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# End-of-life cancer care: a cohort study of immigrants and long-term residents in Ontario, Canada

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## Abstract

**Objective:** To compare recent immigrants and long-term residents in Ontario, Canada on established health service quality indicators of end-of-life cancer care.

**Design:** Retrospective, population-based cohort study of cancer decedents between 2004 and 2015.

**Setting:** Ontario, Canada.

**Participants:** We grouped 13 085 immigrants who arrived in Ontario in 1985 or later into eight major ethnic groups based on birth country, mother tongue and surname, and compared them to 229 471 long-term residents who were ≥18 years at the time of death.

**Primary and secondary outcome measures:** Aggressive care, defined as a composite of ≥2 emergency department visits, ≥2 new hospitalizations, or an intensive care unit admission within 30 days of death; and supportive care, defined as a physician house call within 2 weeks, or palliative nursing or personal support worker home visit within 6 months of death. Multivariable logistic regression was used to examine the association between immigration status and the odds of each main outcome.

**Results:** Compared with long-term residents, immigrants overall and by ethnic group had higher rates of aggressive care (13.7% versus 17.5%, respectively; p<0.001). Among immigrants, Southeast Asians had the highest use while White-Eastern and Western Europeans had the lowest. Supportive care use was similar between long-term residents and immigrants (50.0% versus 50.5%, respectively; p=0.36), though lower among Southeast Asians (46.6%) and higher among White-Western Europeans (55.6%). After adjusting for sociodemographic characteristics and comorbidities, immigrants remained more likely than long-term residents to receive aggressive care (OR: 1.15, 95% CI 1.09 to 1.21), yet were less likely to receive supportive care (OR: 0.95, 95% CI 0.91 to 0.98).

**Conclusions:** Among cancer decedents in Ontario, immigrants are more likely to use aggressive health care services at the end of life than long-term residents, while supportive care varies by ethnicity. Contributors to variation in end-of-life care require further study.

**Keywords:** Immigrants, end of life care, palliative care, cancer

## Article Summary

### Strengths and limitations of this study

- Population-based study of 13 085 immigrant cancer decedents classified into eight major ethnic groups and 229 471 long-term resident cancer decedents in Ontario, Canada.
- Established quality indicators of end-of-life cancer care were compared among immigrants and long-term residents.
- Studying the beliefs and preferences about end-of-life care among immigrants of different ethnic groups are beyond the scope of this study.
- Immigrants who returned to their native country prior to death are not identified by our data sources, and thus, are not included.

## Introduction

Recent global events such as the coronavirus disease 2019 (COVID-19) pandemic have contributed to increasing attention to racial and ethnic inequities in many contexts.[1] Related to health and health care, ethnic disparities have been acknowledged and are well documented in many countries with reports of ethnic groups experiencing greater mortality and risk of some diseases, less access to health care and lower self-reported health.[1–5] For immigrants, additional factors associated with migration, such as language barriers, new environments, limited family and social supports, limited awareness about how to navigate the health care system and diverse expectations and preferences with respect to health care have the potential to further exacerbate health disparities, including at the end of life.

Previous studies of end-of-life (EOL) care have found that immigrants in Canada and the United States are more likely to receive aggressive care, such as admission to an intensive care unit (ICU), mechanical ventilation and feeding tube placement at the end of life compared to non-immigrants.[6,7] Whether these differences extend to immigrants dying of cancer, where arguably prognosis may be more foreseeable and opportunities for advanced care planning greater than with other conditions, is less well studied. As cancer is the second leading cause of death globally, studying health services use among this population when near death is important for providing insights into the quality of their care at this difficult time, and a first step to understanding whether immigrants' needs are being met.[8]

In Canada, a growing immigrant population makes it one of the world's most ethnically and culturally diverse high-income countries, with 7.5 million (21.9%) Canadians reporting to be foreign-born in the 2016 Census.[9] Cancer also accounts for approximately 30% of all deaths, and with an aging population, the incidence of cancer is expected to rise along with the number of deaths.[10] As such, much effort has been put towards improving and measuring the quality of EOL care of Canadians over the last two decades.[11–15] Palliative care when near death has been associated with less acute health care use

and costs, and better quality of life of patients with cancer, including better symptom control, physician communication, emotional support and respectful treatment.[16–20] Together, Canada's ethnic diversity and universal health care system make it an ideal setting for studying health services in multiethnic populations. Ontario, Canada provides is particularly suited for studying immigrant care because 51.1% of the country's immigrants live in the province.[9] The objective of this study is to compare immigrants and long-term residents of Ontario with a cancer cause of death on the use of both aggressive and supportive health care near the time of death.

