22,781 (10.3)	190,243 (18.2)	216,701 (9.5)	1,240,524 (18.2)	0.228	0.025	0.229	0.001
Missing information - n (%)	812 (0.4)	7,109 (0.7)	5,692 (0.3)	36,819 (0.5)	0.043	0.021	0.026	0.018
Ethnic Diversity Quintile								
1 (lowest) - n (%)	4,763 (2.1)	133,438 (12.7)	45,259 (2.0)	942,739 (13.8)	0.412	0.011	0.442	0.032
2 - n (%)	10,983 (4.9)	193,572 (18.5)	103,884 (4.6)	1,293,309 (19.0)	0.43	0.018	0.443	0.013
3 - n (%)	23,825 (10.7)	236,834 (22.6)	223,124 (9.8)	1,476,615 (21.7)	0.323	0.03	0.3	0.022
4 - n (%)	52,696 (23.7)	256,005 (24.4)	519,404 (22.8)	1,573,043 (23.1)	0.016	0.021	0.015	0.032
5 (highest) - n (%)	128,921 (58.1)	220,580 (21.1)	1,377,600 (60.6)	1,489,852 (21.9)	0.818	0.051	0.795	0.02
Missing information - n (%)	812 (0.4)	7,109 (0.7)	5,692 (0.3)	36,819 (0.5)	0.043	0.021	0.026	0.018
Ontario, Regions								
Central East - n (%)	41,398 (18.6)	193,297 (18.5)	458,143 (20.1)	1,340,913 (19.7)	0.005	0.038	0.026	0.031
Central South - n (%)	11,569 (5.2)	120,675 (11.5)	107,687 (4.7)	778,286 (11.4)	0.229	0.022	0.226	0.003
Central West - n (%)	63,567 (28.6)	187,841 (17.9)	671,158 (29.5)	1,341,334 (19.7)	0.255	0.019	0.21	0.045
East - n (%)	13,769 (6.2)	150,520 (14.4)	141,108 (6.2)	939,859 (13.8)	0.271	0	0.255	0.016
North - n (%)	852 (0.4)	57,799 (5.5)	9,669 (0.4)	360,016 (5.3)	0.307	0.006	0.299	0.01
Southwest - n (%)	12,378 (5.6)	126,179 (12.0)	108,366 (4.8)	785,570 (11.5)	0.23	0.037	0.214	0.016
Toronto - n (%)	77,763 (35.0)	207,047 (19.8)	773,909 (34.0)	1,247,651 (18.3)	0.347	0.021	0.385	0.037
Missing Information - n (%)	704 (0.3)	4,180 (0.4)	4,923 (0.2)	18,748 (0.3)	0.014	0.02	0.008	0.021
Immigrant Category								
Category not stated - n (%)	*1-5	NA**	*12-16	NA**	0.004	0.001	0.004	
Economic (Economic class) immigrants - n (%)	94,073 (42.4)	NA**	1,080,673 (47.5)	NA**	1.213	0.103	1.213	

Other immigrants - n (%)	*4028-4032	NA**	*36979-36983	NA**	0.192	0.015	0.192	
Resettled Refugee & Protected Person in Canada - n (%)	47,540 (21.4)	NA**	361,293 (15.9)	NA**	0.738	0.142	0.738	
Sponsored family (Family Class) immigrants - n (%)	76,354 (34.4)	NA**	796,002 (35.0)	NA**	1.024	0.013	1.024	
Missing Information- n (%)		1,047,538 (100.0)		6,812,377 (100.0)	.		.	.
Time since landing (years)								
Mean (SD)	17.9 (9.2)	NA**	16.6 (9.1)	NA**	.	0.14	.	.
Median (Q1-Q3)	18 (11-26)	NA**	17 (9-24)	NA**	.	0.14	.	.
Region of Origin among immigrants - World bank region								
East Asia and Pacific - n (%)	38,207 (17.2)	0 (0.0)	616,686 (27.1)	0 (0.0)	0.645	0.24	0.645	
Europe and Central Asia - n (%)	72,486 (32.7)	0 (0.0)	563,153 (24.8)	0 (0.0)	0.985	0.175	0.985	
Latin America and the Caribbean - n (%)	33,518 (15.1)	NA**	288,652 (12.7)	NA**	0.596	0.07	0.596	
North America - n (%)	5,553 (2.5)	NA**	39,822 (1.8)	NA**	0.227	0.052	0.227	
Not stated - n (%)	54 (0.0)	NA**	480 (0.0)	NA**	0.022	0.002	0.022	
South Asia - n (%)	53,011 (23.9)	NA**	596,797 (26.2)	NA**	0.792	0.054	0.792	
Sub-Saharan Africa - n (%)	19,171 (8.6)	NA**	169,373 (7.4)	NA**	0.435	0.044	0.435	
Missing Data - n (%)		1,047,538 (100.0)		6,812,377 (100.0)				-

*- Small Size cell; **-Not Applicable

The average and median number of ADG comorbidities was slightly higher among immigrants with MHA relative to non-immigrants with MHA. (8.1 vs. 7.7, Std diff=0.10; 8.0 vs. 7.0, Std diff=0.11, respectively). About 83% of immigrants with MH&A lived with five or more comorbidities, compared to about 78% of non-immigrants with MH&A.

The prevalence of common chronic comorbidities was fairly similar across the two groups, with variations in certain conditions. Cancer, COPD, Hypertension (HTN), Asthma, and certain arthritis types were more prevalent among non-immigrants with MH&A compared to immigrants with MH&A. Contrarily, diabetes was more prevalent among immigrants with MH&A relative to non-immigrants with MH&A. (Table 2)

The types of MH&A disorders among immigrants with MH&A were Anxiety and other disorders (71.6%), Major mood disorders (19.6%), Substance abuse (4.9%), and Psychotic disorders (3.9%). Non-immigrants with MH&A had a higher proportion of substance use disorders relative to immigrants with MH&A (9.9% vs 4.9%, Std diff= 0.189), and a lower proportion of anxiety and other disorders relative to immigrants with MH&A (66.2%, vs. 71.4%, Std diff= 0.116). Other major types of MH&A have similar distributions irrespective of immigrant status. About 1.1% of immigrants with MH&A also suffered from cancer which included breast cancer (0.3%), blood, cervix, colorectal, lung, and prostate (0.1% each). (Table2)

There were no significant differences in the proportion of immigrants living with MH&A who did not have a primary care provider compared to non-immigrants living with MH&A (0.7% vs 1.6%, Std = 0.078). Approximately 51.9% of immigrants with MH&A were enrolled in FHG followed by FHN/FHO (22.2%) with 0.7% having no primary care provider.

