Trends and Factors Associated with Suicide Deaths in Older Adults in Ontario, Canada

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ABSTRACT

Background

Suicide in older adults is a significant overlooked problem worldwide. This is especially true in Canada where a national suicide prevention strategy has not been established.

Methods

Using linked health-care administrative databases, this population-level study (2011 to 2015) described the incidence of older adult suicide (aged 65+), and identified clinical and socio-demographic factors associated with suicide deaths.

Results

The findings suggest that suicide remains a persistent cause of death in older adults, with an average annual suicide rate of about 100 per million people over the five-year study period. Factors positively associated with suicide vs. non-suicide death included being male, living in rural areas, having a mental illness, having a new dementia diagnosis, and having increased emergency department visits in the year prior to death; whereas, increased age, living in long-term care, having one or more chronic health condition, and increased interactions with primary health care were negatively associated with a suicide death.

Conclusion

Factors associated with suicide death among older adults highlighted in this study may provide better insights for the development and/or improvement of suicide prevention programs and policies.

Key words: older adult suicide, senior suicide, suicide, factors of suicide, mental health, population health

INTRODUCTION

Suicide is a global phenomenon that afflicts all age groups. Currently, it is the 15th leading cause of death globally resulting in it being labelled as a major public health issue worldwide.[1] In Canada, suicide is the 9th leading cause of death among all age groups which has remained largely unchanged over the last 15 years.[2–5] Despite older adults having the second highest rates of suicide in Canada, resulting in the 12th leading cause of death in this age group,[1–4,6–8] suicide prevention has been overlooked in this cross-section of the population.

To date, the epidemiology of older adult suicide in the Canadian context is lacking. Despite some available information, there remains conflicting understanding of the factors associated with suicide in older adults. For instance, while some reports indicate that diagnosis of dementia, depression, and cancer are associated with older adult suicide,[9–15] others contradict these associations.[16–20] It has been theorized that older adult suicidality sometimes goes unnoticed clinically, as health-care professionals possess a tendency only to categorize an individual as suicidal when they are diagnosed with depression or other mental health issues.[21] This preposition towards privileging depression and other diagnosed mental health issues as a singular causal mechanism to suicidal ideation may result in health-care professionals missing other individual and contextual factors predictive of suicide. In addition, the stigma towards suicide continues to persist,[22] which could also limit the capacity of further evaluating the complex factors of suicide.

With the current limited knowledge regarding older adult suicide in Canada, this study aimed to better understand the prevalence and predictors of suicide in older adults in Ontario, Canada. The objectives of this study were to 1) describe the five-year trend of suicide deaths among older adults in Ontario, Canada (2011 to 2015); 2) develop profiles of older adult suicide versus non-suicide deaths; and 3) identify factors associated with suicide deaths in older adults.

METHODS

Study Design and Setting

A population-level, retrospective study was conducted using linked administrative health-care databases available at ICES

(provincial health care administrative data steward) in order to identify all older adults (aged 65+) who died by either suicide or other non-suicide means between January 2011 and December 2015 in the province of Ontario, Canada. Ontario is the most populous province in Canada, comprising of about 14.7 million people (comprising approximately 40% of Canada), wherein most residents are covered by a single payer health-care insurance system (OHIP [Ontario Health Insurance Plan]).[23,24]

Study Population

The study population was comprised of older adults (aged 65+), who died between 1 January 2011 and 31 December 2015 in the province of Ontario, Canada. All older adults, aged 65 years and over, were included at the start of the analysis phase to establish the rate and trend of mortality at the population level. Older adults who had a missing or invalid OHIP number (thereby not eligible for health services in Ontario), with invalid demographic information such as age and sex (data cleaning), and not residing in Ontario were excluded from the study.

In Ontario, older adults are eligible for government-funded medication use when they turn 65, through the Ontario Drug Benefit program.[23] To enable a two-year look-back period to establish health status for the second phase of the analysis (identifying factors or predictors associated with older adult suicide deaths), individuals less than 67 years old were further excluded, hereon referred to as the analysis cohort.

Data Sources

The following health-care administrative databases held at ICES were used to gather cohort data characteristics: Registered Persons Database, Office of the Registrar General-Deaths (ORGD) Vital Statistics Database, Ontario Population Estimates and Projections (POP) (Ontario Ministry of Health and Long-Term Care: IntelliHEALTH ONTARIO), Ontario Drug Benefit Claims (ODB), CIHI-Discharge Abstract Database (DAD), CIHI-National Ambulatory Care Reporting System (NACRS), Ontario Health Insurance Plan (OHIP), CIHI-Ontario Mental Health Reporting System (OMHRS), ICES Physician Database (IPDB), Cancer Care Ontario-Ontario Cancer Registry (OCR), and ICES-Derived Cohorts (ASTHMA, CHF, COPD, DEMENTIA, HIV, HYPER, OCCC, ODD, ORAD, OMID). Datasets were linked using unique encoded identifiers and analyzed at ICES. Variables were defined using the International Statistical Classification of Diseases Ninth and Tenth revision (ICD-9 and ICD-10) diagnostic codes, and OHIP fee/diagnostic. Definitions of all variables can be found in Appendices A and B.

Outcomes

The primary outcome of interest was a binary classification of death as "death by suicide vs. other suicide deaths", identified on ORGD records as having a cause of death (COD) ICD-9 code between E950 and E959; having an underlying COD ICD-10 code between X60 and X84; or having a manner of death code recorded as "suicide". Our secondary outcome

included three categories, with an addition of "probable suicide" as a separate death classification, identified on ORGD records having a COD ICD-9 code between E980 and E987, or E989; or having an underlying COD ICD-10 code between Y10 and Y32, Y34, or Y87. Refer to Appendix B for detailed description of the codes and references used to generate the COD codes

Predictive Factors

Several socio-demographic and health-related characteristics were collected to describe the analysis cohort and assess factors associated with suicide deaths. The generated profile included pre-existing chronic conditions; new health-care issues (e.g., a recent diagnosis of dementia or cancer); and health-care services utilization (e.g., hospital admissions, emergency room visits, and primary health-care visits). The following look-back periods were selected to capture health and socio-demographic characteristics of older adult deaths (aged 67+): (a) five years for most pre-existing chronic conditions; (b) two years for new diagnoses; and (c) one year for health-care utilization. The following variables were selected to further estimate their association with the 'death by suicide' outcome: age, sex, marital status, income, rurality, living in long-term care (LTC) facilities, comorbidities, new health-care issues, and health-care services utilization.

Statistical Analysis

A time trend analysis was utilized to examine changes in rates of older adult (aged 65+) mortality over a five-year time frame. Descriptive statistics were used to describe the characteristics of the analysis cohort. Frequencies and percentages were used to describe categorical characteristics, while means and standard deviations or medians and interquartile ranges (IQR) were used for continuous characteristics.

To compare characteristics across groups for both the primary and secondary outcomes, chi-square was used for categorical data and t-test was used for continuous data to obtain p values. For the primary outcome, a logistic regression, which predicts the odds of an event given an independent variable,[25] was utilized to estimate the odds ratio 'death by suicide' given the selected covariates. Results are presented as adjusted odds ratios (AORs) with 95% confidence intervals (CI). Furthermore, a sensitivity analysis was conducted to assess the consistency of the odds ratio estimates after combining the 'death by suicide' and the 'death by probable suicide' groups and re-running the regression. The two regression results were then compared to observe any differences. All statistical analyses were performed using SAS Version 9.4 (SAS Institute), utilizing a threshold of alpha at 0.05 ($\alpha = 0.05$).

Ethics Approval

ICES is an independent, non-profit research institute whose legal status under Ontario's health information privacy law allows it to collect and analyze health-care and demographic data, without consent, for health system evaluation and improvement. The use of data in this project was authorized under section 45

of Ontario's *Personal Health Information Protection Act*, which does not require review by a Research Ethics Board.

RESULTS

Over the five-year study time frame (2011–2015), 368,458 older adult deaths were recorded in the province of Ontario, of which 998 (0.27% of all older adult deaths) were coded as a death by suicide. The population rate of suicide deaths was stable over the years, with a slight upward trend ranging from 91 to 100 per million older adult population (Table 1).

After excluding older adults < 67 years of age, the cohort used for further analysis included 354,967 older adult (aged 67+) mortalities (with 869 suicide deaths) in Ontario, Canada (Figure 1; Table 2) over the five-year study time frame (2011–2015).

