Research Article

The Impact of COVID-19 on Immigrants and Refugees Living with Mental Health and Addiction Disorders: A Population-Based Cohort Study in Ontario, Canada

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Abstract

Background: While the COVID-19 pandemic has taken an enormous toll on communities across Canada and the globe, its negative impacts have not been experienced equally. People with mental health and addiction disorders (MH&A) have been found to be at greater risk of COVID-19 infection and worse COVID-19 outcomes. Similarly, although immigrants and refugees contribute to one-quarter of Ontario's population they make up nearly half of Ontario's COVID-19 cases. There is a paucity of information on the impact of COVID-19 on people who are at the intersection of MH&A and socioeconomic deprivation. Our study aimed to address this gap.

Methods: A population-based retrospective cohort study over a one-year period (January 15, 2020, to Feb 15, 2021) was conducted using multiple linked provincial-administrative databases. The study aimed to determine the differential impact of COVID-19 on immigrants and non-immigrants and refugees with MH&A and the general population without MH&A across sociodemographic and health-related factors like age, sex, neighbourhood income, Ontario marginalization index, comorbidities, and access to primary care. We used multivariable regression to adjust for potential confounders.

Results: Our cohort comprised 10,994,464 Ontario residents aged 18 or older and of which approximately 17% lived with MH&A, with immigrants and refugees with MH&A making up 2.6%. People with preexisting MH&A were generally younger and more likely to live in deprived neighbourhoods compared to the general population. Immigrants and refugees with MH&A were more likely to reside in neighbourhoods with greater material deprivation, residential instability, and ethnic concentration compared to non-immigrants with MH&A. Even though the COVID-19 testing rate was lower among immigrants living with MH&A compared to non-immigrants with MH&A (32.7% vs. 37.6%), the confirmed positivity was significantly higher (12.4% vs. 4.5%). Adjusting for confounders we also found Covid 19 testing, hospital admission, intensive care admission, and mortality rates related to COVID-19 were considerably higher among people with MH&A than in the general population.

Conclusion: Our findings provide evidence of the need to accelerate the development of targeted evidence-based policies that can effectively support and protect people living at the intersection of clinical and social inequities in this and future crises.

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Background

Although immigrants and refugees comprise a quarter of the population of Ontario (Canada's largest province by population size and diversity), they have made up about half of the COVID-19 cases [1-2]. This disparity emanates from their underprivileged social and economic position in Canada. In Ontario, immigrants living in low-income neighbourhoods experienced disproportionate COVID-19 health disparities, including higher rates of death from COVID-19 complications than those living in high-income neighbourhoods [3]. Racialized immigrants, particularly those from Sub-Saharan Africa, the Caribbean, South Asia, Southeast Asia and South America, have been particularly hard hit by COVID-19 [2]. A recent report by Toronto Public Health (TPH) showed the highest rate of COVID-19 was among people who identified as South Asian or Indo-Caribbean (27%), Black (16%), Southeast Asian (13%), Arab, Middle Eastern or West Asian (8%) and that there are more COVID-19 infections and hospitalizations for people living in areas with a high prevalence of recent immigrants, low income, and high unemployment [3-4]. Furthermore, immigrants are disproportionately represented in precarious jobs and sectors with greater exposure to COVID-19 and are more likely to live below the poverty line (5). These findings suggest that immigrants in Ontario are generally at a social and economic disadvantage in the context of COVID-19. The association of social inequities with COVID-19 morbidity and mortality is further compounded in the context of underlying chronic health conditions. People living with mental health and addiction disorders (MH&A) have also been found to experience increased susceptibility to COVID-19 putting them at a clinical disadvantage [6-8]. People living with mental illness may face difficulty in following public health guidelines (e.g., physical distancing, self-isolation, wearing masks) due to increased anxiety and stress. Self-isolation, frequent hand sanitizing, and reduced social interaction can further reinforce and deteriorate their mental condition. People with MH&A have also been found to be at greater risk of COVID-19 infection and worse COVID-19 outcomes [9-14]. COVID-19 control measures such as quarantine and social distancing have not only disrupted access to mental health services and harm reduction services, but have also led to a rise in alcohol, cannabis, and tobacco use (13-14). High rates of smoking in this population [12] may also raise the risk of infection and confer a worse prognosis among those who develop the illness. Furthermore, the reduction of services or closure of community MH&A agencies during the COVID-19 pandemic limit access to required mental health services. Taken together, these factors may lead to elevated infection rates and worse prognoses in these populations. Immigrants who live with MH&A are therefore at the intersection of socioeconomic and clinical disadvantages and may be at especially high risk of contracting COVID-19 and/or dying from it compared to non-immigrants with MH&A and the general population. Despite Canada's diverse population, little is known about the rates of MH&A disorders among Canadian immigrants, compounding disadvantages, and increased COVID-19 risk for this group. Our population-based retrospective cohort study, using provincial-level administrative data, aimed to explore the impact of COVID-19 on Ontario's immigrants living with MH&A. The study objectives were:

1) To describe and compare the rates of testing, prevalence, hospitalization, and mortality of COVID-19 among three subgroups: the Ontario immigrant population living with MH&A disorders versus both non-immigrants living with MH&A disorders and the rest of the general population without MH&A (i.e., immigrants and non-immigrants without MH&A)

2) To assess the impact on the study outcomes of socio-demographic and healthcare-related variables (e.g., age, sex, immigration status, region of origin (defined by country of citizenship), neighbourhood income quintile, neighbourhood marginalization index, geographical areas (rural/urban), multi-level morbidities, access to primary care providers and psychiatrists - in person or virtual) on these three subgroups.

Methods

Study Design and Population

A population-based retrospective cohort study over a one-year period (January 15, 2020, to February 15, 2021- corresponding to COVID-19 wave 1 and wave 2 in Ontario, Canada) was conducted using multiple linked healthcare administrative databases at ICES (previously known as the Institute for Clinical Evaluative Sciences). ICES is an independent, non-profit research institute funded by an annual grant from the Ontario Ministry of Health (MOH) and the Ministry of Long-Term Care (MLTC). As a prescribed entity under Ontario's privacy legislation, ICES is authorized to collect and use health care data for the purposes of health system analysis, evaluation and decision support. Secure access to these data is governed by policies and procedures that are approved by the Information and Privacy Commissioner of Ontario.

Data Sources

The study cohort was created by linking the Registered Persons Database (RPDB), Ontario Mental Health Reporting System (OMHRS) database, The National Ambulatory Care Reporting System (NACRS), the Immigration, Refugees and

Citizenship Canada Permanent Resident database (IRCC) and the universal Ontario Health Insurance Plan [OHIP]. The RPDB database contains the age, sex and postal code of all Ontario residents who are eligible for OHIP. The OMHRS includes individuals receiving inpatient adult mental health services in Ontario. The NACRS contains emergency and outpatient visits using a list of primary diagnoses based on ICD-10 CA codes. The IRCC database comprises demographic characteristics of landed immigrants and refugees in Canada since 1985. The OHIP covers the healthcare expenses of all citizens, permanent residents and certain refugees. The study cohort included all Ontario adult residents aged 18+ who were alive on January 15, 2020, who were OHIP eligible for at least 1 year prior to this date, and who had contact with the Ontario health system at least once within the last 10 years prior to January 15, 2020, or in the follow-up period up to Feb 15, 2021. 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 particular billing and diagnosis codes in available databases. We considered someone as having MH&A if they had been diagnosed at least one year before the study end date and had at least one mental health visit (office visit, ER visit, hospitalization) within the past year. Figure 1 shows the creation of the final study cohort which included 10,994,464 people who met our inclusion and exclusion criteria.