Virtual and in-person visits to all types of physicians were higher among immigrants and non-immigrants with MH&A than immigrants and non-immigrants without MH&A **(Table2, Figure 2).**

Table 2: Participants' clinical and health utilization by immigration status

	Group 1	**Group 2**	**Group 3**	**Group 4**	**Standardized Difference**			
Categories	**Immigrants and refugees living with MH&A N= 222,000**	**Canadian-born /long-term residents living with MH&A N= 1,047,538**	**Immigrants and refugees without MH&A N=2,274,963**	**Canadian-born/long-term residents without a history of MH&A N=6,812,377**	**Gr1 vs. Gr2**	**Gr1 vs. Gr3**	**Gr1 vs. Gr4**	**G2 vs. G4**
Type of MHA as per study definition								
Anxiety and other disorders - n (%)	158,922 (71.6)	693,573 (66.2)	0 (0.0)	0 (0.0)	0.116	2.245	2.245	1.98
Major mood disorders - n (%)	43,451 (19.6)	215,158 (20.5)	0 (0.0)	0 (0.0)	0.024	0.698	0.698	0.719
Psychotic disorders - n (%)	8,645 (3.9)	35,366 (3.4)	0 (0.0)	0 (0.0)	0.028	0.285	0.285	0.264
Substance use disorders - n (%)	10,982 (4.9)	103,441 (9.9)	0 (0.0)	0 (0.0)	0.189	0.323	0.323	0.468

Missing Data - n (%)	0 (0.0)		2,274,963 (100.0)	6,812,377 (100.0)		.	.	
Total ADG								
Mean (SD)	8.1 (3.6)	7.7 (3.9)	4.6 (3.5)	4.9 (3.7)	0.087	0.966	0.86	0.744
Median (Q1-Q3)	8 (5-10)	7 (5-10)	4 (2-7)	4 (2-7)	0.11	1.004	0.927	0.783
ADG Categorical								
>7 - n (%)	140,923 (63.5)	606,250 (57.9)	636,007 (28.0)	2,046,568 (30.0)	0.08	0.225	0.234	0.154
3-4 - n (%)	28,143 (12.7)	161,961 (15.5)	478,740 (21.0)	1,458,892 (21.4)	0.011	0.004	0.018	0.029
5-6 - n (%)	42,553 (19.2)	205,386 (19.6)	432,579 (19.0)	1,257,698 (18.5)	0.115	0.763	0.711	0.584
Non-users, no or only unclassified diagnoses, or 1-2) - n (%)	10,381 (4.7)	73,941 (7.1)	727,637 (32.0)	2,049,219 (30.1)	0.102	0.754	0.712	0.62
Number of chronic conditions*								
0-1 - n (%)	133,961 (60.3)	571,038 (54.5)	1,400,589 (61.6)	2,969,410 (43.6)	0.118	0.025	0.34	0.22
2 - n (%)	41,636 (18.8)	205,737 (19.6)	374,614 (16.5)	1,353,953 (19.9)	0.022	0.06	0.028	0.006
3 - n (%)	23,735 (10.7)	122,870 (11.7)	232,396 (10.2)	987,668 (14.5)	0.033	0.016	0.115	0.082
4 - n (%)	12,458 (5.6)	70,635 (6.7)	133,480 (5.9)	642,799 (9.4)	0.047	0.011	0.145	0.099
5+ - n (%)	10,210 (4.6)	77,258 (7.4)	133,884 (5.9)	858,547 (12.6)	0.117	0.058	0.288	0.175
Number of chronic conditions*								
Mean (SD)	1.5 (1.5)	1.7 (1.7)	1.5 (1.6)	2.2 (2.0)	0.169	0.001	0.424	0.258
Median (Q1-Q3)	1 (0-2)	1 (0-3)	1 (0-2)	2 (1-3)	0.16	0.044	0.413	0.251
Primary Care Provider								
0 - n (%)	1,659 (0.7)	16,561 (1.6)	230,147 (10.1)	562,998 (8.3)	0.078	0.423	0.368	0.313
1 - n (%)	220,341 (99.3)	1,030,977 (98.4)	2,044,816 (89.9)	6,249,379 (91.7)	0.078	0.423	0.368	0.313
Enrollment model - Physician/Patient								
Capitation (Family Health Network or Family Health Organization) - n (%)	49,260 (22.2)	332,822 (31.8)	543,818 (23.9)	2,291,540 (33.6)	0.217	0.041	0.257	0.04

Comprehensive Care model - n (%)	15,201 (6.8)	38,187 (3.6)	123,600 (5.4)	188,952 (2.8)	0.144	0.059	0.191	0.049
Family Health group - n (%)	115,223 (51.9)	310,202 (29.6)	1,012,986 (44.5)	1,590,833 (23.4)	0.466	0.148	0.617	0.142
Family Health team - n (%)	21,828 (9.8)	259,876 (24.8)	218,962 (9.6)	1,789,774 (26.3)	0.404	0.007	0.438	0.034
Physician not in PEM - n (%)	18,300 (8.2)	82,039 (7.8)	145,350 (6.4)	344,582 (5.1)	0.015	0.071	0.128	0.113
No physician^ - n (%)	1,657 (0.7)	16,516 (1.6)	227,486 (10.0)	558,570 (8.2)	0.078	0.419	0.367	0.311
OGP (Other Enrollment group) - n (%)	531 (0.2)	7,896 (0.8)	2,761 (0.1)	48,126 (0.7)	0.073	0.028	0.068	0.006
Rate of visits to the physicians per 100 persons								
All physician in-person visits	7.42	7.09	3.85	3.99	-	-	-	-
All physician virtual visits	11.83	11.52	4.88	4.4	-	-	-	-
COVID-19 Diagnosis								
No- n (%)	201,522 (90.8)	992,813 (94.8)	2,094,823 (92.1)	6,491,478 (95.3)	0.155	0.047	0.178	0.024
Yes - n (%)	20,478 (9.2)	54,725 (5.2)	180,140 (7.9)	320,899 (4.7)	0.155	0.047	0.178	0.024
COVID-19 Vaccination								
No- n (%)	26,659 (12.0)	127,526 (12.2)	453,455 (19.9)	1,017,130 (14.9)	0.005	0.218	0.086	0.081
Yes - n (%)	195,341 (88.0)	920,012 (87.8)	1,821,508 (80.1)	5,795,247 (85.1)	0.005	0.218	0.086	0.081
COVID -19 Hospitalization								
No - n (%)	220,988 (99.5)	1,044,407 (99.7)	2,267,549 (99.7)	6,798,808 (99.8)	0.026	0.021	0.045	0.02
Yes - n (%)	1,012 (0.5)	3,131 (0.3)	7,414 (0.3)	13,569 (0.2)	0.026	0.021	0.045	0.02
COVID-19 ICU Admission								
No - n (%)	221,757 (99.9)	1,046,832 (99.9)	2,273,068 (99.9)	6,809,127 (100.0)	0.014	0.008	0.022	0.008
Yes - n (%)	243 (0.1)	706 (0.1)	1,895 (0.1)	3,250 (0.0)	0.014	0.008	0.022	0.008
COVID-19 Mortality								
No - n (%)	221,832 (99.9)	1,046,724 (99.9)	2,273,458 (99.9)	6,807,866 (99.9)	0.001	0.004	0.004	0.004
Yes - n (%)	168 (0.1)	814 (0.1)	1,505 (0.1)	4,511 (0.1)	0.001	0.004	0.004	0.004