Demographic Characteristics

Detailed characteristics comparing older adults who died by suicide and other non-suicide causes are outlined in Table

TABLE 1.
Number of deaths (rate per million older adult population) by suicide and non-suicide causes from 2011 to 2015

Year	Death by Suicide	Death by Non-Suicide Causes
2011	183 (97)	70,185 (37,192)
2012	179 (91)	70,803 (35,866)
2013	207 (100)	73,612 (35,716)
2014	211 (99)	75,814 (35,433)
2015	218 (98)	77,046 (34,798)

Source of population denominators: Ontario Ministry of Health and Long-Term Care: IntelliHEALTH ONTARIO, Data Last Refreshed [July/2020].
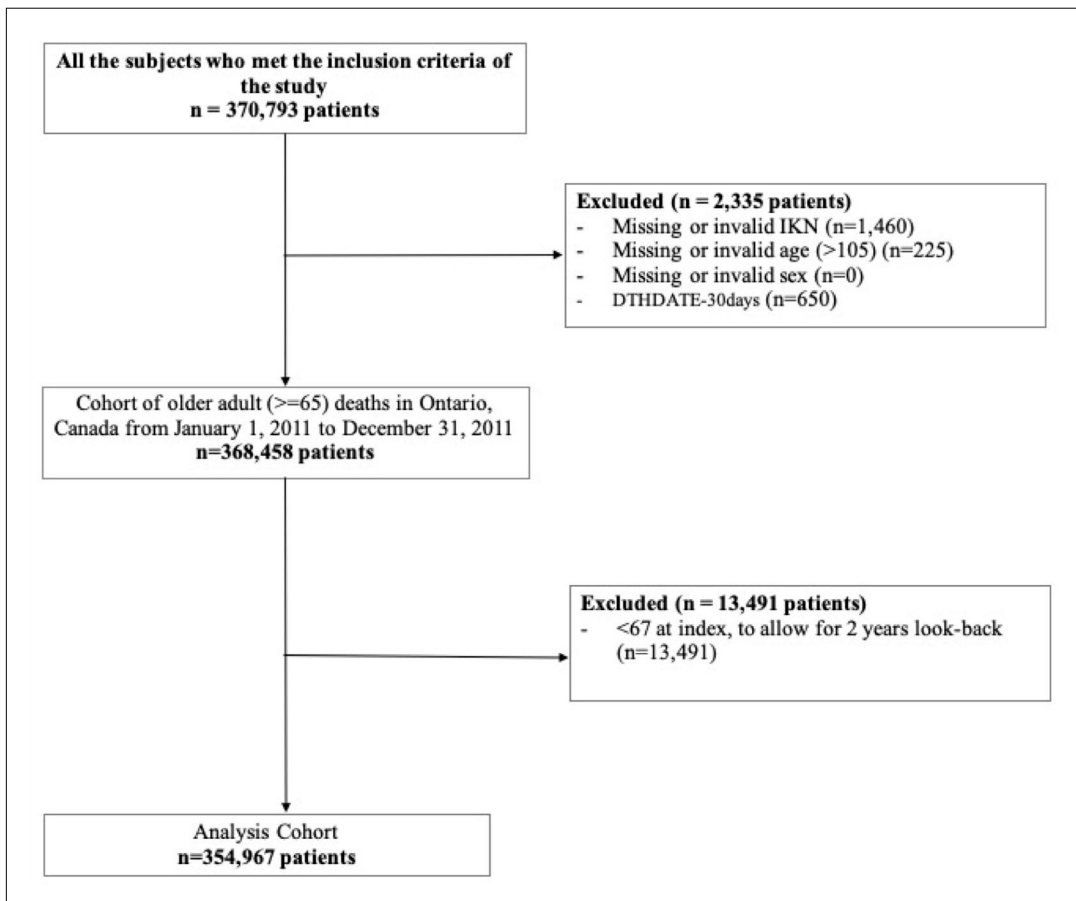

FIGURE 1. Flow chart of cohort selection after meeting the inclusion and exclusion criteria

TABLE 2.
Characteristics of older adult who died by suicide and other non-suicide causes[a]

Characteristic	Death by Suicide	Death by any Other Non-Suicide Causes	p value
	N=869	N=354,098	
Demographics			
Age at Index Date			
Mean (SD)	76.56 ± 7.11	83.25 ± 8.22	<.001
Median (IQR)	76 (70-82)	84 (77-89)	
67-74	390 (44.9%)	62,826 (17.7%)	<.001
75-84	341 (39.2%)	124,212 (35.1%)	
85+	138 (15.9%)	167,060 (47.2%)	
Female, N(%)	215 (24.7%)	187,603 (53.0%)	<.001
Marital Status, N(%)			
Common-law	26 (3.0%)	5,423 (1.5%)	<.001
Divorced	97 (11.2%)	21,892 (6.2%)	
Married	440 (50.6%)	141,476 (40.0%)	
Single	73 (8.4%)	19,280 (5.4%)	
Unknown	0 (0.0%)	21 (0.0%)	
Widowed	229 (26.4%)	165,449 (46.7%)	
Income Quintile, N(%)			
Quintile 1	217 (25.0%)	83,195 (23.5%)	.587
Quintile 2	172 (19.8%)	75,053 (21.2%)	
Quintile 3	164 (18.9%)	68,653 (19.4%)	
Quintile 4	151 (17.4%)	64,293 (18.2%)	
Quintile 5	163 (18.8%)	61,426 (17.3%)	
Rural, Yes, N(%)	160 (18.4%)	49,998 (14.1%)	.001
Year of cohort entry, N(%)			
2011	160 (18.4%)	67,759 (19.1%)	.696
2012	155 (17.8%)	68,246 (19.3%)	
2013	185 (21.3%)	70,751 (20.0%)	
2014	179 (20.6%)	72,985 (20.6%)	
2015	190 (21.9%)	74,357 (21.0%)	
Living in long-term Care (LTC)	12 (1.4%)	108,649 (30.7%)	<.001
Comorbidities in the Previous Two Years, N(%)			
Charlson Comorbidty Index			
0	317 (36.5%)	35,310 (10.0%)	<.001
1	114 (13.1%)	51,966 (14.7%)	
2+	229 (26.4%)	237,021 (66.9%)	
No Hospitalizations	209 (24.1%)	29,801 (8.4%)	
Congestive heart failure (CHF)	113 (13.0%)	139,830 (39.5%)	<.001
Myocardial Infarction (MI)	58 (6.7%)	47,692 (13.5%)	<.001
Asthma	114 (13.1%)	55,648 (15.7%)	.036
Chronic Obstructive Pulmonary Disease (COPD)	292 (33.6%)	148,447 (41.9%)	<.001
Diabetes	241 (27.7%)	134,309 (37.9%)	<.001
Hypertension	624 (71.8%)	297,566 (84.0%)	<.001
Chronic Liver Disease (CLD)	7 (0.8%)	19,352 (5.5%)	<.001
Chronic Kidney Disease (CKD)	122 (14.0%)	114,614 (32.4%)	<.001
Chronic Dialysis User	1-5	5,601-5,605	NR

TABLE 2.
(Continued)

Characteristic	Death by Suicide	Death by any Other Non-Suicide Causes	p value
	N=869	N=354,098	
Rheumatoid Arthritis	18 (2.1%)	12,491 (3.5%)	0.02
Crohn's/Ulcerative Colitis (UC)	6 (0.7%)	2,858 (0.8%)	.701
HIV	1-5	236-240	NR
Cancer	198 (22.8%)	149,590 (42.2%)	<.001
Dementia	68 (7.8%)	131,166 (37.0%)	<.001
Mental Illness			
Psychotic disorders (PSY)	63 (7.2%)	9,673 (2.7%)	<.001
Non-psychotic disorders (nPSY)	498 (57.3%)	115,540 (32.6%)	<.001
Substance abuse disorders (SUB)	58 (6.7%)	11,533 (3.3%)	<.001
Others (Social problems and others; not inc. dementia)	24 (2.8%)	8,750 (2.5%)	.581
New Health-care Issues in the Previous Two Years, N(%)			
New diagnosis of dementia	32 (3.7%)	38,376 (10.8%)	<.001
New diagnosis of cancer	56 (6.4%)	75,147 (21.2%)	<.001
Health-care System Utilization and Access in the Previous One Year			
Number of hospitalizations			
Median (IQR)	0 (0-1)	1 (0-2)	<.001
Number of ER visits			
Median (IQR)	1 (0-2)	2 (1-3)	<.001
Number of visits to PHC			
Median (IQR)	8 (4-14)	16 (9-29)	<.001

aColumns might not add-up due to missing/non-reportable numbers.
IQR = interquartile range; SD = standard deviation; NR = non-reportable.

2. In univariate analyses, older adults who died by suicide tended to be relatively younger (67–74 vs. 85+) (n = 390, 44.9% vs. n = 138, 15.9%); less likely female (n = 215, 24.7%); less likely to live in LTCs (n = 12, 1.4%); and less likely to live in rural areas (n = 160, 18.4%). In the adjusted analyses (Table 3), increasing age (aOR 0.94, 95% CI: 0.93-0.95) and living in LTC (aOR 0.07, 95% CI: 0.04-0.13) were associated with lower odds of suicide. Male (vs. female) sex (aOR 2.91, 95% CI: 2.47-3.44) and residing in a rural region (aOR 1.32, 95% CI: 1.11-1.58) were associated with higher odds of suicide deaths.