Other linked Data Sources

Sociodemographic characteristics for all people aged 18 and over, residing in Ontario and covered by OHIP were obtained from *RPDB* and *2016 Census Statistics Canada data*. Individual's Socioeconomic status (e.g. area-level income and other related indicators of marginalization [15-16] like material deprivation (i.e. income, education, lone-parent families, housing quality), residential instability (i.e. family structure, ownership and occupancy), ethnic

concentration (recent immigrants and visible minorities) and dependency (population workforce eligibility, proportion of population aged 65+ and less than 15) as identified by Ontario Marginalization Index) were determined using ecological linkages based on individuals' postal codes from the Postal Code Conversion File to Canadian 2016 Census. The Rurality Index of Ontario (RIO) score was determined similarly. The *COVID-19 Integrated Testing Data (C19INTGR) which* combines COVID-19 diagnostic laboratory tests and results from the *Ontario Laboratory Information System (OLIS) database, Distributed Labs and Public Health Case & Contact Management (CCM)*, was used to identify COVID-19 test results. *The Canadian Institute of Health Information (CIHI) Discharge Abstract Database (DAD)* was used to ascertain, COVID-19 death, hospital utilization and multi-morbidities. DAD consists of data on all hospital discharges in Ontario with up to 25 diagnostic fields using the ICD-10-CA codes and 20 fields for Canadian Classification of Health Interventions (CCI) procedure codes. The primary care physician type model was identified using the *Client Agency Program Enrolment Database (CAPE) and Corporate Physicians Databases* which capture all Ontarians who are enrolled with a physician in a patient enrolment model (PEM). Type of PEM is based on primary care providers' compensation and provision of incentives and bonuses which include: 1) Family Health Group [FHG] / Comprehensive Care Model [CCM]- Primarily an enhanced fee-for-service blended model,2) Family Health Team [FHT] –primarily blended salary model, 3) Non-FHT (i.e. Family Health Organization (FHO)- Primarily Blended capitation based on complement-based remuneration- or Family Health Network (FHN)- primarily blended capitation based on age and sex of patients, 4) Other PEM (e.g., Community Health Group, Group Health Center, Rural Northern Physician Group (RNPGA)), 5) Traditional fee- for- service (TFFS) (physicians who do not belong to any of the above-mentioned models), and 6) No Care [17-18].

These datasets were linked using *unique encoded identifiers* and analyzed at ICES.

Study outcomes and variables

The primary outcome, COVID-19 diagnosis, was determined based on a positive lab result in OLIS at any point between January 15, 2020 (the date of the first COVID-19 test captured in Ontario in OLIS data) and the latest date in available ICES data (February 15, 2021). Secondary outcomes included hospitalizations, ICU admissions, and mortality due to COVID-19. Hospitalizations and ICU admissions were attributed to COVID if they were within 14 days prior to and up to 60 days after a positive COVID-19 test. Similarly, we defined mortality due to COVID-19 as death within 60 days of diagnosis of COVID-19. We also examined important
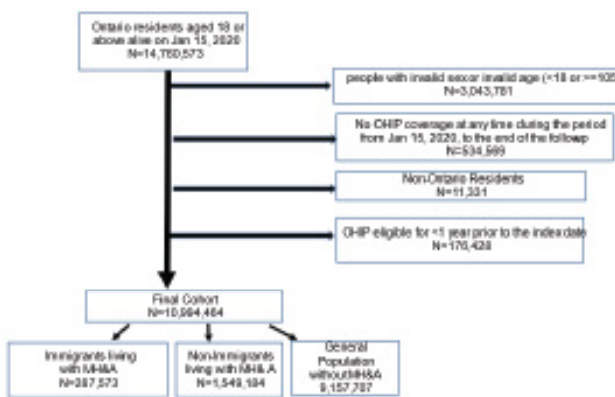

Figure 1: Creation of study Cohort including immigrant and non-immigrant populations with and without Mental Health and addiction disorders in Ontario, Canada.

Table 1: Socio-demographic and health utilization characteristics.

Categories	Group 1 Immigrants and refugees living with MH&A N=287,573	Group 2 Non-immigrants living with MH&A N=1,549,184	Group 3 General Population (Immigrants and Non-immigrants without history of MH&A) N=9,157,707	Standardized Difference[a] Gr1 vs. Gr2	Gr1 vs. Gr3	Gr2 vs. Gr3
Age						
Mean (SD)	46.20 (15.12)	47.52 (18.60)	49.59 (18.59)	0.077	0.2	0.112
Median (Q1-Q3)	46 (35-56)	47 (32-61)	50 (34-64)	0.05	0.191	0.114
18 to 39 - n (%)	104,658 (36.4%)	595,202 (38.4%)	3,119,068 (34.1%)	0.042	0.049	0.091
40 to 69 - n (%)	163,087 (56.7%)	740,024 (47.8%)	4,556,217 (49.8%)	0.18	0.14	0.04
70+ - n (%)	19,828 (6.9%)	213,958 (13.8%)	1,482,422 (16.2%)	0.228	0.294	0.067
Sex						
Female - n (%)	170,300 (59.2%)	917,333 (59.2%)	4,588,069 (50.1%)	0	0.184	0.184
Male - n (%)	117,273 (40.8%)	631,851 (40.8%)	4,569,638 (49.9%)	0	0.184	0.184
Income quintile						
0 Missing information - n (%)	818 (0.3%)	5,773 (0.4%)	23,544 (0.3%)	0.015	0.005	0.021
1 (lowest) - n (%)	74,632 (26.0%)	330,034 (21.3%)	1,703,131 (18.6%)	0.11	0.177	0.068
2 - n (%)	60,030 (20.9%)	310,087 (20.0%)	1,798,117 (19.6%)	0.021	0.031	0.01
3 - n (%)	58,373 (20.3%)	297,901 (19.2%)	1,864,741 (20.4%)	0.027	0.002	0.028
4 - n (%)	53,139 (18.5%)	295,328 (19.1%)	1,879,944 (20.5%)	0.015	0.052	0.037
5 (highest) - n (%)	40,581 (14.1%)	310,061 (20.0%)	1,888,230 (20.6%)	0.157	0.172	0.015
Residential instability quintile						
0 Missing information - n (%)	1,017 (0.4%)	18,682 (1.2%)	78,848 (0.9%)	0.097	0.065	0.034
1 (least residentially unstable) - n (%)	73,458 (25.5%)	263,208 (17.0%)	1,998,932 (21.8%)	0.21	0.087	0.123
2 - n (%)	43,202 (15.0%)	272,257 (17.6%)	1,764,752 (19.3%)	0.069	0.113	0.044
3 - n (%)	39,760 (13.8%)	282,731 (18.3%)	1,693,733 (18.5%)	0.121	0.127	0.006
4 - n (%)	43,302 (15.1%)	307,422 (19.8%)	1,625,657 (17.8%)	0.126	0.073	0.054
5 (most residentially unstable) - n (%)	86,834 (30.2%)	404,884 (26.1%)	1,995,785 (21.8%)	0.09	0.192	0.102
Dependency quintile						
0 Missing information - n (%)	1,017 (0.4%)	18,682 (1.2%)	78,848 (0.9%)	0.097	0.065	0.034
1 (least reliance on the workforce) - n (%)	110,700 (38.5%)	353,911 (22.8%)	2,391,544 (26.1%)	0.344	0.267	0.076
2 - n (%)	64,748 (22.5%)	303,590 (19.6%)	1,816,046 (19.8%)	0.072	0.066	0.006
3 - n (%)	43,815 (15.2%)	277,835 (17.9%)	1,595,154 (17.4%)	0.073	0.059	0.014
4 - n (%)	36,486 (12.7%)	272,527 (17.6%)	1,557,388 (17.0%)	0.137	0.122	0.015
5 (highest (reliance on the workforce) - n (%)	30,807 (10.7%)	322,639 (20.8%)	1,718,727 (18.8%)	0.28	0.229	0.052
Material deprivation quintile						
0 Missing information - n (%)	1,017 (0.4%)	18,682 (1.2%)	78,848 (0.9%)	0.097	0.065	0.034
1 (least deprived) - n (%)	58,235 (20.3%)	343,111 (22.1%)	2,111,652 (23.1%)	0.046	0.068	0.022
2 - n (%)	54,871 (19.1%)	308,270 (19.9%)	1,941,923 (21.2%)	0.021	0.053	0.032