## Methods

### *Study population*

We conducted a population-based retrospective cohort study of residents in Ontario, Canada who died of cancer between 2004 and 2015 and were 18 years or older at the time of death. Cancer decedents were identified from the Registrar General of Ontario Vital Statistics Database, which contains information from the death certificates of all deaths registered in Ontario. The Ontario Cancer Registry, a population-based registry which captures information on over 90% of all incident cancer cases in Ontario was used to determine the cancer diagnosis type.[21] Immigrant status was determined through linkage to the Immigration, Refugees and Citizenship Canada Permanent Resident database (IRCC), which contains sociodemographic information about all immigrants who arrived in Ontario in 1985 or later, referred to as (recent) immigrants from here on. Immigrants identified in the IRCC were then classified into eight major ethnic groups based on previously validated algorithms using their country of birth, mother tongue and surname.[22,23] Immigrants overall and by ethnic group were compared with long-term residents, defined as those born in Canada or who immigrated prior to 1985, on established health service quality indicators of end-of-life cancer care.

### *Quality indicators and data sources*

We examined both aggressive and supportive end-of-life quality care indicators previously identified to be important to patients with cancer and which were measurable using health administrative data.[11,13,24] Our primary aggressive care indicator was a composite of ≥2 emergency department (ED) visits, ≥2 new hospitalizations, or an intensive care unit (ICU) admission within 30 days of death. Secondary aggressive care indicators studied were death in an acute care hospital, new hospital admissions, admission to an ICU and ED visits (all in the 30 days prior to death), and receipt of chemotherapy in the two weeks prior to death.

Our primary supportive care indicator was a composite of having ≥1 physician house call within 2 weeks of death, or ≥1 palliative nursing or personal support worker home visit within 6 months of death. Secondary supportive care indicators studied were the components of this composite indicator, and additionally, home visits in the six months prior to death by a registered nurse and personal support worker, regardless of palliative care intent.

Information about place of death, hospital and ICU admissions was obtained from the Canadian Institute for Health Information Discharge Abstract Database (DAD), which contains information from the discharge abstracts of all hospitals in Canada. ED visits were identified from the National Ambulatory Care Reporting System (NACRS), which captures demographic and clinical information about visits to all EDs in Ontario. Receipt of intravenous chemotherapy and physician house calls were captured using the Ontario Health Insurance Plan (OHIP) Physician Claims database, and home visits identified from Ontario's Home Care Database. All datasets were linked using unique, encoded identifiers and analyzed at ICES (formerly known as the Institute for Clinical Evaluative Sciences). 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 patient consent, for health system evaluation and improvement.

*Patient and public involvement*

The quality indicators examined in this study are informed by prior research and the datasets used are encoded. Thus, patients were not invited to comment on the study design, consulted to interpret the results, or invited to contribute to the writing or editing of this paper for readability or accuracy.

*Statistical analysis*

Data were summarized using mean (standard deviation) for continuous variables, and frequencies (%) for categorical variables. Characteristics of the study population at the time of death among immigrants and long-term residents were compared using standardized differences. For immigrants overall and by ethnic group, we also examined education and language ability at the time of application for immigration, and immigration category (i.e., economic, family, refugee or other).

Quality indicators were calculated as crude proportions. To account for differences in sociodemographics and comorbidities among ethnic groups and long-term residents, for our primary aggressive and supportive care measures only, we conducted multivariable logistic regression analyses, adjusting for age, sex, Charlson score, cancer type, neighbourhood income quintile, community size, health region and year of death. Cancer type was determined at the time of diagnosis, and all remaining covariates were measured at the time of death. Patients with missing income quintile, community size or health region information (<0.05% of both immigrants and long-term residents) were excluded from the regression analyses. Patients with a missing Charlson score due to no hospital admission during the observation period were grouped with patients with a zero score. Comparing immigrant ethnic groups only, we additionally adjusted for education, language ability, time since immigration and immigration category (economic, family, refugee or other). Since our study included deaths over a 12-year period, we also examined whether the effect of immigration status on receiving aggressive and supportive care changed over time by adding a 2-way interaction term between immigration status and year of death into our regression models.

All analyses were conducted at ICES using SAS version 9.4 (SAS Institute, Cary, NC). Two-sided p-values < 0.05 were considered significant.

**Results**

Between 2004 and 2015, we identified 242 556 individuals with a cancer cause of death, of whom 13 085 (5.4%) were recent immigrants (table 1). East Asians and White-Eastern Europeans made up the largest immigrant ethnic groups (n=2987 (22.8%) and n=2499 (19.1%), respectively), whereas Latin Americans were the smallest (n=670 (5.1%)). Compared with long-term residents, recent immigrants were younger at the time of death, comprised a greater proportion of females, and were more likely to live in low income neighbourhoods and urban communities. Lung cancer was the leading cause of death for both immigrants and long-term residents.

Among recent immigrants, 60.6% (n=7884) had less than secondary school education and 47.6% (n=6226) had neither English or French language ability at the time of applying for immigration, though these varied among ethnic groups. By the time of their death, 74.1% (n=9701) had resided in Canada for over ten years, including 80.3% of Latin Americans and 78.6% White-Western Europeans compared with 65.9% of West Asians/Arabs and 67.6% of South Asians.