Mental Illness

From the list of medical illnesses (Table 2), the majority of the older adults who died by suicide had a mental health diagnosis, particularly non-psychotic disorders (n = 498, 57.3%), which was higher compared to the older adults in the non-suicide group (57.3% v. 32.6%, $p < .001$). In the adjusted analysis, mental illness diagnosis showed significantly higher odds of older adult suicide (Table 3). The odds of suicide were 2.75 times higher for psychotic disorder diagnosis (aOR 2.75, 95% CI: 2.08-3.62), and 3.34 times higher for non-psychotic disorder diagnosis (aOR 3.34, 95% CI: 2.91-3.87).

New Health-care Issues

In the adjusted analysis, a new diagnosis of dementia was associated with increased odds of suicide (aOR 1.72, 95% CI: 1.06-2.79), while a new diagnosis of cancer was associated with a substantially lower odds of suicide (aOR 0.32; 95% CI: 0.24-0.44) (Table 3).

Health-care Utilization

In the adjusted analysis, the odds of emergency department use in the year prior to death was associated with moderate increase in the odds of suicide deaths (aOR 1.05, 95% CI 1.02-1.08), whereas visits to a primary care practitioner were associated with a lower odds (aOR 0.98, 95% CI: 0.97-0.99) (Table 3).

Death by Suicide Vs. Death by Probable Suicide

A small number of older adults were recorded as dying by probable suicide means (N = 29) (Table 4). In comparison to older adults who died by suicide causes, those who died by probable suicide causes were younger (median 72, vs. 76, $p < .001$); more often male 37.9% vs. 24.7%, $p < .001$; more likely to have visited a primary health-care practitioner in the previous year (median 9 vs. 8 visits, $p < .001$); and more

TABLE 3.
Adjust odds ratios of characteristics associated with suicide deaths among older adults[a]

Characteristic	OR	95% CI	p value
Demographics			
Age (continuous)	0.94	0.93, 0.95	<.0001
Sex (reference=females)	2.91	2.47, 3.44	<.0001
Marital Status (reference=married)			
Married (combined m=married & c=common-law)	REF		
Widowed (w)	1.08	0.90, 1.29	.4489
Divorced (d)	1.10	0.87, 1.39	.3905
Single (s)	0.90	0.69, 1.16	.5539
Other (combined missing, o=other, u=unknown)	0.84	0.31, 2.33	.719
Income quintile (reference=quintile 5; recode missing to '3')			
Quintile 1	0.93	0.75, 1.15	.7377
Quintile 2	0.85	0.68, 1.06	.3117
Quintile 3	0.89	0.72, 1.11	.769
Quintile 4	0.89	0.71, 1.11	.7249
Quintile 5	REF		
Rural (reference=urban; recode missing to urban)	1.32	1.11, 1.58	.0021
LTC (reference=no)	0.07	0.04, 0.13	<.0001
Comorbidities (reference=no)			
Charlson score			
0 (combined 0 and 'no hospitalizations')	REF		
1	0.36	0.29, 0.44	.0178
2+	0.21	0.17, 0.26	<.0001
Congestive Heart Failure (CHF)	0.46	0.37, 0.58	<.0001
Myocardial Infarction (MI)	0.73	0.55, 0.96	.0241
Asthma	1.05	0.85, 1.30	.6554
Chronic Obstructive Pulmonary Disease (COPD)	0.84	0.72, 0.98	.0227
Diabetes	1.01	0.86, 1.18	.9464
Hypertension	0.98	0.84, 1.15	.8165
Chronic Kidney Disease (CKD)	0.74	0.60, 0.91	.0041
Chronic Dialysis User	0.45	0.14, 1.43	.1777
Rheumatoid Arthritis	0.79	0.50, 1.27	.3374
Crohn's/Ulcerative Colitis (UC)	0.83	0.37, 1.88	.6608
Cancer	0.73	0.61, 0.89	.0018
Dementia	0.31	0.22, 0.45	<.0001
Mental Illness			
Psychotic disorders (PSY)	2.75	2.08, 3.62	<.0001
Non-psychotic disorders (nPSY)	3.36	2.91, 3.87	<.0001
Substance abuse disorders (SUB)	1.20	0.91, 1.59	.2033
Others (OTH- Social problems and others; not inc. dementia)	0.97	0.64, 1.47	.8801
New Health-care Issues			
New diagnosis of dementia (reference=no)	1.72	1.06, 2.79	.0277
New diagnosis of cancer (reference=no)	0.32	0.24, 0.44	<.0001
Health-care System Utilization and Access (continuous)			
Number of hospitalizations	0.95	0.87, 1.04	.2829
Number of ER visits	1.05	1.02, 1.08	.0015
Number of PHC visits	0.98	0.97, 0.99	<.0001

[a]Some variables were omitted due to non-reportable values.
N = 354,967 (869 deaths by suicide); *OR* = odd ratio; *CI* = confidence interval, 95%.

TABLE 4.
Characteristics of older adults who died by suicide and probable suicide causes[a]

Characteristic	Death by Suicide	Death by Probable Suicide[b]	p value
	N=869	N=29	
Demographics			
Age at Index Date			
Mean (SD)	76.56 ± 7.11	75.24 ± 7.42	<.001
Median (IQR)	76 (70-82)	72 (70-80)	
Female, N(%)	215 (24.7%)	11 (37.9%)	<.001
Marital Status, N(%)			<.001
Married	440 (50.6%)	9 (31.0%)	
Widowed	229 (26.4%)	13 (44.8%)	
Health-care System Utilization and Access in the Previous Two Years			
Number of hospitalizations			
Median (IQR)	0 (0-1)	0 (0-1)	<.001
Number of ER visits			
Median (IQR)	1 (0-2)	1 (0-3)	<.001
Number of visits to PHC			
Median (IQR)	8 (4-14)	9 (6-15)	<.001

[a]Other variables were omitted due to missing/non-reportable values.
[b]Probable suicide: with the small number of this cohort, other variables cannot be further reported.
IQR = interquartile range; SD = standard deviation.

likely widowed (44.8% vs. 26.4%; $p < .001$). In sensitivity analysis, wherein the outcome included death by suicide or death by probable suicide, results of the primary adjusted analyses remained unchanged (Appendix C).

DISCUSSION

This study demonstrates that suicide remains to be a persistent cause of death among older adults (aged 65+) in Ontario, averaging roughly 200 suicide deaths per year from 2011 to 2015. Among all older adult deaths recorded over the five-year study period, 0.27% was resultant of suicide. Several factors were analyzed in this study to further understand the factors associated with suicide in older adults. Being male, living in rural areas, having a mental illness, a new dementia diagnosis, and having increased emergency department visits were positively associated with suicide deaths; whereas, increased age, living in long-term care, having chronic health conditions, and increased interactions with primary health care were negatively associated with suicide deaths.

Although suicide is prevalent in older adults, the findings reported in this work are likely an underestimate, due to a range of misclassification and systemic biases related to the reporting of suicide.[26–28] The lack of transparency in reporting older adult suicides may perhaps be due to the lingering stigma and culture surrounding suicide, or the medical/legal complexity of registering suicide cases in general.[8,21] Older adults also tend to be excluded from contemporary suicide prevention programs and policy in Canada, as these programs tend to focus on youth and young adults.[2,3,22,29]

Previous studies have reported the main characteristics of older adults who died by suicide as being younger (aged 65–74), male, and married,[9,11,30] which were consistent with the findings in this study, with the exception of marital associations.[9,11,31-33] Research studies from New Zealand,[30] Denmark,[11] and The United States of America[9] have consistently shown more suicide deaths in older adults who were younger (less than 80 years old), while emphasizing that older adults (aged 80–85+) presented with more physical health issues than those under the age of 80 years.[9,30] Furthermore, these older adults (aged 80+) visited their general practitioners more for physical issues rather than for mental health issues.[9,11,30] The findings in this research study showed the cohort to be relatively younger, although age was not found to be predictive of suicide. A 2019 U.S. descriptive study[9] of 16,924 older adults (aged 65+) reported higher odds of suicide risk for those who were older (aged 75–84; and 85+), which contrasted this research study's finding in terms of age. This could perhaps be due to the systematic underreporting of suicide deaths in older adults,[26–28] as mentioned previously, or lack of understanding regarding the underlying risk factors associated with suicide deaths during health-care visits. More research is needed to better ascertain the true impacts of various characteristics of older adults and the association with suicide death.