** - Excluding mental illnesses as a category among Immigrants/Non-Immigrants with MHA*

^ - Patient had no core primary care fee codes for 2 years prior to index

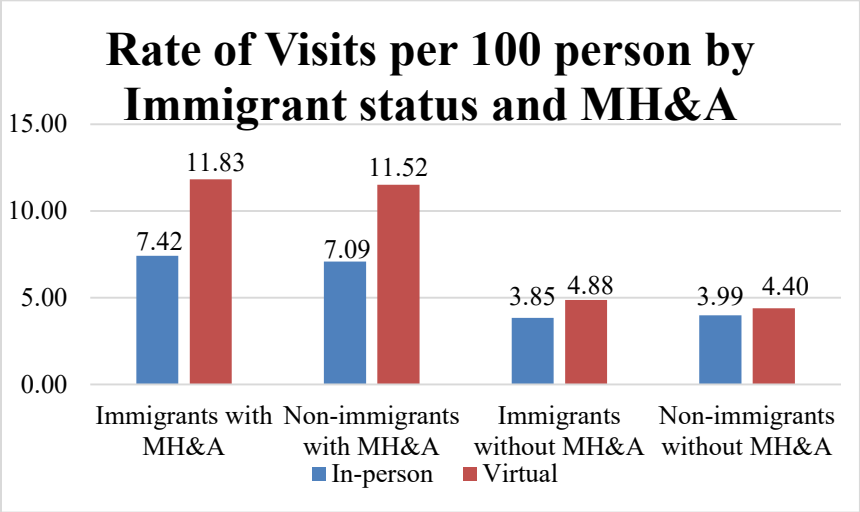

Figure 2: Percentage of in-patient and virtual visits to all physicians by immigration and MH&A status

3.1 COVID-19 Confirmed Positive Test

While a lower proportion of immigrants with MH&A compared to non-immigrants with MH&A were tested for COVID-19 (i.e., 52.2% (95%CI: 52.0%, 52.42%) vs. 55.3%, (95%CI: 55.19%, 55.38%)), *confirmed positive test results were significantly higher among immigrants with MH&A* (17.7%) than non-immigrants with MH&A (9.5%). (Figure 3).

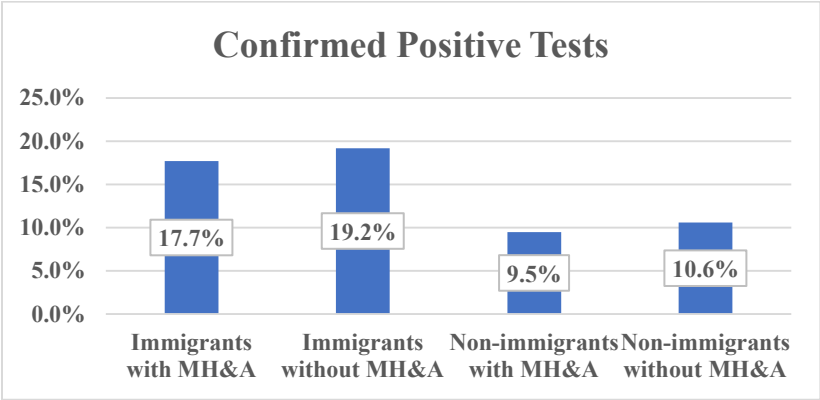

Figure 3: Percent positivity among those tested by immigration and MH&A status

3.2 COVID-19 Diagnosis

The prevalence of COVID-19 diagnosis was significantly higher among immigrants than non-immigrants (8% vs. 4.8%, Std diff =0.133). Interestingly, the prevalence of COVID-19 was also significantly higher among immigrants with MH&A compared to both non-immigrants with and without MH&A (9.2% vs. 5.2%, Std diff= 0.155, 9.2% vs. 4.7%, Std

diff=0.178 respectively). Although the prevalence of COVID-19 was slightly higher among immigrants with MH&A compared to immigrants without MH&A, the difference was not significant (9.2% vs, 7.9%, Std diff=0.047). The prevalence of COVID-19 was significantly higher among immigrants without MH&A than non-immigrants without MH&A (7.9% vs. 4.7%, Std diff=0.132) **(Figure 4).**

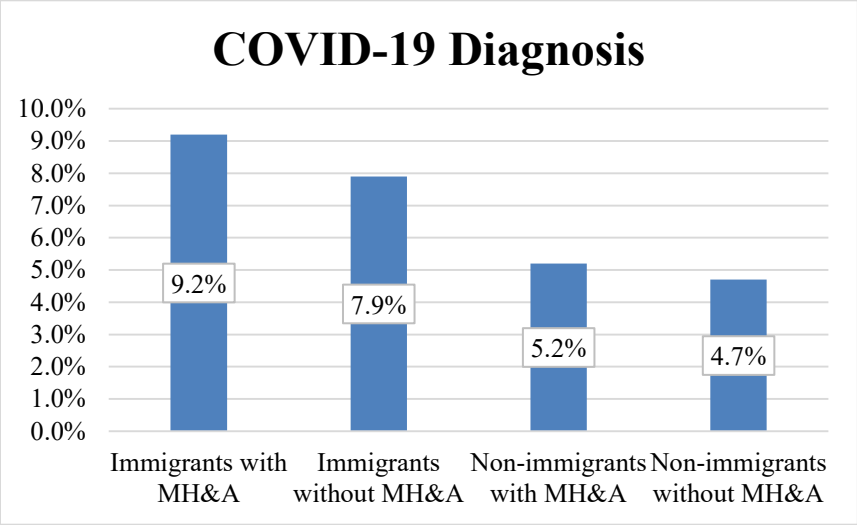

Figure 4: Prevalence of COVID-19 diagnosis by immigrant and MH&A status

3.3 COVID-19 Hospitalization, ICU Admission and Mortality

No significant difference in COVID-19 hospitalization, ICU admission and mortality rates were observed across immigrants and non-immigrants with or without MH&A.