3 - n (%)	52,498 (18.3%)	283,578 (18.3%)	1,756,653 (19.2%)	0.001	0.024	0.022
4 - n (%)	54,560 (19.0%)	281,891 (18.2%)	1,659,758 (18.1%)	0.02	0.022	0.002
5 (most deprived) - n (%)	66,392 (23.1%)	313,652 (20.2%)	1,608,873 (17.6%)	0.069	0.137	0.068
Ethnic diversity quintile						
0 Missing information - n (%)	1,017 (0.4%)	18,682 (1.2%)	78,848 (0.9%)	0.097	0.065	0.034
1 (least diverse) - n (%)	8,029 (2.8%)	279,012 (18.0%)	1,506,577 (16.5%)	0.515	0.476	0.041
2 - n (%)	15,749 (5.5%)	303,396 (19.6%)	1,541,403 (16.8%)	0.436	0.367	0.071
3 - n (%)	31,552 (11.0%)	325,830 (21.0%)	1,619,966 (17.7%)	0.277	0.193	0.085
4 - n (%)	68,386 (23.8%)	337,622 (21.8%)	1,885,002 (20.6%)	0.047	0.077	0.03
5 (most diverse) - n (%)	162,840 (56.6%)	284,642 (18.4%)	2,525,911 (27.6%)	0.86	0.615	0.22
Rurality index (2008)						
0 to 9 (Urban) - n (%)	270,008 (93.9%)	1,071,042 (69.1%)	6,539,554 (71.4%)	0.673	0.622	0.05
10 to 39 (Suburban) - n (%)	14,380 (5.0%)	340,388 (22.0%)	1,822,463 (19.9%)	0.513	0.463	0.051
≥40 (Rural) - n (%)	2,250 (0.8%)	116,668 (7.5%)	695,261 (7.6%)	0.343	0.345	0.002
Missing information – n (%)	935 (0.3%)	21,086 (1.4%)	100,429 (1.1%)	0.113	0.092	0.024
# of Comorbidities						
0-1 - n (%)	91,539 (31.8%)	313,043 (20.2%)	4,262,359 (46.5%)	0.267	0.305	0.582
2 - n (%)	69,168 (24.1%)	373,734 (24.1%)	1,746,167 (19.1%)	0.002	0.121	0.123
3+ - n (%)	126,866 (44.1%)	862,407 (55.7%)	3,149,181 (34.4%)	0.233	0.2	0.438
Primary care patient enrolment model						
FHG/CCM - n (%) (Family Health Group, Comprehensive Care Model)	166,017 (57.7%)	474,160 (30.6%)	2,785,080 (30.4%)	0.568	0.572	0.004
FHT - n (%) (Family Health Team)	30,472 (10.6%)	445,884 (28.8%)	2,473,831 (27.0%)	0.47	0.43	0.039
non-FHT (i.e.FHO/FHN) - n (%)	68,658 (23.9%)	495,758 (32.0%)	2,794,195 (30.5%)	0.081	0.073	0.009
Other PEM - n (%) (Other Primary care Enrolment Model)	728 (0.3%)	13,233 (0.9%)	70,767 (0.8%)	0.182	0.15	0.032
TFFS - n (%) (Fee for service)	19,485 (6.8%)	94,064 (6.1%)	416,715 (4.6%)	0.029	0.096	0.068
No care - n (%)	2,213 (0.8%)	26,085 (1.7%)	617,119 (6.7%)	0.083	0.318	0.254
Admission category						
Not in IRCC - n (%)	0 (0.0%)		7,171,088 (78.3%)		2.687	
Immigrants - n (%)	223,603 (77.8%)		1,629,195 (17.8%)		1.501	
Refugees - n (%)	58,767 (20.4%)		323,702 (3.5%)		0.539	
Other immigrants - n (%)	5,203 (1.8%)		33,722 (0.4%)		0.139	
World region (country of citizenship)						
Missing - (newcomers to Ontario [not in IRCC]) - n (%)	0 (0.0%)		7,171,088 (78.3%)		2.687	
East Asia & Pacific - n (%)	41,148 (14.3%)		471,638 (5.2%)		0.313	
Europe & Central Asia - n (%)	43,854 (15.2%)		237,706 (2.6%)		0.455	
Latin America & the Caribbean - n (%)	50,589 (17.6%)		300,973 (3.3%)		0.481	

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Middle East & North Africa – n (%)	40,612 (14.1%)	184,244 (2.0%)	0.456	
North America - n (%)	8,104 (2.8%)	37,738 (0.4%)	0.192	
South Asia - n (%)	69,990 (24.3%)	530,300 (5.8%)	0.537	
Sub-Saharan Africa - n (%)	17,173 (6.0%)	113,629 (1.2%)	0.256	
Western Europe - n (%)	16,066 (5.6%)	110,164 (1.2%)	0.244	
Other - n (%)	37 (0.0%)	227 (0.0%)	0.012	
Landing years				
Mean (SD)	17.93 (9.13)	16.43 (9.27)	0.163	
Median (Q1-Q3)	18 (11-26)	16 (9-24)	0.163	
not in IRCC - n (%)	0 (0.0%)	7,171,088 (78.3%)	2.687	
Recent (≤4 years) - n (%)	31,382 (10.9%)	292,881 (3.2%)	0.305	
Intermediate (5 to ≤9 years) - n (%)	35,462 (12.3%)	289,388 (3.2%)	0.348	
Long-term residents (10+ years) - n (%)	220,729 (76.8%)	1,404,350 (15.3%)	1.565	
a Standardized difference >0.1 was used to indicate a statistically significant imbalance in the distribution of the characteristics				

characteristics related to healthcare service use. These included sociodemographic and clinical characteristics: age, sex, immigration category, landing years in Canada (≤ 4 years, 5-9 years and 10+), region of origin based on country of citizenship (East Asia & the Pacific, Europe & Central Asia, Latin America & the Caribbean, Middle East & North Africa, North America, South Asia, Sub-Saharan Africa, and Western Europe), neighbourhood income quintile (1 - lowest income to 5 – highest income), Ontario Marginalization Index- each dimension is organized into quintiles (1- least deprived to quintile 5- the most deprived), Rurality categories of urban, suburban and rural-based on the Rurality Index of Ontario (RIO) score ((0 to 9 (urban), 10 to 39 (suburban), 40 or greater (rural)), number of ED visits, primary care providers and psychiatrists visits within 14 days prior to and up to 60 days after the positive COVID case, type of primary care patient enrollment model (PEM) if any, and level of multimorbidity.

Ethical Review

ICES (formerly known as Institute for Clinical Evaluative Sciences), an independent, not-for-profit corporation, 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

Analysis

Descriptive statistics, specifically means and standard deviation (SD) for continuous variables and proportions for categorical variables, were used to report characteristics of the study population across 3 subgroups (i.e., G1: Immigrants and refugees with a history of MH&A), G2: Non-immigrants with a history of MH&A), G3: General population including both immigrants and non-immigrants without MH&A). For each study variable, 95% Confidence interval or standard differences (Std diff) between subgroups were obtained. A standard difference of >0.1 was considered as a statistically significant imbalance in the distribution of the characteristics across subgroups. We used logistic regression to assess the adjusted odds ratios (AORs) of COVID-19 outcomes with 95% CI for immigrants and non-immigrants with MH&A compared to the general population without MH&A, after accounting for covariates. The binary outcomes included 1) COVID tests performed (yes/no), 2) COVID positive tests (yes/no), 3) COVID hospitalization among those with the positive test (yes/no), 4) ICU admission among those with the positive test (yes/no), 5) COVID death among those with the positive test (yes/no)) across study subgroups. Based on findings from descriptive analyses, our regression model included covariates with Std diff >0.1 (i.e. age, sex, income quintile (this was included in place of ONT Marginalization Index as they were highly correlated), primary care model, Rurality index, and the number of co-morbidities). Significance was set at $p < 0.05$.