Male gender has also been commonly described in the literature as a predictor of older adult suicide.[1,3,9,11,30] Although not specifically directed to older adult suicide, the influence of men's health information-seeking behaviours[34] and traditional or stereotypical views of masculinity[35] may

perhaps explain this association. While marital status did not produce a significant relationship in this study, other studies reported that various factors, such as gender or income, could influence the association of marital status with older adult suicide.[36,37]

Several studies have also uncovered associations between various physical/mental health conditions with older adult suicide, particularly dementia, depression, and cancer.[9–18,20] Findings from this research study further reinforced that a diagnosis of mental illness appears to be a health condition that is highly associated with older adult suicide. This expected finding suggests that mental illness is an immense factor in older adult suicide that must be effectively managed. Previous research has reported that a new diagnosis of dementia, between six months and three years after initial diagnosis, was associated with older adult suicide.[10,15] In this study, a new diagnosis of dementia showed to be highly associated with older adult suicide. A possible explanation for the increased risk is that older adults who are newly diagnosed with dementia still have the cognitive ability to understand the hardships (i.e., functional/cognitive decline) ahead, and are able to initiate suicide death if they deem themselves potentially incapable in the future.[20,38]

Past research exploring the association of living in a LTC facility and suicide in older adults remains inconclusive.[9,15,39] Two recent 2019 research studies[9,39] completed in the United States claimed that living within or transitioning to LTC facilities is a predictive factor of suicide. Interestingly, the findings of this population-level study demonstrated that admission to LTC showed a reduction in odds of suicide for older adults, which was congruous with the findings of another earlier American research study[15] that reported a lowered suicide risk for nursing home admissions. While more specific research will be needed to clarify these findings, it has been suggested that the protective mechanism of LTC facilities on older adult suicide may be due to the "structured, supervised nature" of LTC facilities and the higher prevalence of patients with advanced cognitive/physical limitations.[15]

Other research from the United States, Canada, and New Zealand observed that older adults who died by suicide commonly visited their family doctor within seven to 30 days before death.[12,14,17,30] While this study examined health-care visits within one year prior to suicide death, further work should be completed to examine if there are any other predictors of suicide related to the window of time between PHC visit and suicide death. Enhanced screening during patient-provider interactions to assess underlying risk factors of suicide, particularly in relation to mental illness and new diagnosis of dementia, should be considered in light of these findings.

Living in a rural environment was another significant factor determined in this study, such that it showed a positive association to suicide. It has been reported that older adults residing in rural and small population areas have the lowest access to health-care services.[40] Moreover, rural residents commonly lack access to family physicians, nurse practitioners, specialty physicians, and other health-care services.[34,40] The lack of access to health-care services in rural areas force rural residents to travel to urban areas to seek care, which may result in more emergency department usage.[34] Future suicide prevention program and health policy for older adults should consider aspects related to health-care access equity.

Implications and Future Directions

The findings of this study have implications and future directions for research and policy. For instance, future exploration regarding the factors surrounding living in LTC and aging-in-place should be conducted, particularly those living in rural or remote areas. Current and future digital health technology should also be examined in order to influence action and support for older adult suicide prevention programs/policies. It is evident that the increased adoption of digital health technologies (i.e., electronic health record, remote patient monitoring, telemedicine, etc.) across Canada has allowed health-care providers to efficiently access patient health information, which aids in the decision-making process and quality of care.[41-44] With the continued usage and innovation of digital health technology to help span the care continuum, the assessment and evaluation of patient needs should be further integrated into healthy system planning.[45]

Further, the legalization of medical assistance in dying (MAiD) in many jurisdictions, societal awareness of MAiD, and the impact of MAiD interventions upon older adult suicide should also all be considered in future work. From a policy perspective, ongoing training of health-care providers to improve suicide screening assessments on older adults must also be explored in further depth. Health-care providers can take a proactive role toward advocating for the needs of older adults, by developing care models and supportive mechanisms that can better identify at-risk individuals. Moreover, the needs of older adults who are systematically oppressed due to historical prejudice and discrimination, such as those who are homeless or part of the 2SLGBTQ+ community, should not be overlooked as well.[46-48]

Strengths and Limitations

The findings from this population-based research study provided insights related to the complexity of suicide in older adults in Ontario, Canada. The interlinked population-level data provided a comprehensive overview of the prevalence and the factors directly associated with older adult suicide, which can be used to inform decision-making processes surrounding suicide prevention programs and policies, both provincially and nationally.

While the study possessed strengths, there are several limitations that should be considered when interpreting the findings of this study. First, the accuracy of suicide deaths listed in this study may not fully express the true number of older adult suicides in Ontario, Canada. Even with defining suicide deaths in older adults using ORGD requirements, suicide deaths could still potentially have been misclassified or underreported.[1,8,21] Further research to examine the issue

of misclassification or underreporting of suicide deaths and the specific characteristic profile of older adults who died by suicide or experienced suicide attempts should be sought. Second, as with studies utilizing secondary data,[49-51] the variables selected for inclusion in the study were limited to those captured by health-care administrative data, and in some cases, were not as specific as would have been preferred. Although efforts to control for confounding were undertaken, due to the administrative nature of the source data, residual confounding is likely. For example, factors previously identified as being associated with suicide deaths (i.e., chronic pain, new diagnosis of specific mental illnesses, and other social determinants of health) could not be included because they were either unavailable or poorly defined in the administrative data sources. Third, the exclusion criteria of this study meant that the health inequities of other older adult subcohorts (i.e., newcomers, individuals experiencing homelessness, 2SLBTQ+) could not be assessed in further depth. With the reported rise of emergency shelter usage among homeless older adults in Canada,[47] economic barriers of newcomers accessing health-care services during a three-month wait period prior to provincial coverage,[52] and lack of mental health services stemming from traumatic experiences faced by 2SLGBTQ+ Canadian older adults,[48] it is essential that these factors—along with other unmet needs—be further explored in future research. Finally, while MAiD was legalized in Canada in 2016, this medical intervention was purposefully excluded in this study through the selection of the 2011–2015 period in an effort to reduce the potential of residual confounding. While excluding MAiD could be conceived as a study limitation, the results of this study could be used to inform future MAiD-specific research related to older adults in the province of Ontario.

CONCLUSION

With an average of 200 deaths of older adults (aged 65+) in Ontario per year for five years (2011–2015), it is important to be aware that suicide exists in the older adult population. Although not an exhaustive list, the factors highlighted in this population-based study provide a better understanding of the complexity of suicide in older adults, and can be used to provide insights for the improvement of programs and policies related to this demographic.

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CONFLICT OF INTEREST DISCLOSURES

We have read and understood the Canadian Geriatrics Journal's policy on conflicts of interest disclosure and declare no conflicts of interest.

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APPENDIX A. Databases and Definitions Used

TABLE A1: ICES databases used in the study and their descriptions

Database	Description
Registered Persons Database (RPDB)	Contains basic demographic information (age and sex), income (categorized into quintiles), location or residence (rurality and urban, and geographical location i.e., LHIN-Local Health Integration Network)
Office of the Registrar General – Deaths (ORGD) Vital Statistics Database	Contains data on Ontario individuals' mortality (i.e. causes and other demographic information)
Ontario Population Estimates and Projections (POP)	Contains data on populations estimates and projections in Ontario
Ontario Drug Benefit Claims (ODB)	Contains claims for prescription drugs received under the ODB program (most are for those $\geq$65 years of age)
CIHI-Discharge Abstract Database (DAD)	Contains patient-level data for acute, rehab, chronic and day surgery institutions in Ontario
CIHI-National Ambulatory Care Reporting System (NACRS)	Contains patient visits to hospital- and community-based ambulatory care centres (i.e. emergency departments, day surgery units, hemodialysis units, and cancer care clinics)
Ontario Health Insurance Plan (OHIP)	Contains claims data on inpatient and outpatient services paid for by the Ontario Health Insurance Plan for most healthcare professionals in the province
CIHI-Ontario Mental Health Reporting System (OMHRS)	Contains administrative, clinical (diagnoses and procedures), demographic, and administrative information for all admissions to adult designated inpatient mental health beds
ICES Physician Database (IPDB)	Contains data about all physicians who have practiced in Ontario and other data included in the OHIP Claims History Database, the OHIP Corporate Provider Database (CPDB), and the Ontario Physician Human Resource Data Centre Database (OPHRDC)
Cancer Care Ontario-Ontario Cancer Registry (OCR)	Contains data on all Ontario residents who have been newly diagnosed with or died of cancer (except non-melanoma skin cancers)
Ontario Asthma Database (ASTHMA)	An ICES-derived cohort that contains all Ontario individuals identified as having Asthma
Ontario Congestive Heart Failure Database (CHF)	An ICES-derived cohort that contains all Ontario individuals identified as having CHF
Ontario Chronic Obstructive Pulmonary Disease (COPD)	An ICES-derived cohort that contains all Ontario patients with COPD
Ontario Dementia Database (DEMENTIA)	An ICES-derived cohort that contains all Ontario individuals with Dementia
Ontario Human Immunodeficiency Database (HIV)	An ICES-derived cohort that contains all Ontario HIV positive patients
Ontario Hypertension Database (HYPER)	An ICES-derived cohort that contains all Ontario individuals identified as having hypertension
Ontario Crohn's and Colitis dataset (OCCC)	An ICES-derived cohort that contains all Ontario individuals identified as having Crohn's or Colitis
Ontario Diabetes Database (ODD)	An ICES-derived cohort that contains all incident cases of diabetes in Ontario
Ontario Rheumatoid Arthritis Database (ORAD)	An ICES-derived cohort that contains all Ontario individuals identified as having Rheumatoid Arthritis
Ontario Myocardial Infarction Database (OMID)	An ICES-derived cohort that contains hospitalized patients with first acute myocardial infarction