3.4 COVID-19 Vaccinations

Although the uptake of the first and second vaccine doses was nearly equal across immigrants and non-immigrants, regardless of MH&A status, each additional dose of the vaccine resulted in a decrease in the proportion of people getting vaccinated across all four groups, especially among immigrants with or without MH&A **(Figure 5).**

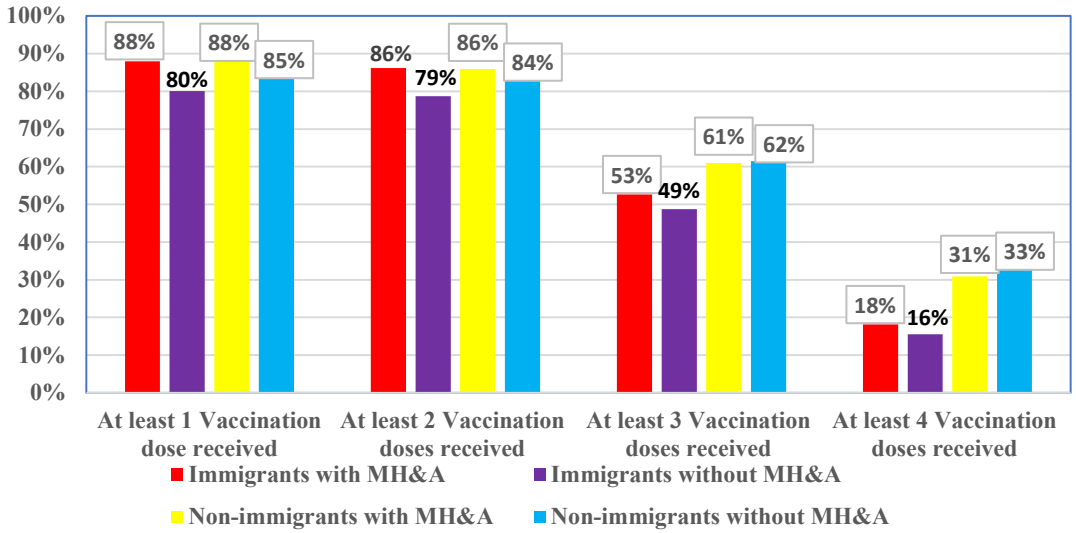

Figure 5: Vaccination Doses by Immigration Status and MH&A Disorders

3.5 Multivariate Analysis of COVID-19 Outcome Measures:

Table 3 shows our multivariate logistic regression model as related to COVID-19 diagnosis. After adjusting for other variables in the model, *Immigrants living with and without MH&A* were 52% and 66% more likely to be diagnosed with COVID-19 than non-immigrants without MH&A, while non-immigrants with MH&A were 13% less likely to be diagnosed with COVID-19 compared to non-immigrants without MH&A. Immigrants from *Latin America and the Caribbean* were 16% more likely to be diagnosed with COVID-19 compared to non-immigrants. The prevalence of COVID-19 diagnoses was *inversely related to neighbourhood income*. Those living in the lowest-income neighbourhoods were 24% more likely to be diagnosed with COVID-19 compared to the highest-income neighbourhoods. The COVID-19 diagnosis increased with *increasing number of comorbidities*. Patients enrolled in *FHG* were 24% more likely to be diagnosed with COVID-19 than those enrolled in a family health team. In other regions of Ontario, people with COVID-19 diagnosis were 60% to 20% less than in the Toronto region.

Table 3: Logistic regression results by Immigrant status and MH&A - COVID-19 Diagnosis

Variables	Odds Ratios (95% confidence interval)
Immigration status (Non-immigrant without MH&A as the reference group)	
Immigrants with MH&A	1.52 (1.49, 1.56)
Immigrants without MH&A	1.66 (1.63, 1.69)

Non-Immigrants with MH&A	0.87 (0.86, 0.88)
Age (1-year increase)	0.98 (0.98, 0.98)
Female (vs. Male)	0.93 (0.92, 0.93)
Neighbourhood income quintile (quintile 5 as the reference group)	
Income quintile 1 (lowest)	1.24 (1.23, 1.25)
Income quintile 2	1.16 (1.15, 1.17)
Income quintile 3	1.18 (1.17, 1.19)
Income quintile 4	1.11 (1.1, 1.12)
Not stated/Missing *	1.11 (1.03, 1.2)
Region of origin (Canada as the reference group)	
East Asia and the Pacific	0.66 (0.65, 0.68)
Europe and Central Asia	0.84 (0.83, 0.86)
Latin America and the Caribbean	1.16 (1.14, 1.19)
North America	0.55 (0.52, 0.57)
South Asia	0.97 (0.96, 0.99)
Not stated/Missing	1.22 (0.92, 1.62)
Length of OHIP eligibility time in Ontario (At least 20 years as the reference group)	
Less than 3 years	1 (0.98, 1.01)
At least 3 or 5 years: 3-9 years	0.95 (0.94, 0.96)
At least 10 years: 10-19 years	0.96 (0.95, 0.96)
Region of residence in Ontario (Toronto region as the reference group)	
Central East	0.79 (0.78, 0.79)
Central South	0.8 (0.79, 0.81)
Central West	0.91 (0.9, 0.92)
East	0.56 (0.55, 0.56)
North	0.4 (0.39, 0.41)
Southwest	0.69 (0.68, 0.7)
Not Stated/Missing	0.8 (0.76, 0.85)
Co-morbidities (0-2 ADG as the reference group)	
3-4 ADGs	1.37 (1.36, 1.38)
5-6 ADGs	1.55 (1.53, 1.56)
7+	1.82 (1.81, 1.84)
Patient Enrollment Model (Family Health Team (FHT)-primarily capitation-based team model as the reference group)	
Family Health Groups (FHG)/ Comprehensive Care Model (CCM)	1.24 (1.23, 1.25)
Family Health Networks (FHN)/Family Health Organization (FHO)	1.08 (1.07, 1.09)
Physicians not in PEM	1.22 (1.21, 1.24)
Having no primary care physician	0.68 (0.67, 0.69)
Other	0.95 (0.9, 1)