Results

The study cohort comprised 10,994,464 Ontario people aged 18 or more and of which approximately 17% (1,836,757) lived with MH&A, with immigrants and refugees with MH&A

making up 2.6% of the total cohort. Baseline characteristics of cohort subgroups (i.e., Immigrants and refugees living with MH&A (G1), Non-immigrants living with MH&A(G2), and General population (i.e., Both immigrant and non-immigrants without MH&A (G3)) are presented in Table1. The average age was significantly lower among immigrants and non-immigrants living with MH&A than in the general population (i.e. both immigrants and non-immigrants without MH&A) (G1=46.2 vs. G2=47.5 vs. G3= 49.6 years old). Close to 60% of those living with MH&A were women (i.e., G1 =59.2% vs. G2=59.2 % vs. G3= 50.1%). Ninety-four percent of G1 lived in urban areas as opposed to 69% of G2 and 71% of G3. About 23% of immigrants and refugees with MH&A were in Canada for less than 10 years. The top source regions for G1 included South Asia (24.3%), Latin America & the Caribbean (17.6%), Europe & Central Asia (15.2%), East Asia & the Pacific (14.3%), and the Middle East & North Africa (14.1%). A significantly higher proportion of immigrants and refugees living with MH&A resided in the lowest-income neighbourhoods compared to non-immigrants living with MH&A (i.e. 26.0% vs. 21.6, std=0.11); and the general population-i.e., immigrants and non-immogrants without MH&A- (i.e.,26.0% vs. 18.6%, std =0.18). Furthermore, they were more likely to reside in neighbourhoods with greater material deprivation, residential instability, and ethnic concentration compared to non-immigrants with MH&A (G2), and the general population (G3).

About 1% of immigrants and refugees living with MH&A did not have a family doctor compared to approximately 2% of non-immigrants with MH&A and 7% of the general population-i.e., immigrants and non-immigrants without MH&A. The most common primary care models that immigrants and refugees were enrolled in were enhanced fee for service (i.e. FHG/CCM) (G1= 57.7%, G2=30.6%, G3= 30.4%). Although immigrants and non-immigrants living with MH&A were more likely to be tested for COVID-19 than those without MH&A (see Table 2a), the rate of testing was significantly higher among non-immigrants living with MH&A than immigrants and refugees living with MH&A (i.e., 37.6%, [95% CI: 37.56%-37.71%] vs. 32.7%, [95% CI:32.51%-32.85%]). Despite this lower rate of testing, immigrants and refugees with MH&A were more likely to have a positive test (12.4% among those tested) compared to either non-immigrants with MH&A or the general population (i.e. immigrants and non-immigrants without MH&A) (4.5 % and 7.1% respectively). Of 93,982 immigrants and refugees living with MH&A who were tested for COVID-19, 78% were immigrants, 20% were refugees, and 79% lived in Canada for 10 years or more. (See Table 2b). Those living with MH&A who lived in neighbourhoods with lower income and higher degrees of ethnic diversity, residential instability, or material deprivation were tested significantly more than those

without MH&A. Of 11,679 immigrants and refugees living with MH&A with confirmed positive test results, 60% were women and more than half (i.e. 56.8%) were in the 40-69 age group. A similar pattern emerged for non-immigrants living with MH&A and the general population (i.e. immigrants and non-immigrants without MH&A) (See Table 2C). Furthermore, the confirmed positivity was higher among those who resided in the neighbourhoods with the lowest income (G1=31.9%, G2=23.5%, G3=24.6%), and higher degrees of ethnic diversity (G1=66.9%, G2=32.2%, G3=49.1%), and material deprivation (G1=30.3%, G2=22.2%, G3=24.2%). The confirmed positivity was higher for both immigrants and non-immigrants with MH&A than the general population who resided in the neighbourhood with the highest degree of residential instability (i.e. G=29.4%, G2=29%, G3=24%). The highest proportion of confirmed positivity was among immigrants and refugees from South Asia (33.1) followed by Latin America & the Caribbean (20.7%) and the Middle East and North- Africa (14%). The highest proportion of confirmed positivity was among immigrants and refugees with 2-3 comorbidities (39.7%). Among non-immigrants with MH&A and the general population, the highest proportion of confirmed positivity was for those with 4 or more comorbidities and 0-1 comorbidities respectively. (See Table 2c).

Of confirmed COVID-19 cases, 13% of non-immigrants with MH&A were hospitalized compared to 8.5% of immigrants and refugees with MH&A and 8.3% of the general population (Table 3). However, the proportion of COVID-19-related ED visits was higher among Immigrants and refugees with MH&A (30.2%) compared to the other two groups (27.6% and 21.7% respectively). COVID-19 death within 60 days of a positive test was higher among non-immigrants with MH&A compared to immigrants and refugees with MH&A or the general population without MH&A (i.e., 6.1% vs. 1.9% vs. 3.5%) (See table 3).

The average number of visits to primary care physicians and psychiatrists within 14 days prior to and up to 60 days after the positive COVID test was more among non-immigrants with MH&A (i.e., 5.11 and 1.11 respectively) compared to immigrants and refugees with MH&A (i.e., 4.42 and 0.75) and the general population (i.e., 2.73 and 0.04). Interestingly the average number of virtual visits was higher among immigrants and refugees with MH&A (i.e., 6.15) as opposed to non-immigrants with MH&A and the general population (4.69 and 3.13 respectively).

Table 4 shows adjusted odds ratios (AORs) of COVID-19 outcomes for immigrants and non-immigrants with MH&A compared to the general population (i.e., immigrants and non-immigrants without MH&A). The results show that COVID-19 testing was 32% higher among non-immigrants

Table 2a: Percent tested for COVID-19 and percent positivity among those tested by sub-group

	Immigrants and refugees with	Non-immigrants with a history of MH&A	General Population (Immigrants and Non-Immigrants without a history of MH&A)
	a history of MH&A	N=1,549,184	N=9,157,707
	N=287,573		
	n (%)	n (%)	n (%)
Tested	93,982 (32.7%)	583,011 (37.6%)	2,632,641 (28.7%)
Confirmed positive (among tested)	11,678 (12.4%)	26,320 (4.5%)	187,344 (7.1%)

Table 2b: Percent tested for COVID-19 by cohort subgroup stratified by sociodemographic and healthcare-related variables

	Immigrants and refugees with		Non-Immigrants with a history of MH&A		General population (Immigrants and Non-Immigrants without MH&A)	
	a history of MH&A		N= 1,549,184		N= 9,157,707	
	N= 287,573					
Categories	Tested n (%)	95% CI	Tested n (%)	95% CI	Tested n (%)	95% CI
	n= 93,982		n= 583,011		N=2,632,641	
Age						
18 to 39 - n (%)	38,378 (40.8%)	(40.50%, 41.10%)	241,673 (41.5%)	(41.30%, 41.60%)	1,021,409 (38.8%)	(38.70%, 38.90%)
40 to 69 - n (%)	50,398 (53.6%)	(53.30%, 53.90%)	260,834 (44.7%)	(44.60%, 44.90%)	1,214,511 (46.1%)	(46.10%, 46.20%)
70+ - n (%)	5,206 (5.5%)	(5.40%, 5.70%)	80,504 (13.8%)	(13.70%, 13.90%)	396,721 (15.1%)	(15.00%, 15.10%)
Sex						
Female - n (%)	57,350 (61.0%)	(60.70%, 61.30%)	369,954 (63.5%)	(63.30%, 63.60%)	1,416,820 (53.8%)	(53.80%, 53.90%)
Male - n (%)	36,632 (39.0%)	(38.70%, 39.30%)	213,057 (36.5%)	(36.40%, 36.70%)	1,215,821 (46.2%)	(46.10%, 46.20%)
Admission category						
1. Other immigrants - n (%)	1,801 (1.9%)	(1.80%, 2.00%)				
2. Refugees - n (%)	19,083 (20.3%)	(20.00%, 20.60%)				
3. Immigrants - n (%)	73,098 (77.8%)	(77.50%, 78.00%)				
Length of stay						
>10 years - n (%)	73,846 (78.6%)	(78.30%, 78.80%)				
≤9 years - n (%)	20,136 -21.40%	(21.20%, 21.70%)				
World region (country of citizenship)						

Citation: Mandana Vahabi, Maria Koh, Josephine Pui-Hing Wong, Luis Palma, Alexander Kopp, Aisha K. Lofters. The Impact of COVID-19 on Immigrants and Refugees Living with Mental Health and Addiction Disorders: A Population-Based Cohort Study in Ontario, Canada. Archives of Clinical and Biomedical Research. 8 (2024): 135-152.