TABLE A2: Databases and codes used to define medical conditions

Medical Conditions	Definition
Congestive Heart Failure (CHF)[1]	The CHF Database was used to identify patients with CHF, based on 1 Hospitalization record (CIHI-DAD, CIHI-SDS, OMHRS, OHIP billing for Q050), or 1 OHIP/ED (ambulatory record) followed by a second record from either source (Hosp/ED/OHIP) within 1 year. OHIP OHIP diagnostic code: 428 CIHI-DAD, CIHI-SDS ICD-9 diagnostic code: 428 ICD-10 diagnostic code: I500, I501, I509
Acute Myocardial Infarction (MI)[2]	The OMID Database was used to identify patients with a history of acute MI using OHIP, CIHI-DAD, and CIHI-SDS. OHIP OHIP service codes: C132, C133, C134, C135, C136, C137, C139, C435, C602, C603, C604, C605, C606, C607, C609, C675, C002, C003, C004, C005, C006, C007, C009, C905, G297, G557, G558, G559, G400, G401, G402, G405, G406, G407, R742, R743, Z434, Z442. CIHI-DAD, CIHI-SDS CCI procedure codes: 3IS10, 3IP10, 2HZ28, 1IJ50, 1IJ57, or 1IJ76 CCP procedure codes: 4802, 4803, 4809, 4892, 4893, 4894, 4895, 4896, 4897, 4898, 4996, or 4997 ICD-9 diagnostic codes: 410, 411, 413, or 428 ICD-10 diagnostic codes: I21, I50, or I20
Asthma[3]	The ASTHMA database was used to identify patients with asthma, based on ≥1 Hospitalization or ≥2 OHIP (ambulatory claims) in a two-year period. OHIP OHIP diagnostic code: 493 CIHI-DAD ICD-9 diagnostic code: 493 ICD-10 diagnostic codes: J45, J46
Chronic Obstructive Pulmonary Disease (COPD)[4]	The COPD database was used to identify patients with COPD, based on ≥1 Hospitalization (DAD/SDS) or ≥3 OHIP (ambulatory care) in a two-year period. OHIP OHIP diagnostic codes: 491, 492, 496 CIHI-DAD ICD-9 diagnostic codes: 491, 492, 496 ICD-10 diagnostic codes: J41, J42, J43, J44
Diabetes[5,6]	The ODD database was used to identify patients with diabetes, based on ≥2 OHIP diagnosis code OR ≥ 1 Hospitalization OR ≥1 physician claim with a diabetes-specific fee code within 2 years. OHIP OHIP diagnostic code: 250 OHIP service codes: Q040, K029, K030, K045, K046 CIHI-DAD, CIHI-SDS ICD-9 diagnostic code: 250 ICD-10 diagnostic codes: E10, E11, E13, E14
Hypertension (HTN)[7,8]	The HYPER Database was used to identify patients with diabetes, based on ≥1 Hospitalization (admission and discharge with a diagnosis of hypertension) OR ≥2 OHIP claim (physician billing claims) in a 2-year period; OR 1 OHIP followed by OHIP/Hospitalization within two years. OHIP OHIP diagnostic codes: 401, 402, 403, 404, or 405 CIHI-DAD, CIHI-SDS ICD-9 diagnostic codes: 401, 402, 403, 404, 405 ICD-10 diagnostic codes: 110, 111, 112, 113, 115

TABLE A2: (Continued)

Medical Conditions	Definition
Chronic Liver Disease (CLD)[9]	The DAD, NACRS and OHIP databases were used to identify patients with CLD, using the following definitions: Any hospitalization or ED visit with a diagnosis code, OR Any OHIP claim with both a feecode and diagnosis code OHIP OHIP diagnostic codes: 070, 571, 573 OHIP fee codes: Z551 and Z554 DAD ICD-10 diagnostic codes: B16, B17, B18, B19, B942, E830, E831, I85, K70, K713, K714, K715, K717, K721, K729, K73, K74, K753, K754, K758, K759, K76, K77, R160, R162, R17, R18, Z225. Refer to Appendix B, Table B1 (BC_CLD) for detailed description of the listed codes.
Chronic Kidney Disease (CKD)[9-13]	The DAD, NACRS and OHIP databases were used to identify patients with CLD. OHIP OHIP diagnostic codes: 403, 580, 581, 585. DAD ICD-10 diagnostic codes: E102, E112, E132, E142, I12, I13, N00, N01, N02, N03, N04, N05, N06, N07, N08, N10, N11, N12, N13, N14, N16, N17, N18, N19, N20, N21, N22, N23, N25. Refer to Appendix B, Table B2 (BC_CKD) for detailed description of the listed codes.
Chronic Dialysis User[13,14]	The DAD and OHIP databases were used to identify patients who were chronic dialysis users, based on any 2 codes separated by at least 90 days, but less than 150 days. OHIP OHIP fee codes: R849, G323, G325, G326, G860, G862, G863, G865, G866, G082, G083, G085, G090, G091, G092, G093, G094, G095. DAD CCI procedure codes:1PZ21HQBS, 1PZ2HQBR, 1PZ21HPD4 Refer to Appendix B, Table B3 (BC_CDU) for detailed description of the listed codes.
Rheumatoid Arthritis[15]	The ORAD database was used to identify patients with Rheumatoid Arthritis, based on ≥1 Hospitalization with any type of RA diagnosis code OR ≥3 OHIP claim in a two-year period (with ≥1 of the claims made by a musculoskeletal specialist). OHIP OHIP diagnostic codes: 714 DAD ICD-10 diagnostic codes: M05, M06.
Crohn's/Ulcerative Colitis[16]	The OCCC database was used to identify patients with Crohn's/Ulcerative Colitis, using the following definition for older adults (65+): Two years of OHIP eligibility and ≥5 Hospitalization/ED/OHIP in a four-year period and ≥1 ODB claim for IBD medication OHIP OHIP diagnostic codes: 555, 556. DAD ICD-10 diagnostic codes: K50, K51.
Human Immunodeficiency Virus (HIV)[17]	The HIV database was used to identify patients with HIV, based on ≥3 OHIP claims in a three-year period. OHIP OHIP diagnostic codes: 042, 043, 044. DAD ICD-10 diagnostic codes: B20, B21, B22, B23, B24.
Cancer[18]	The OCR database was used to identify patients with a history of cancer in Ontario, except for non-melanoma skin cancer. For recent diagnosis of cancer, this definition was used: "New" Dx of cancer are those beginning within 2-year prior to index date

TABLE A2: (Continued)

Medical Conditions	Definition
Dementia[19]	The DEMENTIA database was used to identify patients with dementia, based on ≥1 Hospitalization (DAD/SDS) for dementia; OR ≥1 ODB claim for cholinesterase inhibitors; OR ≥3 OHIP claim at least 30 days apart in a two-year period. For new diagnosis of dementia, this definition was used: "New" Dx of dementia are those beginning within 2-year prior to index date. OHIP OHIP diagnostic codes: 290, 331 CIHI-DAD, CIHI-SDS ICD-9 diagnostic codes: 0461, 290, 294, 331.0, 331.1, 331.5 ICD-10 diagnostic codes: F00, F01, F02, F03, G30 ODB 1 prescription for a cholinesterase inhibitor
Mental Illness-Psychotic Disorders[20,21]	The DAD, OMHRS, and OHIP databases were used to identify patients with psychotic disorders, based on hospitalization with a diagnosis code OR 2 claims in 2 years or less with both a feecode and diagnosis code from the following code list: OHIP OHIP diagnosis codes: 295, 296, 297, 298. OHIP fee codes: K005, K007, K623, A001, A003, A004, A005, A006, A007, A008, A888, A901, A905. DAD ICD-10 diagnosis codes: F20, F22, F23, F24, F25, F28, F29, F323, F333. DSM-IV 295, 297, 298, 312 Refer to Appendix B, Table B4 (BC_PSY) for detailed description of the listed codes.
Mental Illness-Non-Psychotic Disorders[20,21]	The DAD, OMHRS, and OHIP databases were used to identify patients with non-psychotic disorders, based on 1 hospitalization with a diagnosis code OR 2 claims in 2 years or less with both a feecode and diagnosis code from the following code list: OHIP OHIP diagnosis codes: 300, 301, 302, 306, 309, 311 OHIP fee codes: K005, K007, K623, A001, A003, A004, A005, A006, A007, A008, A888, A901, A905 DAD ICD-10 diagnosis codes: F21, F30, F31, F321, F322, F328, F330, F331, F332, F334, F338, F339, F348, F349, F380, F381, F388, F39, F40, F41, F42, F43, F48, F60, F93. DSM-IV 296, 300, 30000, 3002, 3003, 3004, 30113, 3083, 3090, 30924, 30928, 3093, 3094, 3098, 3099. Refer to Appendix B, Table B5 (BC_nPSY) for detailed description of the listed codes.
Mental Illness-Substance Use Disorders[20,21]	The DAD, OMHRS, and OHIP databases were used to identify patients with substance abuse disorders, based on 1 hospitalization with a diagnosis code OR 2 claims in 2 years or less with both a feecode and diagnosis code from the following code list: OHIP OHIP fee codes: K005, K007, K623, A001, A003, A004, A005, A006, A07, A008, A888, A901, A905. OHIP diagnosis codes: 303, 304. DAD ICD-10 diagnosis codes: F10, F11, F12, F13, F14, F15, F16, F17, F18, F19, F55 DSM-IV 291 (all 291 codes, excluding 291.82), 292 (all 292 codes, excluding 292.85), 303, 304, 305 Refer to Appendix B, Table B6 (BC_SUB) for detailed description of the listed codes.
Mental Illness-Others (Social Problems and Others; not including dementia)[20,21]	The DAD, OMHRS, and OHIP databases were used to identify patients with other mental illness and social problems (excluding dementia), based 2 claims in 2 years or less with both a feecode and diagnosis code from the following code list: OHIP OHIP fee codes: K005, K007, K623, A001, A003, A004, A005, A006, A007, A008, A888, A901, A905 OHIP diagnostic codes: 897, 898, 899, 900, 901, 901, 902, 904, 905, 906, 909. DAD ICD-10 diagnostic codes: F44, F45, F50, F51, F52, F53, F45, F55, F59, F61, F62, F63, F64, F65, F66, F68, F69, F70, F71, F72, F73, F78, F79, F80, F81, F82, F83, F84, F88, F89, F90, F91, F92, F94, F95, F98, F99. Refer to Appendix B, Table B7 (BC_OTH) for detailed description of the listed codes.