Figure 6 shows the regression model as relates to COVID-19 hospitalization. *Immigrants living with and without MH&A* were almost *twice more* likely to be hospitalized for COVID-19 than non-immigrants without MH&A, while non-immigrants with MH&A were 34% more likely to be hospitalized compared to non-immigrants without MH&A. Furthermore, females were 32% less likely than men to be hospitalized. Immigrants from *Latin America and the Caribbean* were 12% more likely to be hospitalized compared to those from Canada. The prevalence of COVID-19 hospitalization was inversely related to neighbourhood income. Those living in *the lowest-income neighbourhoods* were about 2.5 times more likely to be hospitalized compared to the highest-income neighbourhoods. The COVID-19 hospitalization increased by increasing number of comorbidities. Those with *7 or more comorbidities were 3 times more likely to be hospitalized* than those with 0-2 comorbidities. Patients enrolled in FHG were 38% more likely to be hospitalized than those enrolled in a family health team. COVID-19 hospitalizations across other regions of Ontario were 66% to 26% less than in the Toronto region.

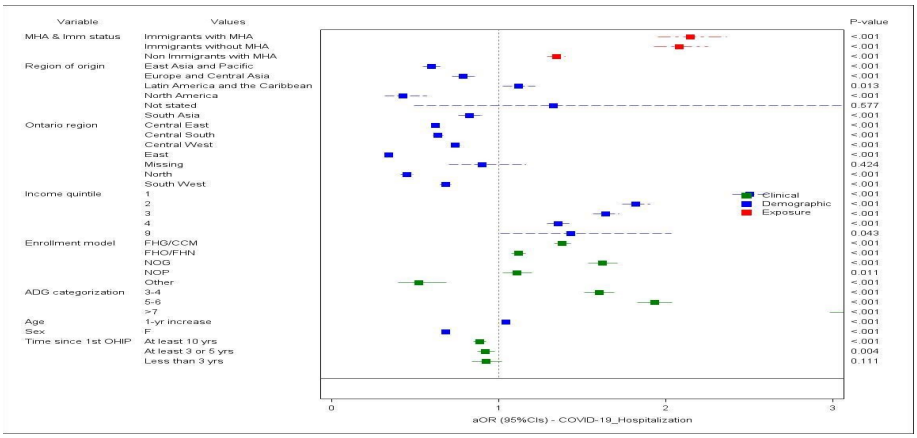

Figure 6: Logistic regression results by Immigrant status and MH&A COVID-19 Hospitalization

Table 4 shows the final regression model as relates to COVID-19 ICU Admission. *Immigrants living with or without MH&A were about 2.3 more likely to be admitted to* ICU for COVID-19 compared to non-immigrants without MH&A, while non-immigrants with MH&A were 28% more likely to be admitted to ICU compared to non-immigrants without MH&A. Immigrants from *Latin America and the Caribbean* were 12% more likely to be admitted to ICU compared to non-immigrants. The prevalence of ICU admission was inversely related to neighbourhood income. *Those living in the lowest-income neighbourhoods were about 2.6 times more likely to be admitted to ICU* compared to the highest-income neighbourhoods. ICU admission increased by increasing number of comorbidities. Those with *7 or more comorbidities were about 3 times more likely to be* admitted to ICU than those with 0-2 comorbidities. *Patients without primary care providers* were 19% more likely to be admitted to ICU compared to those enrolled in a family health team. Patients enrolled in FHG were 35% more likely to be admitted to ICU than those enrolled in a family health team. ICU admissions were 58% to 23% less likely across other regions in Ontario compared to Toronto.

Table 4: Logistic regression results by immigrant status and MH&A COVID-19 ICU Admission

Variables	**Odds Ratios (95% confidence interval)**
Immigration status (Non-immigrant without MH&A as the reference group)	
Immigrants with MH&A	2.25 (1.86, 2.73)
Immigrants without MH&A	2.24 (1.92, 2.62)
Non-Immigrants with MH&A	1.28 (1.18, 1.39)
Age (1 year increase)	1.04 (1.04, 1.04)
Female (vs. Male)	0.48 (0.46, 0.51)
Neighbourhood income quintile (quintile 5 as the reference group)	
Income quintile 1 (lowest)	2.62 (2.4, 2.87)
Income quintile 2	1.9 (1.73, 2.08)
Income quintile 3	1.65 (1.5, 1.81)
Income quintile 4	1.33 (1.2, 1.47)
Not stated/Missing	1.95 (1.01, 3.75)
Region of origin (Canada as the reference group)	
East Asia and the Pacific	0.7 (0.59, 0.83)
Europe and Central Asia	0.73 (0.62, 0.87)
Latin America and the Caribbean	1.12 (0.94, 1.34)
North America	0.53 (0.31, 0.9)
South Asia	0.87 (0.74, 1.03)
Not stated/Missing	1.33 (0.19, 9.56)
Length of OHIP eligibility time in Ontario (At least 20 years as the reference group)	
Less than 3 years	0.59 (0.47, 0.74)
At least 3 or 5 years	0.77 (0.68, 0.86)
At least 10 years	0.84 (0.77, 0.92)
Region of residence in Ontario (Toronto region as the reference group)	
Central East	0.63 (0.58, 0.68)
Central South	0.76 (0.69, 0.84)

Central West	0.77 (0.72, 0.83)
East	0.42 (0.38, 0.47)
North	0.5 (0.42, 0.6)
Southwest	0.75 (0.68, 0.83)
Not stated/Missing	0.83 (0.49, 1.4)
Co-morbidities (0-2 ADG as the reference group)	
3-4 ADGs	1.53 (1.38, 1.7)
5-6 ADGs	1.92 (1.74, 2.13)
7+	2.84 (2.59, 3.12)
Patient Enrollment Model (Family Health Team (FHT)-primarily capitation-based team model as the reference group)	
Family Health Groups (FHG)/ Comprehensive Care Model (CCM)	1.35 (1.25, 1.46)
Family Health Networks (FHN)/Family Health Organization (FHO)	1.12 (1.03, 1.21)
Physicians not in PEM	1.67 (1.5, 1.86)
Having no primary care physician	1.19 (1.03, 1.38)
Other	0.52 (0.31, 0.89)