East Asia & Pacific - n (%)	11,802 (12.6%)	(12.30%, 12.80%)				
Europe & Central Asia - n (%)	12,805 (13.6%)	(13.40%, 13.80%)				
Latin America & the Caribbean - n (%)	18,166 (19.3%)	(19.10%, 19.60%)				
Middle East & North Africa - n (%)	13,747 (14.6%)	(14.40%, 14.90%)				
North America - n (%)	3,161 (3.4%)	(3.20%, 3.50%)				
South Asia - n (%)	22,491 (23.9%)	(23.70%, 24.20%)				
Sub-Saharan Africa - n (%)	6,665 (7.1%)	(6.90%, 7.30%)				
Western Europe - n (%)	5,138 (5.5%)	(5.30%, 5.60%)				
Other - n (%)	7 (0.0%)	(0.00%, 0.00%)				
Income quintile						
1 (lowest) - n (%)	24,792 (26.4%)	(26.10%, 26.70%)	123,131 (21.1%)	(21.00%, 21.20%)	495,876 (18.8%)	(18.80%, 18.90%)
2 - n (%)	19,553 (20.8%)	(20.50%, 21.10%)	115,472 (19.8%)	(19.70%, 19.90%)	511,791 (19.4%)	(19.40%, 19.50%)
3 - n (%)	19,015 (20.2%)	(20.00%, 20.50%)	111,855 (19.2%)	(19.10%, 19.30%)	531,092 (20.2%)	(20.10%, 20.20%)
4 - n (%)	17,235 (18.3%)	(18.10%, 18.60%)	111,162 (19.1%)	(19.00%, 19.20%)	534,969 (20.3%)	(20.30%, 20.40%)
5 (highest) - n (%)	13,098 (13.9%)	(13.70%, 14.20%)	118,850 (20.4%)	(20.30%, 20.50%)	551,437 (20.9%)	(20.90%, 21.00%)
Residential instability quintile						
1 (lowest) - n (%)	23,033 (24.5%)	(24.20%, 24.80%)	96,333 (16.5%)	(16.40%, 16.60%)	555,808 (21.1%)	(21.10%, 21.20%)
2 - n (%)	13,936 (14.8%)	(14.60%, 15.10%)	99,901 (17.1%)	(17.00%, 17.20%)	492,085 (18.7%)	(18.60%, 18.70%)
3 - n (%)	12,855 (13.7%)	(13.50%, 13.90%)	104,158 (17.9%)	(17.80%, 18.00%)	477,334 (18.1%)	(18.10%, 18.20%)
4 - n (%)	14,460 (15.4%)	(15.20%, 15.60%)	116,130 (19.9%)	(19.80%, 20.00%)	477,031 (18.1%)	(18.10%, 18.20%)
5 (highest) - n (%)	29,330 (31.2%)	(30.90%, 31.50%)	158,068 (27.1%)	(27.00%, 27.20%)	602,809 (22.9%)	(22.80%, 22.90%)
Dependency quintile						
1 (lowest) - n (%)	36,855 (39.2%)	(38.90%, 39.50%)	135,885 (23.3%)	(23.20%, 23.40%)	700,052 (26.6%)	(26.50%, 26.60%)
2 - n (%)	20,996 (22.3%)	(22.10%, 22.60%)	113,967 (19.5%)	(19.40%, 19.60%)	520,913 (19.8%)	(19.70%, 19.80%)

3 - n (%)	14,197 (15.1%)	(14.90%, 15.30%)	102,557 (17.6%)	(17.50%, 17.70%)	450,701 (17.1%)	(17.10%, 17.20%)
4 - n (%)	11,562 (12.3%)	(12.10%, 12.50%)	99,504 (17.1%)	(17.00%, 17.20%)	434,730 (16.5%)	(16.50%, 16.60%)
5 (highest) - n (%)	10,004 (10.6%)	(10.40%, 10.80%)	122,677 (21.0%)	(20.90%, 21.10%)	498,671 (18.9%)	(18.90%, 19.00%)
Material deprivation quintile						
1 (lowest) - n (%)	19,244 (20.5%)	(20.20%, 20.70%)	133,215 (22.8%)	(22.70%, 23.00%)	617,406 (23.5%)	(23.40%, 23.50%)
2 - n (%)	17,521 (18.6%)	(18.40%, 18.90%)	116,545 (20.0%)	(19.90%, 20.10%)	553,365 (21.0%)	(21.00%, 21.10%)
3 - n (%)	16,954 (18.0%)	(17.80%, 18.30%)	106,838 (18.3%)	(18.20%, 18.40%)	500,475 (19.0%)	(19.00%, 19.10%)
4 - n (%)	17,805 (18.9%)	(18.70%, 19.20%)	104,003 (17.8%)	(17.70%, 17.90%)	471,933 (17.9%)	(17.90%, 18.00%)
5 (highest) - n (%)	22,090 (23.5%)	(23.20%, 23.80%)	113,989 (19.6%)	(19.40%, 19.70%)	461,888 (17.5%)	(17.50%, 17.60%)
Ethnic diversity quintile						
1 (lowest) - n (%)	2,665 (2.8%)	(2.70%, 2.90%)	101,629 (17.4%)	(17.30%, 17.50%)	413,107 (15.7%)	(15.60%, 15.70%)
2 - n (%)	5,151 (5.5%)	(5.30%, 5.60%)	113,962 (19.5%)	(19.40%, 19.60%)	445,049 (16.9%)	(16.90%, 17.00%)
3 - n (%)	10,578 (11.3%)	(11.10%, 11.50%)	125,253 (21.5%)	(21.40%, 21.60%)	482,147 (18.3%)	(18.30%, 18.40%)
4 - n (%)	22,785 (24.2%)	(24.00%, 24.50%)	129,854 (22.3%)	(22.20%, 22.40%)	557,794 (21.2%)	(21.10%, 21.20%)
5 (highest) - n (%)	52,435 (55.8%)	(55.50%, 56.10%)	103,892 (17.8%)	(17.70%, 17.90%)	706,970 (26.9%)	(26.80%, 26.90%)
Comorbidities						
0-1 - n (%)	29,780 (31.7%)	(31.40%, 32.00%)	112,255 (19.3%)	(19.20%, 19.40%)	1,176,957 (44.7%)	(44.60%, 44.80%)
2-3 - n (%)	39,452 (42.0%)	(41.70%, 42.30%)	257,633 (44.2%)	(44.10%, 44.30%)	853,317 (32.4%)	(32.40%, 32.50%)
4+ - n (%)	24,750 (26.3%)	(26.10%, 26.60%)	213,123 (36.6%)	(36.40%, 36.70%)	602,367 (22.9%)	(22.80%, 22.90%)

living with MH&A (AOR 1.32 [95% CI: 1.32-1.33) and12% higher among immigrants and refugees with MH&A (AOR 1.12 [95% CI: 1.11-1.12]) compared to the general population after adjusting for relevant variables. However, confirmed positivity among people tested was 41% higher in immigrants and refugees with MH&A (AOR 1.41 [95% CI: 1.38-1.44] and 36% lower among non-immigrants with MH&A (AOR 0.64 [95% CI 0.64-0.65] compared to the general population.

Moreover, hospitalization was 29% higher (AOR 1.29[95% CI: 1.24-1.35], ICU admission was 8% higher and deaths after 60 days of positive test results were 22% higher for non-immigrants with MH&A (AOR 1.16[95% CI (1.09, 1.24) compared to the general population. Although Immigrants and refugees living with MH&A were 8% more likely to be hospitalized compared to the general population they were 31% less likely to die within 60 days of a positive test result.