TABLE A3: Databases and codes used to define mortality

Mortality	Definition
Suicide[22-26]	The ORGD database was used to gather data on suicide deaths in older adults, based on the following: COD in: E950-E959, OR COD_UNDERLYING_ICD10 in: X60-X84, OR MANNER_OF_DEATH = "4" ICD-9 E950, E951, E952, E953, E954, E955, E956, E957, E958, E959 ICD-10 *Poisoning*: X60, X61, X62, X63, X64, X65, X66, X67, X68, X69 *Asphyxiation*: X70, X71 *Violence (firearms, explosives, crashes and stabbings)*: X72, X73, X74, X75, X76, X77, X78, X79, X80, X81, X82 *Other*: X83, X84 Refer to Appendix B, Table B8 (OUT_SUIC) for detailed description of the listed codes.
Non-Suicide	The ORGD database was used to gather data on non-suicide deaths in older adults, based on: For primary exposure: COD or COD_UNDERLYING_ICD10 codes not in Appendix B, Table B8 (OUT_SUIC). For secondary exposure: COD or COD_UNDERLYING_ICD10 codes not in Appendix B, Table B8 (OUT_SUIC) or Appendix B, Table B9 (OUT_NONSUIC_PROB).
Probable Suicide[22,23,27-29]	The ORGD database was used to gather data on probable suicide deaths in older adults, based on the following: COD in: E980-E987, E989 COD_UNDERLYING_ICD10 in: Y10-Y32, Y34, Y87 ICD-9 *Undertermined Poisoning*: E980, E981, E982 *Undertermined Asphyxiation*: E983, E984 *Undetermined injury from Violence (firearms, explosions, stabbing)*: E985, E986 *Undetermined Injury from Fall*: E987 E989 ICD-10 *Poisoning or Undetermined Poisoning*: Y10, Y11, Y12, Y13, Y14, Y15, Y16, Y17, Y18, Y19 *Hanging, Strangulation and Suffocation, Drowning*: Y20, Y21 *Violence (firearms, explosives, crashes and stabbings)*: Y22, Y23, Y24, Y25, Y26, Y27, Y28, Y29, Y30, Y31, Y32, Y34 Y87 Refer to Appendix B, Table B9 (OUT_NONSUIC_PROB) for detailed description of the listed codes.

APPENDIX B: Definitions of Codes for Other Non-ICES-derived Variables

TABLE B1: Chronic liver disease (BC_CLD) variable—definitions of codes used[9]

Code Type	Codes	Description
DAD DXCODE ICD 10	B16	Acute hepatitis B
	B17	Other acute viral hepatitis
	B18	Chronic viral hepatitis
	B19	Unspecified viral hepatitis
	B942	Sequelae of viral hepatitis
	E830	Disorder of copper metabolism
	E831	Disorder of iron metabolism
	I85	Esophageal varices
	K70	Alcoholic liver disease
	K713	Toxic liver disease with chronic persistent hepatitis
	K714	Toxic liver disease with chronic lobular hepatitis
	K715	Toxic liver disease with chronic active hepatitis
	K717	Toxic liver disease with fibrosis and cirrhosis of liver
	K721	Chronic hepatic failure
	K729	Hepatic failure, unspecified
	K73	Chronic hepatitis, not elsewhere classified
	K74	Fibrosis and cirrhosis of liver
	K753	Granulomatous hepatitis, not elsewhere classified
	K754	Autoimmune hepatitis
	K758	Other specified inflammatory liver diseases
	K759	Inflammatory liver disease, unspecified
	K76	Other diseases of the liver
	K77	Liver disorders in diseases classified elsewhere
	R160	Hepatomegaly, not elsewhere classified
	R162	Hepatomegaly with splenomegaly, not elsewhere classified
	R17	Unspecified jaundice
	R18	Ascites
	Z225	Carrier of viral hepatitis B
OHIP DXCODE	070	Viral hepatitis
	571	Cirrhosis of the liver (e.g. alcoholic cirrhosis, biliary cirrhosis)
	573	Other diseases of the liver
OHIP fee	Z551	Liver-incision-biopsy, needle
	Z554	Liver-incision-biopsy

TABLE B2: Chronic kidney disease (BC_CKD) variable—definitions of codes used[9-13]

Code Type	Codes	Description
DAD DX10CODE - ICD 10	E102	Type 1 diabetes mellitus with incipient diabetic nephropathy
	E112	Type 2 diabetes mellitus with end-stage renal disease [ESRD]
	E132	Other specified diabetes mellitus with incipient diabetic nephropathy
	E142	Unspecified diabetes mellitus with incipient diabetic nephropathy
	I12	Hypertensive Renal Disease
	I13	Hypertensive heart and renal disease
	N00	Acute nephritic syndrome
	N01	Rapidly progressive nephritic syndrome
	N02	Recurrent and persistent hematuria
	N03	Chronic nephritic syndrome
	N04	Nephrotic syndrome
	N05	Unspecified nephritic syndrome
	N06	Isolated proteinuria with specified morphological lesion
	N07	Hereditary nephropathy, not elsewhere classified
	N08	Glomerular disorders in diseases classified elsewhere
	N10	Acute tubulo-interstitial nephritis
	N11	Chronic tubulo-interstitial nephritis
	N12	Tubulo-interstitial nephritis, not specified as acute or chronic
	N13	Obstructive and reflux uropathy
	N14	Drug- and heavy-metal-induced tubulo-interstitial and tubular conditions
	N16	Renal tubulo-interstitial disorders in disease classified elsewhere
	N17	Acute renal failure
	N18	Chronic renal failure
	N19	Unspecified kidney failure
	N20	Calculus of kidney and ureter
	N21	Calculus of lower urinary tract
	N22	Calculus of urinary tract in diseases classified elsewhere
	N23	Unspecified renal colic
	N25	Disorders resulting from impaired renal tubular function
OHIP DXCODE	403	Hypertensive Renal Disease
	580	Acute glomerulonephritis
	581	Nephrotic syndrome
	585	Chronic renal failure, uremia

Table B3: Chronic dialysis user (BC_CDU) variable—definitions of codes used[13,14]

Source	Code	Description
CCI	1PZ21HQBS	Dialysis, urinary system NEC continuous venovenous hemodialysis
	1PZ21HQBR	Dialysis, urinary system NEC hemodialysis
	1PZ21HPD4	Dialysis, urinary system NEC peritoneal dialysis using dialysate
OHIP feecode	R849	Dialysis – Haemodialysis - Initial & acute
	G323	Dialysis – Haemodialysis - Acute, repeat (max 3)
	G325	Dialysis – Haemodialysis - Medical component (incl. in unit fee)
	G326	Dialysis - Chronic, contin. haemodialysis or haemofiltration each
	G860	Chronic hemodialysis hospital location
	G862	Hospital self-care chronic hemodialysis
	G863	Chronic hemodialysis IHF location
	G865	Chronic Home hemodialysis
	G866	Intermittent hemodialysis treatment centre
	G082	Continuous venovenous haemodialfiltration
	G083	Continuous venovenous haemodialysis
	G085	Continuous venovenous haemofiltration
	G090	Veneovenous slow continuous ultrafiltration
	G091	Continuous arteriovenous haemodialysis
	G092	Continuous arteriovenous haemodiafiltration
	G093	Haemodiafiltration - Contin. Init & Acute (repeatx3)
	G094	Haemodiafiltration - Contin. Chronic
	G095	Slow Continuous Ultra Filtration - Initial & Acute (repeat)

TABLE B4: Mental illness–psychotic disorders (BC_PSY) variable—definitions of codes used[20,21]