Figure 7 shows the final regression model as relates to COVID-19 Mortality. COVID-19 mortality among *immigrants living with MH&A* was 63% higher than *non-immigrants without MH&A* while COVID-19 mortality among non-immigrants with MH&A was 29% more than non-immigrants without MH&A. Furthermore, immigrants without MH&A were about 67% more likely to die from COVID-19 than non-immigrants without MH&A. Immigrants from *Latin America and the Caribbean* were 33% more likely to die from COVID-19 compared to individuals from Canada. COVID-19 mortality was inversely related to neighbourhood income. Those living in *the lowest-income neighbourhoods were about 2.5 times more likely* to die from COVID-19 compared to the highest-income neighbourhoods. COVID-19 mortality increased by increasing number of comorbidities. Those with 7 or more comorbidities were about 3.6 times more likely to die from COVID-19 than those with 0-2 comorbidities. Patients enrolled in FHG were 32% more likely to die from COVID-19 than those enrolled in the family health team. Interestingly, patients with physicians who were not enrolled in PEM were 73% more likely to die from COVID-19 than those enrolled in a family health team. COVID-19 mortality was 62% to 21% less likely in other regions in Ontario compared to the Toronto region.

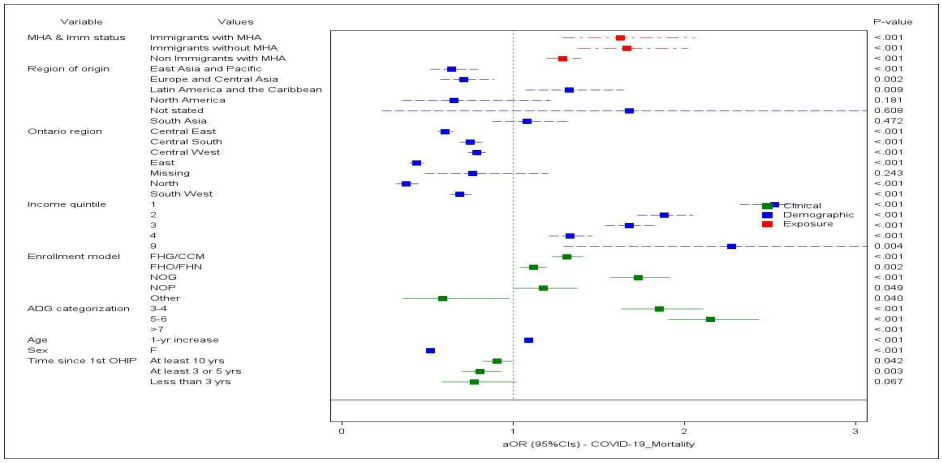

Figure 7: Logistic regression results by Immigrant status and MH&A COVID-19 Mortality

Table 5 shows the final regression model as relates to the uptake of COVID-19 Vaccination. COVID-19 vaccination among immigrants living with MH&A was 3% more than non-immigrants without MH&A while COVID-19 vaccination among non-immigrants with MH&A was 17% less than non-immigrants without MH&A. Furthermore, COVID-19 vaccination among immigrants without MH&A was about 14% less than non-immigrants without MH&A. Immigrants from South Asia, East Asia and the Pacific were more likely (i.e.54% and 44%respectively) to receive COVID-19 vaccination compared to individuals from Canada. COVID-19 vaccination was directly related to neighbourhood income. Those living in the lowest-income neighbourhoods were about 37% less likely to receive COVID-19 vaccination compared to the highest-income neighbourhoods. COVID-19 vaccination increased by increasing number of comorbidities. Those with 7 or more comorbidities were about 2.8 times more likely to receive COVID-19 vaccination than those with 0-2 comorbidities. Patients with physicians who were not enrolled in PEM were 30% less likely to undergo vaccination than those enrolled in family health team. The uptake of COVID-19 vaccination was more likely in the East (25%) and North regions of Ontario (12%) compared to the Toronto region.

Table 5: Logistic regression results by immigrant status and MH&A - COVID-19 Vaccination

Variables	**Odds Ratios (95% confidence interval)**
Immigration status (Non-immigrant without MH&A as the reference group)	
Immigrants with MH&A	1.03 (1.01, 1.05)
Immigrants without MH&A	0.86 (0.85, 0.87)
Non-Immigrants with MH&A	0.83 (0.82, 0.83)
Age (1-year increase)	1 (1, 1)

Female (vs. Male)	0.95 (0.94, 0.95)
Neighbourhood income quintile (quintile 5 as the reference group)	
Income quintile 1 (lowest)	0.63 (0.62, 0.63)
Income quintile 2	0.74 (0.74, 0.75)
Income quintile 3	0.82 (0.82, 0.83)
Income quintile 4	0.91 (0.9, 0.91)
Not stated/Missing	0.66 (0.64, 0.7)
Region of origin (Canada as the reference group)	
East Asia and the Pacific	1.44 (1.42, 1.46)
Europe and Central Asia	0.64 (0.63, 0.65)
Latin America and the Caribbean	0.88 (0.87, 0.89)
North America	0.62 (0.61, 0.64)
South Asia	1.54 (1.52, 1.56)
Not stated/Missing	0.81 (0.65, 1.01)
Length of OHIP eligibility time in Ontario (At least 20 years as the reference group)	
Less than 3 years	1.4 (1.38, 1.41)
At least 3 or 5 years	0.82 (0.81, 0.82)
At least 10 years	0.73 (0.72, 0.73)
Region of residence in Ontario (Toronto region as the reference group)	
Central East	1 (0.99, 1)
Central South	0.91 (0.9, 0.91)
Central West	1 (0.99, 1)
East	1.25 (1.24, 1.26)
North	1.12 (1.11, 1.13)
Southwest	0.93 (0.93, 0.94)
Not stated/Missing	0.67 (0.65, 0.7)
Co-morbidities (0-2 ADG as the reference group)	
3-4 ADGs	2.4 (2.39, 2.41)
5-6 ADGs	2.75 (2.74, 2.77)

7+	2.84 (2.82, 2.85)
Patient Enrollment Model (Family Health Team (FHT)-primarily capitation-based team model as the reference group)	
Family Health Groups (FHG)/ Comprehensive Care Model (CCM)	0.79 (0.79, 0.8)
Family Health Networks (FHN)/Family Health Organization (FHO)	0.93 (0.93, 0.94)
Physicians not in PEM	0.7 (0.69, 0.7)
Having no primary care physician	0.22 (0.22, 0.22)
Other	1.01 (0.99, 1.04)

4. Discussion

Our follow up retrospective cohort study revealed that approximately 9% of Ontario's immigrants and refugees lived with preexisting MH&A disorders, compared to about 13% of non-immigrants with MH&A in Ontario which is consistent with healthy immigrant effect. Among those immigrants with MH&A, around 0.4% faced addiction challenges, whereas about 1% of non-immigrants with MH&A struggled with addictions. While both immigrants and non-immigrants living with MH&A disorders were more likely to be impoverished and reside in economically and socially deprived neighborhoods compared to non-immigrants without MH&A, immigrants with MH&A were more socially deprived than their non-immigrant counterparts, highlighting the additional burdens they face. These findings align with research indicating that individuals experiencing mental health and addiction (MH&A) disorders often face significant economic hardships, to be under-housed, living in group homes, unable to afford masks and take other precautions [12,14-18, 26-28]. Additionally, immigration status exacerbates social deprivation due to the numerous challenges immigrants encounter during resettlement, such as language barriers, limited social support, employment obstacles, and financial constraints [3-7, 29-30].