Table 2c: Percent tested positive for COVID-19 by immigration groups and various subgroups

Categories	Immigrants and refugees with a history of MH&A		Non-Immigrants with a history of MH&A		General population (Immigrants and Non-Immigrants without a history of MH&A)	
	Positive n (%) n=11,678	95% CI	Positive n (%) n=26,320	95% CI	Positive n (%) N=187,344	95% CI
Age						
18 to 39 - n (%)	4,259 (36.5%)	(35.60%, 37.30%)	10,013 (38.0%)	(37.50%, 38.60%)	74,969 (40.0%)	(39.80%, 40.20%)
40 to 69 - n (%)	6,633 (56.8%)	(55.90%, 57.70%)	10,564 (40.1%)	(39.50%, 40.70%)	86,105 (46.0%)	(45.70%, 46.20%)
70+ - n (%)	786 (6.7%)	(6.30%, 7.20%)	5,743 (21.8%)	(21.30%, 22.30%)	26,270 (14.0%)	(13.90%, 14.20%)
Sex						
Female - n (%)	6,960 (59.6%)	(58.70%, 60.50%)	15,697 (59.6%)	(59.00%, 60.20%)	96,221 (51.4%)	(51.10%, 51.60%)
Male - n (%)	4,718 (40.4%)	(39.50%, 41.30%)	10,623 (40.4%)	(39.80%, 41.00%)	91,123 (48.6%)	(48.40%, 48.90%)
Admission category						
1. Other immigrants - n (%)	259 (2.2%)	(2.00%, 2.50%)				
2. Refugees - n (%)	3,140 (26.9%)	(26.10%, 27.70%)				
3. Immigrants - n (%)	8,279 (70.9%)	(70.10%, 71.70%)				
Length of stay						
>10 years - n (%)	9,032 (77.3%)	(76.60%, 78.10%)				
≤9 years - n (%)	2,646 (22.7%)	(21.90%, 23.40%)				
World region (country of citizenship)						
East Asia & Pacific - n (%)	1,296 (11.1%)	(10.50%, 11.70%)				
Europe & Central Asia - n (%)	1,184 (10.1%)	(9.60%, 10.70%)				
Latin America & the Caribbean - n (%)	2,413 (20.7%)	(19.90%, 21.40%)				
Middle East & North Africa - n (%)	1,632 (14.0%)	(13.30%, 14.60%)				
North America - n (%)	145 (1.2%)	(1.00%, 1.40%)				
South Asia - n (%)	3,867 (33.1%)	(32.30%, 34.00%)				
Sub-Saharan Africa - n (%)	910 (7.8%)	(7.30%, 8.30%)				
Western Europe - n (%)	231 (2.0%)	(1.70%, 2.20%)				
Other - n (%)	0 (0.0%)	NA				
Income quintile						

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1 (lowest) - n (%)	3,725 (31.9%)	(31.10%, 32.70%)	6,176 (23.5%)	(23.00%, 24.00%)	46,089 (24.6%)	(24.40%, 24.80%)
2 - n (%)	2,624 (22.5%)	(21.70%, 23.20%)	5,599 (21.3%)	(20.80%, 21.80%)	41,457 (22.1%)	(21.90%, 22.30%)
3 - n (%)	2,477 (21.2%)	(20.50%, 22.00%)	5,258 (20.0%)	(19.50%, 20.50%)	39,951 (21.3%)	(21.10%, 21.50%)
4 - n (%)	1,786 (15.3%)	(14.60%, 15.90%)	4,672 (17.8%)	(17.30%, 18.20%)	32,815 (17.5%)	(17.30%, 17.70%)
5 (highest) - n (%)	1,039 (8.9%)	(8.40%, 9.40%)	4,448 (16.9%)	(16.40%, 17.40%)	26,521 (14.2%)	(14.00%, 14.30%)
Residential instability quintile					
1 (lowest) - n (%)	3,189 (27.3%)	(26.50%, 28.10%)	5,267 (20.0%)	(19.50%, 20.50%)	50,338 (26.9%)	(26.70%, 27.10%)
2 - n (%)	1,667 (14.3%)	(13.60%, 14.90%)	4,085 (15.5%)	(15.10%, 16.00%)	30,650 (16.4%)	(16.20%, 16.50%)
3 - n (%)	1,493 (12.8%)	(12.20%, 13.40%)	4,178 (15.9%)	(15.40%, 16.30%)	28,924 (15.4%)	(15.30%, 15.60%)
4 - n (%)	1,867 (16.0%)	(15.30%, 16.70%)	4,793 (18.2%)	(17.70%, 18.70%)	31,176 (16.6%)	(16.50%, 16.80%)
5 (highest) - n (%)	3,430 (29.4%)	(28.50%, 30.20%)	7,634 (29.0%)	(28.50%, 29.60%)	45,038 (24.0%)	(23.80%, 24.20%)
Dependency quintile					
1 (lowest) - n (%)	4,651 (39.8%)	(38.90%, 40.70%)	6,658 (25.3%)	(24.80%, 25.80%)	61,855 (33.0%)	(32.80%, 33.20%)
2 - n (%)	2,753 (23.6%)	(22.80%, 24.30%)	5,332 (20.3%)	(19.80%, 20.70%)	40,797 (21.8%)	(21.60%, 22.00%)
3 - n (%)	1,742 (14.9%)	(14.30%, 15.60%)	4,536 (17.2%)	(16.80%, 17.70%)	30,605 (16.3%)	(16.20%, 16.50%)
4 - n (%)	1,364 (11.7%)	(11.10%, 12.30%)	4,143 (15.7%)	(15.30%, 16.20%)	26,367 (14.1%)	(13.90%, 14.20%)
5 (highest) - n (%)	1,136 (9.7%)	(9.20%, 10.30%)	5,288 (20.1%)	(19.60%, 20.60%)	26,502 (14.1%)	(14.00%, 14.30%)
Material deprivation quintile					
1 (lowest) - n (%)	1,601 (13.7%)	(13.10%, 14.30%)	5,239 (19.9%)	(19.40%, 20.40%)	31,287 (16.7%)	(16.50%, 16.90%)
2 - n (%)	1,720 (14.7%)	(14.10%, 15.40%)	4,884 (18.6%)	(18.10%, 19.00%)	33,419 (17.8%)	(17.70%, 18.00%)
3 - n (%)	2,225 (19.1%)	(18.30%, 19.80%)	5,001 (19.0%)	(18.50%, 19.50%)	36,974 (19.7%)	(19.60%, 19.90%)
4 - n (%)	2,565 (22.0%)	(21.20%, 22.70%)	4,869 (18.5%)	(18.00%, 19.00%)	39,034 (20.8%)	(20.70%, 21.00%)
5 (highest) - n (%)	3,535 (30.3%)	(29.40%, 31.10%)	5,964 (22.7%)	(22.20%, 23.20%)	45,412 (24.2%)	(24.00%, 24.40%)
Ethnic diversity quintile					
1 (lowest) - n (%)	164 (1.4%)	(1.20%, 1.60%)	2,513 (9.5%)	(9.20%, 9.90%)	12,160 (6.5%)	(6.40%, 6.60%)
2 - n (%)	387 (3.3%)	(3.00%, 3.60%)	3,613 (13.7%)	(13.30%, 14.10%)	17,663 (9.4%)	(9.30%, 9.60%)
3 - n (%)	947 (8.1%)	(7.60%, 8.60%)	4,877 (18.5%)	(18.10%, 19.00%)	24,774 (13.2%)	(13.10%, 13.40%)

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4 - n (%)	2,333 (20.0%)	(19.30%, 20.70%)	6,470 (24.6%)	(24.10%, 25.10%)	39,487 (21.1%)	(20.90%, 21.30%)
5 (highest) - n (%)	7,815 (66.9%)	(66.10%, 67.80%)	8,484 (32.2%)	(31.70%, 32.80%)	92,042 (49.1%)	(48.90%, 49.40%)
Comorbidities						
0-1 - n (%)	3,642 (31.2%)	(30.30%, 32.00%)	5,063 (19.2%)	(18.80%, 19.70%)	93,666 (50.0%)	(49.80%, 50.20%)
2-3 - n (%)	4,635 (39.7%)	(38.80%, 40.60%)	10,219 (38.8%)	(38.20%, 39.40%)	53,242 (28.4%)	(28.20%, 28.60%)
4+ - n (%)	3,401 (29.1%)	(28.30%, 29.90%)	11,038 (41.9%)	(41.30%, 42.50%)	40,436 (21.6%)	(21.40%, 21.80%)

Table 3: Health care utilization and COVID-19 mortality among those living with and without MH&A who have at least one positive COVID test