Code Type	Codes	Description
ICD-10	F20	Schizophrenia
	F22	Persistent delusional disorders
	F23	Acute and transient psychotic disorders
	F24	Induced delusional disorder
	F25	Schizoaffective disorders
	F28	Other nonorganic psychotic disorders
	F29	Unspecified nonorganic psychosis
	F323	Severe depressive episode with psychotic symptoms
	F333	Recurrent depressive disorder, current episode severe with psychotic symptoms
OHIP DXCODE	295	Schizophrenia
	296	Manic depressive psychosis, involutional melancholia
	297	Paranoid states
	298	Other psychoses
OHIP FEE CODE	K005	Primary mental healthcare - Individual care (30 mins)
	K007	Psychotherapy
	K623	Form 1 (APA)
	A001	Minor assessment
	A003	General assessment
	A004	General re-assessment
	A005	Consultation
	A006	Repeat consultation
	A007	Intermediate assessment
	A008	Mini assessment
	A888	Partial assessment
	A901	House call assessment
	A905	Limited consultation
DSM-4	295	Schizophrenia
	297	Delusional Disorders
	298	Psychotic Disorders
	312	Impulse Control Disorders (-omanias)

TABLE B5: Mental illness–non-psychotic disorders (BC_nPSY) variable—definitions of codes used[20,21]

Code Type	Codes	Description
ICD-10	F21	Schizotypal disorder
	F30	Manic episode
	F31	Bipolar affective disorder
	F321	Moderate depressive episode
	F322	Severe depressive episode without psychotic symptoms
	F328	Other depressive episodes
	F330	Recurrent depressive disorder, current episode mild
	F331	Recurrent depressive disorder, current episode moderate
	F332	Recurrent depressive disorder, current episode severe without psychotic symptoms
	F334	Recurrent depressive disorder, currently in remission
	F338	Other recurrent depressive disorders
	F339	Recurrent depressive disorder, unspecified
	F348	Other persistent mood [affective] disorders
	F349	Persistent mood [affective] disorder, unspecified
	F380	Other single mood [affective] disorders
	F381	Other recurrent mood [affective] disorders
	F388	Other specified mood [affective] disorders
	F39	Unspecified mood [affective] disorder
	F40	Phobic anxiety disorders
	F41	Other anxiety disorders
	F42	Obsessive-compulsive disorder
	F43	Reaction to severe stress, and adjustment disorders
	F48	Other neurotic disorders
	F60	Specific personality disorders
	F93	Emotional disorders with onset specific to childhood
OHIP DXCODE	300	Anxiety neurosis, hysteria, neurasthenia, obsessive compulsive neurosis, reactive depression
	301	Personality disorders (e.g., paranoid personality, schizoid personality, obsessive compulsive personality)
	302	Sexual deviations
	306	Psychosomatic disturbances
	309	Adjustment reaction
	311	Depressive or other non-psychotic disorders, not elsewhere classified
OHIP FEE CODE	K005	Primary mental healthcare - Individual care (30 mins)
	K007	Psychotherapy
	K623	Form 1 (APA)
	A001	Minor assessment
	A003	General assessment
	A004	General re-assessment
	A005	Consultation
	A006	Repeat consultation
	A007	Intermediate assessment
	A008	Mini assessment
	A888	Partial assessment
	A901	Housecall assessment
	A905	Limited consultation
DSM-4	296	Major Depressive and Bipolar Disorders
	300	Anxiety Disorder NOS
	3000	Panic and Anxiety Disorders
	3002	Phobias
	3003	Obsessive-compulsive disorder
	3004	Dysthymic Disorder
	30113	Cyclothymic Disorder
	3083	Acute Stress Disorder
	3090	Adjustment Disorder with Depression
	30924	Adjustment Disorder with Anxiety
	30928	Adjustment Disorder with Mixed Anxiety and Depressed Mood
	3093	Adjustment Disorder with Disturbance of Conduct
	3094	Adjustment Disorder with Mixed Disturbances of Emotions and Conduct
	3098	Post-traumatic Stress Disorders
	3099	Adjustment Disorder, Unspecified

TABLE B6: Mental illness–substance abuse disorders (BC_SUB) variable—definitions of codes used[20,21]

Code Type	Codes	Description
OHIP DXCODE	303	Alcohol intoxication
	304	Substance dependence
ICD-10	F10	Mental and behavioural disorders due to use of alcohol
	F11	Mental and behavioural disorders due to use of opioids
	F12	Mental and behavioural disorders due to use of cannabinoids
	F13	Mental and behavioural disorders due to use of sedatives or hypnotics
	F14	Mental and behavioural disorders due to use of cocaine
	F15	Mental and behavioural disorders due to use of other stimulants, including caffeine
	F16	Mental and behavioural disorders due to use of hallucinogens
	F17	Mental and behavioural disorders due to use of tobacco
	F18	Mental and behavioural disorders due to use of volatile solvents
	F19	Mental and behavioural disorders due to multiple drug use and use of other psychoactive substances
	F55	Abuse of non-dependence-producing substances
OHIP FEE CODE	K005	Primary mental healthcare - Individual care (30 mins)
	K007	Psychotherapy
	K623	Form 1 (APA)
	A001	Minor assessment
	A003	General assessment
	A004	General re-assessment
	A005	Consultation
	A006	Repeat consultation
	A007	Intermediate assessment
	A008	Mini assessment
	A888	Partial assessment
	A901	Housecall assessment
	A905	Limited consultation
	303	Alcohol intoxication
	304	Substance dependence
	305	Substance Abuse

TABLE B7: Mental illness–social problems and others, not including dementia (BC_OTH) Variable—definitions of codes used[20,21]

Code Type	Codes	Description
OHIP DXCODE	897	Economic problems
	898	Marital issues
	899	Parent-child issues
	900	Problems with aged parents or in-laws
	901	Family disruption/divorce
	902	Education problems
	904	Social maladjustment
	905	Occupational problems
	906	Legal problems
	909	Other problems of social adjustment
ICD 10	F44	Dissociative [conversion] disorders
	F45	Somatoform disorders
	F50	Eating disorders
	F51	Nonorganic sleep disorders
	F52	Sexual dysfunction, not caused by organic disorder or disease
	F53	Mental and behavioural disorders associated with the puerperium, not elsewhere classified
	F54	Psychological and behavioural factors associated with disorders or diseases classified elsewhere
	F55	Abuse of non-dependence-producing substances
	F59	Unspecified behavioural syndromes associated with physiological disturbances and physical factors
	F61	Mixed and other personality disorders
	F62	Enduring personality changes, not attributable to brain damage and disease
	F63	Habit and impulse disorders
	F64	Gender identity disorders
	F65	Disorders of sexual preference
	F66	Psychological and behavioural disorders associated with sexual development and orientation
	F68	Other disorders of adult personality and behaviour
	F69	Unspecified disorder of adult personality and behaviour
	F70	Mild mental retardation
	F71	Moderate mental retardation
	F72	Severe mental retardation
	F73	Profound mental retardation
	F78	Other mental retardation
	F79	Unspecified mental retardation
	F80	Specific developmental disorders of speech and language
	F81	Specific developmental disorders of scholastic skills
	F82	Specific developmental disorder of motor function
	F83	Mixed specific developmental disorders
	F84	Pervasive developmental disorders
	F88	Other disorders of psychological development
	F89	Unspecified disorder of psychological development
	F90	Hyperkinetic disorders
	F91	Conduct disorders
	F92	Mixed disorders of conduct and emotions
	F94	Disorders of social functioning with onset specific to childhood and adolescence
	F95	Tic disorders
	F98	Other behavioural and emotional disorders with onset usually occurring in childhood and adolescence
	F99	Mental disorder, not otherwise specified

TABLE B7: (Continued)

Code Type	Codes	Description
OHIP FEE CODE	K005	Primary mental healthcare - Individual care (30 min)
	K007	Psychotherapy
	K623	Form 1 (APA)
	A001	Minor assessment
	A003	General assessment
	A004	General re-assessment
	A005	Consultation
	A006	Repeat consultation
	A007	Intermediate assessment
	A008	Mini assessment
	A888	Partial assessment
	A901	House call assessment
	A905	Limited consultation
DSM-4	299	Autism-Spectrum Disorders
	30016	Factitious Disorder With Predominantly Psychological Signs and Symptoms
	30019	Factitious Disorder, NOS
	3026	Gender Identity Disorder
	3071	Anorexia Nervosa
	3072	Tic Disorders
	3073	Stereotypic Movement Disorders
	3075	Eating Disorders
	30751	Bulimia Nervosa
	3076	Enuresis (Involuntary Urination), Not Due to a Medical Condition
	3077	Encopresis (Involuntary Defecation), Without Constipation and Overflow Incontinence
	314	Attention-Deficit/Hyperactivity Disorder
	315	Learning Disorders
	7876	Encopresis (Involuntary Defecation), With Constipation and Overflow Incontinence

TABLE B8: 'Death by suicide' (OUT_SUIC) outcome—definitions of codes used[22-26]