The study findings validated our hypothesis that the combination of immigration status and preexisting MH&A issues significantly influenced COVID-19 adverse outcomes. The combined impact persisted after controlling for various socioeconomic and clinical confounders, including age, sex, income, region of origin and residence in Ontario, length of OHIP eligibility, and comorbidities. Overall, immigrants with and without MH&A were significantly more likely to be diagnosed with COVID-19, hospitalized, admitted to ICU and die from COVID-19 than non-immigrants without MH&A. In general people living with MH&A have a lower life expectancy than the general population, are more vulnerable to stress resulting in relapse and decreased self-care and more likely to not being able to access mental health services due to cutback in in-person groups and day programs [18].

The disparity in COVID-19 outcomes was far more pronounced for immigrants with MH&A highlighting the severe vulnerability of this group. Notably, compared to our initial study [13], the adverse effects of COVID-19 were more pronounced among immigrants with MH&A than non-immigrants with MH&A over a longer period of the pandemic.

This highlights how prolonged material and social deprivation coupled with reduced access to health services due to lockdown or limited availability of non-COVID related care, can significantly worsen health outcomes for populations with complex health and social care needs [31].

Our findings also revealed a stark income gradient in COVID-19 outcomes. Residents of the lowest-income neighborhoods were 24% more likely to be diagnosed with COVID-19 and about 2.5 times more likely to be hospitalized, admitted to the ICU, or die from the virus compared to those in the highest-income neighborhoods. These findings are consistent with other studies that highlight social constructs as fundamental determinants of health [5-8,31-32]. Key factors that increase the risk of COVID-19 exposure and transmission like inability to work from home, living in overcrowded housing, reliance on public transportation is closely linked to people's income, employment status, and education level [6-9]. In Ontario, racialized populations which include a significant number of immigrants, are disproportionately represented in the essential workforce and low-wage sectors such as food service, retail, construction, and security. Considering immigrants' low income, precarious employment without paid sick leave, and inability to buffer income losses due to work interruptions or termination, they are often forced to continue working outside their homes despite being sick or facing potential threats in their work environment. Hence, due to the lack of employment benefits and job insecurity, immigrants are put at a heightened risk of exposure to COVID-19 [29-36].

A Canadian population survey reported that about 53% of visible minorities experienced a decrease in income and 50% had difficulty meeting their financial obligations or paying their rent or mortgage during COVID-19 [37]. Notably, the reduction in income and difficulty in meeting financial obligations varied by immigrants' length of stay in Canada and their region of origin [37-38]. For instance, recent immigrants had more challenges in meeting their financial obligation and paying their rent or mortgage compared to established immigrants (48% vs. 31% and 42% vs. 24% respectively). Latin American and Black communities, including Caribbeans, experienced greater income reductions compared to other visible minorities (70% and 61% respectively). Our findings indicate a higher risk of COVID-19 diagnosis, hospitalization, ICU admission, and mortality, along with lower vaccination uptake among immigrants from Latin America and the Caribbean. These disparities can be partially attributed to their structural social disadvantages. Moreover, other known factors factors such as structural racism, allostatic load (i.e. the cumulative burden of chronic stress and life events) and a history of unethical experimentation on Black populations [39] can contribute to their skepticism towards vaccines and the healthcare system.

Our study found a significantly higher proportion of immigrants with and without MH&A resided in ethnically diverse neighbourhoods, compared to non-immigrants with or without MH&A. In Ontario, neighborhoods with high ethnic concentrations tend to have a greater percentage of low-income residents, recent immigrants, apartment buildings, and a higher average number of persons per household compared to neighborhoods with lower ethnic concentrations [40]. Living in overcrowded, multi-generational housing makes effective self-isolation for confirmed cases impractical [5-8, 29-36]. These findings underscore that people facing both social deprivation and preexisting chronic health conditions, such as MH&A, require not only clinical but also social and material supports- including financial aid, food security, housing subsides, employment assistance, paid sick leave, and childcare to navigate the pandemic. It is crucial that COVID-19 recovery efforts and future crisis responses incorporate targeted upstream interventions and support systems that address the specific needs of structurally and clinically marginalized populations.

We also found that COVID-19 vaccination uptake dropped dramatically after receiving the first two doses across all our four cohorts. The stark decrease in vaccination rates may be attributed to vaccine hesitancy stemming from concerns about vaccine safety, side effects, and effectiveness. This hesitancy is particularly relevant when more contagious variants of COVID-19 such as the Delta variant and Omicron have placed equally both unvaccinated and vaccinated individuals at high risk of hospitalization and admission to ICU [40-41], escalating the debate over the necessity of supplemental doses for effective pandemic control. However, the drop in vaccination was notably more drastic among immigrants with or without MH&A compared to non-immigrants with or without MH&A. Low vaccine uptake among ethno-racial minority groups has been previously reported and attributed to factors such as lack or limited access to culturally sensitive and literacy-appropriate information, exposure to vaccine misinformation, mistrust in government and medial organizations that is rooted in historical systemic racism and unethical medical conduct, and system failures in vaccine accessibility [41-50]. These findings highlight the necessity for targeted, culturally specific outreach, education, and care. Implementing strategies such as community ambassadors/champions, and pop-up clinics can effectively reach marginalized populations in high-need areas [51-54]. Recruiting, training, and mobilizing community ambassadors/champions, particularly those with international medical training, would be an effective strategy for disseminating culturally and linguistically appropriate, scientifically accurate information during crises. These champions could hold community forums to discuss relevant health information and public health guidelines, allowing community members to ask questions and gain a better understanding of the issues [52-53]. Additionally, hosting community-based outreach pop-up COVID-19 vaccine clinics in accessible locations, such as faith-based organizations, settlement agencies, and ethnic food stores, without prior booking, has proven to be an effective strategy for promoting vaccine uptake [54-55]. Furthermore, the lower 3rd and 4th vaccine uptake observed among immigrants living with and without MH&A may also be related to structural barriers such as unstable residence, food insecurity, length of stay, and more problematic drug use among those immigrants with MH&A which in turn may make vaccination a lower priority for this population.