Outcome		Immigrants and refugees with a history of MH&A N= 11,678	Canadian-born/ long-term residents with a history of MH&A N= 26,320	General population without MH&A N= 187,344	Overall N= 225,342
ED visit		3,525 (30.2%)	7,254 (27.6%)	40,599 (21.7%)	51,378 (22.8%)
COVID-19 hospitalization		987 (8.5%)	3,430 (13.0%)	15,517 (8.3%)	19,934 (8.8%)
COVID-19 ICU admission amongst those who were hospitalized		197 (20.0%)	628 (18.3%)	3,393 (21.9%)	4,218 (21.2%)
COVID-19 death within 60 days of a positive test		225 (1.9%)	1,595 (6.1%)	6,523 (3.5%)	8,343 (3.7%)
Number of visits to Primary care physicians		9,747 (83.5%)	20,863 (79.3%)	122,794 (65.5%)	153,404 (68.1%)
Number of visits to primary care physicians	Mean (SD)	4.42 (6.07)	5.11 (7.98)	2.73 (4.85)	3.10 (5.44)
	Median (Q1-Q3)	3 (1-6)	2 (1-6)	1 (0-3)	1 (0-4)
Number of visits to psychiatrists		1,675 (14.3%)	4,810 (18.3%)	2,862 (1.5%)	9,347 (4.1%)
	Mean (SD)	0.75 (3.68)	1.11 (4.67)	0.04 (0.56)	0.20 (1.91)
	Median (Q1-Q3)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)
Number of visits to virtual care		10,076 (86.3%)	20,141 (76.5%)	133,879 (71.5%)	164,096 (72.8%)
	Mean (SD)	6.15 (6.84)	4.69 (6.44)	3.13 (4.19)	3.47 (4.74)
	Median (Q1-Q3)	4 (2-8)	3 (1-6)	2 (0-4)	2 (0-5)

Table 4: Logistic regression analysis of COVID 19 outcomes among immigrants and non-immigrants with MH&A compared to general population without MH&A adjusted for age, sex, income quintile, primary care model, rurality index, and number of comorbidities

Outcome	Immigrants and refugees with a history of MH&A	Canadian-born/long-term residents with a history of MH&A	General population without MH&A
COVID 19 testing	1.12 (1.11, 1.12)	1.32 (1.32, 1.33)	1
Positive test	1.41 (1.38, 1.44)	0.64 (0.64, 0.65)	1
Hospitalization amongst those who tested positive	1.08 (1.01, 1.16)	1.29 (1.24, 1.35)	1
ICU amongst those who tested positive	0.99 (0.85, 1.15)	1.08 (0.98, 1.18)	1
Death within 60 days amongst those who tested positive	0.69 (0.6, 0.79)	1.22 (1.15, 1.3)	1

Discussion

In this population-based, retrospective cohort study, we found that about 17% of the Ontario population aged 18 and over lived with MH&A and of those 2.6% were immigrants and refugees with MH&A. Both immigrants and non-immigrants with a history of MH&A were generally younger and poorer and had increased levels of material deprivation, residential instability, and comorbidities. Furthermore, immigrants and non-immigrants with MH&A who tested positive were more intensive users of health services (e.g., primary care providers, psychiatrists, ER, and hospitals) compared to the general population (i.e., immigrants and non-immigrants without MH&A. Immigrants and refugees with MH&A were significantly more likely to live in ethnically diverse and socio-economically deprived neighbourhoods than non-immigrants with MH&A. Our findings are consistent with other research that shows people living with MH&A are at high risk of poverty due to unemployment/ under-employment and low income [19-21]. Our study illustrated that after adjusting for covariates (i.e., sex, age, income, geographic location(i.e. rurality index), comorbidities, primary care model) Covid 19 testing and hospital admission was considerably higher among both immigrants and non-immigrants living with MH&A than the general population (i.e immigrants and non-immigrants without MH&A). The higher rates of testing may be related to the Ontario testing strategy which altered substantially throughout the outbreak. Initially, testing was only offered to symptomatic individuals or people with pre-existing risk factors (e.g., advanced age, comorbidities, homelessness). People with MH&A may have been more likely to fall into the groups eligible and/ or prioritized for testing. On May 29, 2020, it was revised to include all people regardless of having symptoms or risk factors [22]. Furthermore, the higher testing may be related to the higher average number of in-person visits to primary care providers and psychiatrists which may have facilitated the testing process.

Interestingly, the rate of confirmed positivity was significantly higher among immigrants and refugees living with MH&A but lower among non-immigrants with MH&A compared to immigrants and non-immigrants without MH&A. This may be due to the higher proportion of immigrants and refugees living in low-income, materially deprived and residentially unstable neighbourhoods than non-immigrants with MH&A. Considering that the general population comparison group included immigrants without MH&A this may explain why the rate of confirmed positivity was lower among non-immigrants with MH&A compared to the general population. Our findings are consistent with previous studies reporting higher rates of COVID-19 test positivity among people living in areas with higher concentrations of immigrants and refugees and low socioeconomic [23-30]. The synergy among occupational risk factors (e.g., employment in low-paid essential workplaces such as manufacturing, pharmacies, and groceries), living arrangements (e.g., residing in crowded multi-generational homes), and limited economic power may explain higher COVID-19 infection rates in immigrants and refugees. [1-5].

Non-immigrants with preexisting mental disorders were more likely to be hospitalized, stay in intensive care and die from COVID-19 than the general population (immigrants and non-immigrants without MH&A). This suggests cases of COVID-19 were more severe and critical in this group. It is plausible that living in neighbourhoods with low income and greater material deprivation and residential instability may be a risk factor in seeking care at a later stage. The financial stress may contribute to a need to continue employment and delay medical care despite symptoms. The preexisting MH&A may also be a deterrent to seeking care in a timely manner. Our study showed that a considerable proportion of immigrants and non-immigrants with preexisting MH&A lived in neighbourhoods with greater material deprivation and residential instability. Material deprivation represents not only low income and education but also other dimensions

of neighbourhood vulnerability such as lone-parent families, poor housing, income from government transfer payments, and unemployment. Similarly, residential instability signifies neighbourhood quality and social support which includes such aspects as living alone, moving frequently, and living in an overcrowded dwelling. [16]. Social inequities may be the driving force behind the COVID-19 mortality disparities. Living in socially deprived neighbourhoods may have also induced these outcomes through factors that our study was not able to measure like greater exposure to SARs-CoV-2 viral load. Higher rates of mortality in disadvantaged neighbourhoods warrant further investigations and remediations. Understanding contributing factors to mortality disparities can help to direct investment in current public health infrastructure that could mitigate health inequities during crises. Healthy public policies that promote social investment in materially deprived communities prior to disaster may reduce health disparities that otherwise would emerge during the crises.

The lower ICU admission and Covid 19 mortality rates among immigrants and refugees living with MH&A may be related to their younger age compared to the non-immigrants with MH&A and the general population (immigrants and non-immigrants without MH&A). Based on the Canadian immigration point system which is youth-oriented, applicants aged 47 or older get no point under the age factor [31] which consequently reduces the chance of immigration for older immigrants. Moreover, The *healthy immigrant effect* which implies immigrants tend to be healthier than their native-born counterparts, at least initially upon arrival to their host country [32-33], may likely contribute to our understanding of the differences in ICU admission and COVID-19-related mortality. It is also plausible that we underestimated the prevalence of MH&A among immigrants and refugees, as it has been reported in other studies that some immigrants to Canada, especially those from non-European countries, underutilize mental health services until later on in the course of illness due to multiple access barriers such as language, stigma, and discrimination [34-35]. In our study, MH&A cases were based on hospital and physician visits, so immigrants and refugees who either were reluctant to use mental health services or used non-OHIP-covered practitioners (e.g. social workers, psychologists or nurse practitioners) may have been inadvertently excluded.

Limitations

To our knowledge, no studies have actually quantified the prevalence of MH&A among immigrants and refugees in Ontario, Canada, or examined the intersectional impact of socio-economic inequities and mental disorders on COVID-19 vulnerability across population subgroups. These are the unique contributions of our study. However, there are some limitations to this study that should be considered when reviewing the results. First, the use of administrative data limits the ability to address causation or account for some other confounders which may affect the observed association, such as social support, education and literacy, and physical environment. Second, we defined MH&A based on hospital and physician visits. We considered someone as having MH&A if they had been diagnosed at least one year before the study end date and had at least one mental health visit (office visit, ER visit, hospitalization) within the past year. We excluded outpatient visits with non-OHIP-covered practitioners (e.g., social workers, psychologists or nurse practitioners). This could have led to an underestimation of the prevalence of MH&A. Third, changes made to Ontario's COVID-19 testing criteria throughout the course of the pandemic may have affected access to COVID-19 screening among our study cohort. Fourth, we used the Ontario Marginalization Index to assign individuals to a summary level of neighbourhood marginalization, that although validated, may not reflect individual-level marginalization. This also holds true for our use of income neighbourhood as a proxy for individual income. Fifth, our study used four dimensions of the ON-Marg Index without the ability to stratify across each of their respective constructs in order to quantify their association with COVID-19-related outcomes. Sixth, we clumped Mental health and Addiction disorders which made it difficult to ascertain what proportion experienced mental health disorders and what proportion struggled with addiction disorders. Considering that our study found that almost 60% of persons living with MH&A were women suggests that this population was overwhelmingly composed of persons experiencing mental health disorders such as depression and anxiety rather than substance use disorders of which men are much more highly represented than women. Further exploration is needed to assess the impact of COVID-19 on MH&A disorders. Finally, our data is based on the first 2 waves of COVID-19 and the trends may have changed over the course of the pandemic. Hence, our findings may not be applicable to other waves of the pandemic.