Code Type	Codes	Description
ICD10	*Poisoning*	
	X60	Intentional self-poisoning by and exposure to nonopioid analgesics, antipyretics and antirheumatics
	X61	Intentional self-poisoning by and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified
	X62	Intentional self-poisoning by and exposure to narcotics and psychodysleptics [hallucinogens], not elsewhere classified
	X63	Intentional self-poisoning by and exposure to other drugs acting on the autonomic nervous system
	X64	Intentional self-poisoning by and exposure to other and unspecified drugs, medicaments and biological substances
	X65	Intentional self-poisoning by and exposure to alcohol
	X66	Intentional self-poisoning by and exposure to organic solvents and halogenated hydrocarbons and their vapours
	X67	Intentional self-poisoning by and exposure to other gases and vapours
	X68	Intentional self-poisoning by and exposure to pesticides
	X69	Intentional self-poisoning by and exposure to other and unspecified chemicals and noxious substances
	Asphyxiation	
	X70	Intentional self-harm by hanging, strangulation and suffocation
	X71	Intentional self-harm by drowning and submersion
	Violence (firearms, explosives, crashes and stabbings)	
	X72	Intentional self-harm by handgun discharge
	X73	Intentional self-harm by rifle, shotgun and larger firearm discharge
	X74	Intentional self-harm by other and unspecified firearm discharge
	X75	Intentional self-harm by explosive material
	X76	Intentional self-harm by smoke, fire and flames
	X77	Intentional self-harm by steam, hot vapours and hot objects
	X78	Intentional self-harm by sharp object
	X79	Intentional self-harm by blunt object
	X80	Intentional self-harm by jumping from a high place
	X81	Intentional self-harm by jumping or lying before moving object
	X82	Intentional self-harm by crashing of motor vehicle
	Other	
	X83	Intentional self-harm by other specified means
	X84	Intentional self-harm by unspecified means
ICD9	E950	Suicide and self-inflicted poisoning by solid or liquid substances
	E951	Suicide and self-inflicted poisoning by gases in domestic use
	E952	Suicide and self-inflicted poisoning by other gases and vapors
	E953	Suicide and self-inflicted injury by hanging strangulation and suffocation
	E954	Suicide and self-inflicted injury by submersion (drowning)
	E955	Suicide and self-inflicted injury by firearms air guns and explosives
	E956	Suicide and self-inflicted injury by cutting and piercing instrument
	E957	Suicide and self-inflicted injury by jumping from high place
	E958	Suicide and self-inflicted injury by other and unspecified means
	E959	Late effects of self-inflicted injury

TABLE B9: 'Death by probable suicide' (OUT_NONSUIC_PROB) outcome—definitions of codes used[22-26]

Code Type	Codes	Description
ICD9		*Undetermined Poisoning*
	E980	Poisoning by solid or liquid substances undetermined whether accidentally or purposely inflicted
	E981	Poisoning by gases in domestic use undetermined whether accidentally or purposely inflicted
	E982	Poisoning by other gases undetermined whether accidentally or purposely inflicted
		Undetermined Asphyxiation
	E983	Hanging strangulation or suffocation undetermined whether accidentally or purposely inflicted
	E984	Submersion (drowning), undetermined whether accidentally or purposely inflicted
		Undetermined Injury from Violence (firearms, explosions, stabbing)
	E985	Injury by firearms, air guns and explosives undetermined whether accidentally or purposely inflicted
	E986	Injury by cutting and piercing instruments, undetermined whether accidentally or purposely inflicted
		Undetermined Injury from Fall
	E987	Falling from high place undetermined whether accidentally or purposely inflicted
	E989	Late effects of injury, undetermined whether accidentally or purposely inflicted
ICD10		*Poisoning or Undetermined Poisoning*
	Y10	Poisoning by and exposure to nonopioid analgesics, antipyretics and antirheumatics, undetermined intent
	Y11	Poisoning by and exposure to antiepileptic, desative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified, undetermined intent
	Y12	Poisoning by and exposure to narcotics and psychodysleptics [hallucinogens], not elsewhere classified, undetermined intent
	Y13	Poisoning by and exposure to other drugs acting on the autonomic nervous system, undetermined intent
	Y14	Poisoning by and exposure to other and unspecified drugs, medicaments and biological substances, undetermined intent
	Y15	Poisoning by and exposure to alcohol, undetermined intent
	Y16	Poisoning by and exposure to organic solvents and halogenated hydrocarbons and their vapours, undetermined intent
	Y17	Poisoning by and exposure to other gases and vapours, undetermined intent
	Y18	Poisoning by and exposure to pesticides, undetermined intent
	Y19	Poisoning by and exposure to other and uspecified chemicals and noxious substances, undetermined intent
		Hanging, Strangulation and Suffocation, Drowning
	Y20	Hanging, strangulation and suffocation, undetermined intent
	Y21	Drowning and submersion, undetermined intent
		Violence (firearms, explosives, crashes and stabbings)
	Y22	Handgun discharge, undetermined intent
	Y23	Rifle, shotgun and larger firearm discharge, undetermined intent
	Y24	Other and unspecified firearm discharge, undetermined intent
	Y25	Contact with explosive material, undetermined intent
	Y26	Exposure to smoke, fire and flames, undetermined intent
	Y27	Contact with steam, hot vapours and hot objects, undetermined intent
	Y28	Contact with sharp object, undetermined intent
	Y29	Contact with blunt object, undetermined intent
	Y30	Falling, jumping or pushed from a high place, undetermined intent
	Y31	Falling, lying or running before or into moving object, undetermined intent
	Y32	Crashing of motor vehicle, undetermined intent
	Y34	Unspecified event, undetermined intent
	Y87	Sequelae of intentional self-harm, assault and events of undetermined intent

APPENDIX C: Sensitivity analysis—adjust odds ratios of characteristic associated with suicide or probable suicide deaths among older adults who died in Ontario between 2011 and 2015[a]

Characteristic	OR	95% CI	p value
Demographics			
Age (continuous)	0.937	0.928, 0.946	<.0001
Sex (reference=females)	2.88	2.447, 3.39	<.0001
Marital Status (reference=married)			
Married (combined m=married & c=common-law)	REF		
Widowed (w)	1.121	0.942, 1.335	.3064
Divorced (d)	1.126	0.899, 1.411	.3247
Single (s)	0.899	0.696, 1.16	.5142
Other (combined missing, o=other, u=unknown)	0.823	0.299, 2.268	.661
Income quintile (reference=quintile 5; recode missing to '3')			
Quintile 1	0.935	0.761, 1.15	.5965
Quintile 2	0.845	0.682, 1.047	.3201
Quintile 3	0.874	0.703, 1.085	.6168
Quintile 4	0.876	0.702, 1.094	.6614
Quintile 5	REF		
Rural (reference=urban; recode missing to urban)	1.308	1.098, 1.558	.0026
LTC (reference=no)	0.096	0.057, 0.162	<.0001
Comorbidities (reference=no)			
Charlson score			
0 (combined 0 and 'no hospitalizations')	REF		
1	0.362	0.295, 0.446	.0234
2+	0.21	0.172, 0.257	<.0001
Congestive Heart Failure (CHF)	0.456	0.368, 0.565	<.0001
Myocardial Infarction (MI)	0.748	0.571, 0.98	.0353
Asthma	1.019	0.826, 1.257	.8599
Chronic Obstructive Pulmonary Disease (COPD)	0.829	0.712, 0.965	.0156
Diabetes	0.985	0.841, 1.155	.8566
Hypertension	1	0.855, 1.169	.9983
Chronic Liver Disease (CLD)	0.184	0.087, 0.391	<.0001
Chronic Kidney Disease (CKD)	0.745	0.607, 0.915	.0049
Chronic Dialysis User (please remove if unstable estimates)	0.438	0.139, 1.386	.1601
Rheumatoid Arthritis	0.856	0.546, 1.342	.4983
Crohn's/Ulcerative Colitis (UC)	0.803	0.357, 1.808	.5964
Cancer	0.749	0.619, 0.906	.003
Dementia	0.307	0.217, 0.434	<.0001
Mental Illness			
Psychotic disorders (PSY)	2.826	2.161, 3.697	<.0001
Non-psychotic disorders (nPSY)	3.34	2.902, 3.843	<.0001
Substance abuse disorders (SUB)	1.241	0.944, 1.631	.1218
Others (OTH- Social problems and others; not inc. dementia)	1.012	0.677, 1.512	.9534

APPENDIX C: (Continued)

Characteristic	OR	95% CI	p value
New Health-Care Issues			
New diagnosis of dementia (reference=no)	1.727	1.075, 2.773	.0238
New diagnosis of cancer (reference=no)	0.332	0.244, 0.452	<.0001
Health-Care System Utilization and Access (continuous)			
Number of hospitalizations	0.96	0.879, 1.048	.362
Number of ER visits	1.044	1.015, 1.074	.0028
Number of PHC visits	0.98	0.975, 0.986	<.0001

[a]Some variables were omitted due to non-reportable values.
N = 354,967 (898 deaths by suicide or probable suicide); OR = odds ratio; CI = confidence interval, 95%.

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