Finally, our study found that the majority of both immigrants and non-immigrants living with MH&A issues had primary care providers and used in-person and online health care more frequently than the people without MH&A during the pandemic. However, patients without primary care providers or not enrolled in family health teams, which facilitates access to interprofessional care and does not follow a fee-for service model, were less likely to undergo vaccination and more likely to experience poor COVID-19-related outcomes. This suggests that health systems should prioritize proactive approaches to connecting individuals to primary care, particularly interprofessional team-based care. Ensuring broader access to comprehensive primary care, particularly in vulnerable populations, will be an important step in promoting positive health outcomes.

Limitations and Future Studies

Our follow-up population-based study makes a distinctive contribution by pioneering the examination of the COVID-19 pandemic's impact on populations facing both social and clinical deprivations. Although this research adds valuable insights to the expanding field of pandemic-related health disparities, there are a few limitations that should be considered when reviewing the results. *First*, the use of administrative data limits our ability to deduce causation or

account for some other variables which may affect the observed association, and increase exposure, such as race, education, literacy, dwelling type, food security, kind of employment, and type of MH&A and treatments. *Second*, long-term care homes followed a different trajectory of COVID-19 exposure and outcomes, leading to their exclusion from this study. As a result, the impact of COVID-19 on immigrants and non-immigrants with MH&A living in long-term care homes remains unexplored. *Third*, because the IRCC Permanent Residence database started on Jan 1, 1985, immigrants who landed in Ontario prior to this date will not be categorized as immigrants. Individuals who landed in Canada via another province and subsequently moved to Ontario may be misclassified. However, these misclassifications would pull the effect towards null. *Fourth*, Due to the focus of our study on investigating the varying impact of COVID-19 among immigrants and non-immigrants with and without MH&A issues, we could not explore immigrants' length of stay (such as recent immigrants with less than 5 years versus long-term immigrants), which is known to influence COVID-19 exposure. Instead, we examined the length of OHIP eligibility time in Ontario. Future studies should explore the impact of immigrants' length of stay living with and without MH&A on COVID-19 outcomes to provide a more comprehensive understanding of these factors. *Fifth*, the study did not include community health centres (CHCs) in the analysis. It is important to note that CHCs see a disproportionate number of newcomers and refugees within the primary care models. However, the proportion of Ontarians seen in CHCs is quite small. *Sixth*, the generalizability of this research remains limited as this study explores the Ontario population specifically and other geographies may not have the same distribution by immigrant status. *Seventh* changes made to Ontario's COVID-19 testing criteria throughout the pandemic may have affected access to COVID-19 screening among our study cohort and led to an undercount of the true number of confirmed cases. *Eight*, social determinants of health like income, marginalization index at the neighbourhood that although validated, may not reflect individual-level income or marginalization. *Ninth*, the ethnic concentration of a neighborhood, a dimension of the Ontario Marginalization Index, can be protective in some contexts, serving as an ethnic enclave for individuals who choose to live among their ethnic groups. However, in other contexts, such as during a pandemic when over-crowding occurs, it can become disadvantageous. *Tenth*, our study did not examine the association between vaccine uptake and other sociodemographic determinants of health such a food security, length of stay or drug use. Future research should address this gap to provide a more comprehensive understanding of the factors influencing vaccine uptake. *Finally,* our study did not assess the impact of COVID-19 by type of MH&A (i.e. Psychotic disorders, non- psychotic disorders and substance use disorders). This represents an important area for future study.

5. Conclusions

In this follow-up population-based retrospective cohort study conducted in Ontario, Canada, we discovered that immigrants and refugees living with MH&A disorders were more socially deprived and significantly more likely to be diagnosed with COVID-19, hospitalized, admitted to the ICU, and die from it compared to their counterparts. These findings validated our hypothesis that the combination of immigration status and preexisting MH&A issues significantly influenced COVID-19 adverse outcomes. This disparity is astonishing considering Canada's reputation for its multicultural diversity, inclusivity, and availability of universal healthcare.

Additionally, the study illustrated a clear income gradient across COVID-19 outcomes and variations by immigrants' and refugees' regions of origin, with those from Latin America and the Caribbean at higher risk of adverse COVID-19 outcomes. We also identified a protective effect associated with being in a Family Health Team primary care model.

These findings underscore the need for policymakers to recognize the compounded social and clinical disadvantages faced by immigrants, particularly ethno-racialized immigrants living with MH&A disorders. This awareness highlights the importance of prioritizing these groups in future crises. Implementing targeted upstream policies and community-based support systems—such as training and mobilizing community champions to promote culturally sensitive and linguistically appropriate preventive measures—can mitigate the disproportionate impacts of the pandemic and future crises on these vulnerable communities. Health equity should be at the center of all policy responses and public health guidelines, fostering greater equity and resilience in the face of future man-made or natural crises.

Declarations:

Ethics approval and consent to participate

ICES (formerly known as Institute for Clinical Evaluative Sciences) is a prescribed entity under section 45 of Ontario's Personal Health Information Protection Act. Section 45 authorizes ICES to collect personal health information, without consent, for the purpose of analysis or compiling statistical information with respect to the management of, evaluation or monitoring of, the allocation of resources to or planning for all or part of the health system. Projects conducted under section 45, by definition, do not require review by a Research Ethics Board. This project was conducted under section 45, and approved by ICES' Privacy and Legal Office. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not Applicable

Availability of data and material

All data generated or analyzed during this study are included in tables provided in this published article.

Competing interest

The authors declare that they have no competing interests.

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Authors' contributions

L.M. and A.K. extracted and analyzed the data according to specifications provided by A.L. and M.V. M.V. processed and analyzed the data and prepared the original draft of the manuscript. L.M. and M.V. prepared the tables and figures.

The remaining co-authors -J.W., C.D., K.F M.N., W.T., A.J., G.D., R.H and J.R- reviewed the article critically for intellectual content. All authors gave final approval of the version to be published and agreed to serve as guarantors of the work.

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