Conclusions

COVID-19 does not discriminate. It invades all segments of the population regardless of age, sex, class, race, ethnicity, religion, disability or sexual orientation. However, where invasion has actually occurred the ramifications are not the same across different segments of the population which overtly highlights that social inequalities are at the heart of the COVID-19 outcome disparities. We found the association of social inequities with COVID-19 morbidity and mortality is further compounded in the context of underlying MH&A. People with preexisting MH&A who lived in deprived neighbourhoods were more at risk of encountering COVID-19, being hospitalized, staying in the ICU and eventually dying from it. Our study provides crucial

information on the structural determinants of COVID-19 disparities among already disadvantaged groups. This can help policymakers and healthcare service providers to develop targeted evidence-based policies and interventions that can effectively support and protect immigrants living with MH&A during pandemic recovery and in future crises, whether infection-driven or otherwise.

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 this published article [and its supplementary information files]

Competing interest

The authors declare that they have no competing interests.

Authors' contributions

M.K, L.P., & A.K extracted and analyzed the data based on specifications provided by MV & A.L. MV processed and analyzed the data and drafted the article, figure 1 and tables. A.L & J.W reviewed the article critically for intellectual content. All the authors gave final approval of the version to be published and agreed to serve as guarantors of the work.

References

1. Ontario COVID-19 Data Tool. Public Health Ontario (2021).

2. Guttmann A, Gandhi S, Wanigaratne S, et al. COVID-19 in Immigrants, Refugees and Other Newcomers in Ontario: Characteristics of Those Tested and Those Confirmed Positive ICES (2020).

3. Toronto Public Health. COVID-19 by Ethno-Racial Identity by Proportions. Toronto: Toronto Public Health (2021).

4. Statistics Canada. COVID 19 Impacts on Immigrants and People Designated as Visible Minorities (2020).

5. National Advisory Committee on Poverty. Understanding Systems: The 2021 report of the National Advisory Council on Poverty (2021).

6. Murphy L, Markey K, O' Donnell C, et al. The impact of the COVID-19 pandemic and its related restrictions on people with pre-existent mental health conditions: A scoping review. Archives of psychiatric nursing 35 (2021): 375-389.

7. Hendrikx LJ, Williamson C, Baumann J, et al. The impact of the COVID-19 pandemic on treatment-seeking veterans in the United Kingdom with pre-existing mental health difficulties: A longitudinal study. Journal of traumatic stress 35 (2022): 330-337.

8. Skoda E, Bäuerle A, Schweda A, et al. Severely increased generalized anxiety, but not COVID-19-related fear in individuals with mental illnesses: A population-based cross-sectional study in Germany. International journal of social psychiatry 67 (2021): 550-558.

9. Lee S, Yang J, Moon S, et al. Association between mental illness and COVID-19 susceptibility and clinical outcomes in South Korea: a nationwide cohort study. The Lancet Psychiatry 7 (2020): 1025-1031.

10. Li L, Li F, Fortunati F, et al. Association of a Prior Psychiatric Diagnosis With Mortality Among Hospitalized Patients With Coronavirus Disease 2019 (COVID-19) Infection. JAMA Network Open 3 (2020): e2023282.

11. Wang Q, Xu R, Volkow N. Increased risk of COVID -19 infection and mortality in people with mental disorders: analysis from electronic health records in the United States. World Psychiatry 20 (2020): 124-130.

12. Smith PH, Mazure CM, McKee SA. Smoking and mental illness in the U.S. population. Tob Control 23 (2014): e147-e153.

13. Mental Illness and Addiction: Facts and Statistics. CAMH (2021).

14. Mental Health in Canada: Covid-19 and Beyond. Toronto, ON: CAMH (2020).

15. Ontario Marginalization Index (ON-Marg). Public Health Ontario (2021).

16. Matheson FI, van Ingen T. 2016 Ontario marginalization index. Toronto, ON: St. Michael's Hospital; 2018. Joint publication with Public Health Ontario (2018).

17. Health Force Ontario, Family Medicine Compensation and Practice Models in Ontario [Internet]. Health Force Ontario (2019).

18. Glazier RH, Klein-Geltink J, Kopp A, et al. Capitation and enhanced fee-for-service models for primary care reform: a population-based evaluation. Canadian Medical Association journal (CMAJ) 180 (2009): E72-E81.

19. Hakulinen C, Elovainio M, Arffman M, et al. Mental disorders and long-term labour market outcomes: nationwide cohort study of 2 055 720 individuals. Acta psychiatrica Scandinavica 140 (2019): 371-381.

20. Mojtabai R, Stuart EA, Hwang I, et al. Long-term effects of mental disorders on employment in the National Comorbidity Survey ten-year follow-up. Social Psychiatry and Psychiatric Epidemiology 50 (2015): 1657-1668.

21. Lerner D, Adler DA, Chang H, et al. Unemployment, Job Retention, and Productivity Loss Among Employees With Depression. Psychiatric services (Washington, D.C.) 55 (2004): 1371-1378.

22. Solmi M, Radua J, Olivola M, et al. Age at onset of mental disorders worldwide: large-scale meta-analysis of 192 epidemiological studies. Molecular psychiatry 27 (2021): 281-295.

23. O'Neill B, Kalia S, Hum S, et al. Socioeconomic and immigration status and COVID-19 testing in Toronto, Ontario: retrospective cross-sectional study. BMC public health 22 (2022): 1067-1067.

24. Public Health Ontario. COVID-19 in Ontario: A Summary of Wave 1 Transmission Patterns and Case Identification (2022).

25. Chung H, Fung K, Ferreira-Legere LE, et al. COVID-19 Laboratory Testing in Ontario: Patterns of Testing and Characteristics of Individuals Tested, as of April 30, 2020. Toronto: ICES (2020)

26. Impacts on Immigrants and People Designated as Visible Minorities (2021).

27. Clark E, Fredricks K, Woc-Colburn L, et al. Disproportionate impact of the COVID-19 pandemic on immigrant communities in the United States. PLoS neglected tropical diseases 14 (2020): e0008484-e0008484.

28. Ross J, Diaz CM, Starrels JL. The Disproportionate Burden of COVID-19 for Immigrants in the Bronx, New York. Archives of internal medicine (1960). 180 (2020): 1043.

29. COVID-19's devastating toll on Montreal's poorest neighbourhoods. The Canadian Broadcasting Corporation (CBC). CQ-Roll Call, Inc (2020).

30. O'Neill B, Kalia S, Hum S, et al. Socioeconomic and immigration status and COVID-19 testing in Toronto, Ontario: retrospective cross-sectional study. BMC public health 22 (2022): 1067-1067.

31. Government of Canada. Six selection factors – Federal Skilled Worker Program (2022).

32. Hyman I, Jackson B. The healthy immigrant effect: a temporary phenomenon. Health Policy Research Bulletin 17 (2010): 17-21.

33. Ng E. The healthy immigrant effect and mortality rates. Health Reports, 22 (2011): 25-29

34. Whitley R, Kirmayer LJ, Groleau D. Understanding Immigrants' Reluctance to Use Mental Health Services: A Qualitative Study from Montreal. Canadian journal of psychiatry 51 (2006): 205-209.

35. Fung K, Guzder J. Canadian Immigrant Mental Health. In: Moussaoui D., Bhugra D., Tribe R., Ventriglio A. (eds) Mental Health, Mental Illness and Migration. Mental Health and Illness Worldwide. Springer, Singapore (2021).