*Aggressive care*

Compared with long-term residents, immigrants overall and by ethnic group had generally higher rates of aggressive health care use on both the composite (immigrants overall, 17.5% vs. long-term residents, 13.7%; p<0.001) and individual indicators (p<0.05 for all) (figure 1 and supplementary table 1). Among immigrants, West Asian/Arabs, Southeast Asians and South Asians had the highest composite aggressive care rates (range 20.2% to 21.0%). However, East Asians also had notably high rates of death in an acute care hospital and new hospital admissions within 30 days of death. Overall,

White-Eastern and Western Europeans had the lowest rates of aggressive care on the individual and composite indicators (14.3% and 15.1%, respectively).

In unadjusted regression analyses, all ethnic groups except White-Eastern and Western Europeans were at significantly greater risk than long-term residents of receiving aggressive care, defined as our composite indicator (figure 2 and supplementary table 2, $p<0.05$). After adjustment, immigrants overall, as well as East Asians, South Asians, Southeast Asians and West Asians/Arabs remained more likely than long-term residents to receive aggressive care (odds ratio, OR: 1.15, 95% CI 1.09 to 1.21 for immigrants overall). The effect of immigration status also did not change over time ($p=0.54$ for interaction with year of death). Among immigrants only, additional adjustment for education, language ability, time since immigration and immigration category resulted in minimal change in ethnic groups' likelihood of receiving aggressive care relative to each other.

Supportive care

Immigrants overall and long-term residents had similar rates of supportive care on both the composite and individual indicators (50.5% versus 50.0%, respectively for composite; $p=0.36$) (figure 3 and supplementary table 1). By ethnic group, rates of supportive care varied with White-Western Europeans having the highest use on the composite indicator (55.6%) and Southeast Asians having the lowest (46.6%). On the four individual indicators, White-Eastern and Western Europeans, Latin American and West Asians/Arabs generally had the highest rates, including close to 70% of patients receiving a home visit by a registered nurse during the six months prior to death, while East Asians again had the lowest rates.

Although in unadjusted analyses, the odds of immigrants overall receiving supportive care was not significantly different than long-term residents (OR: 1.02, 95% CI 0.98-1.06), they were less likely to do so after adjustment (OR: 0.95, 95% CI 0.91 to 0.98) (figure 4 and supplementary table 3). Differences after adjustment were attributable to differences in age, sex, neighbourhood income quintile and

Charlson score. Furthermore, the effect of immigration status did not change over time (p=0.41 for interaction with year of death). Among ethnic groups, Southeast Asians, Blacks and East Asians were the least likely to receive supportive care (ORs: 0.75, 95% CI 0.66 to 0.85; 0.82, 95% CI 0.72 to 0.93; 0.89, 95% CI 0.82 to 0.96, respectively versus long-term residents), and White-Western European were most likely (OR: 1.16, 95% CI 1.03 to 1.30 versus long-term residents). Similar to aggressive care, the relative likelihood of receiving supportive care among ethnic groups did not change after adjustment for immigration factors.

**Discussion**

In this study of cancer decedents utilization of both aggressive and supportive care at the end of life in Ontario, Canada between 2004 and 2015, we found that after accounting for differences in sociodemographics and comorbidities, compared with long-term residents, recent immigrants were more likely to use aggressive care (defined by emergency department visits and new hospital or ICU admissions) and less likely to receive supportive care (defined by physician house calls and palliative nursing/personal support worker home visits). Among ethnic groups West Asian/Arabs, Southeast Asians and South Asians had the highest rates of aggressive care use. Southeast Asians also had the lowest rates of supportive care, along with Blacks and East Asians. In contrast, White-Western Europeans had one of the lowest rates of aggressive care and the highest rates of supportive care.

Our findings are consistent with studies of patients with any cause of death. Among Ontario residents both with and without cancer, recent immigrants have been reported to be more likely than long-term residents to die in an acute care hospital and be admitted to a hospital and ICU in their last month of life.[7] Additionally, decedents born in Europe were not at significantly different risk of dying in an ICU than long-term residents, while those born in Southeast Asia and South Asia were more likely to do so. In the US, patients of Black, Hispanic and Asian ethnic groups both with and without cancer have also been reported to be more likely to receive aggressive care at the end of life, and less likely to access

palliative care, whether at home, in a hospice or elsewhere.[6,25–31] Regarding palliative care, they are also more likely to access it closer to death and more likely to disenroll.[30,31] However, few of these studies differentiate between immigrants and non-immigrants, and our results suggest that even in the context of cancer, where ongoing treatment near death is of questionable benefit, immigrants in Ontario are similarly more likely to use aggressive care health services and less likely to receive supportive care at the end of life as patients dying of other causes.

Our findings may be explained by several factors. Communication barriers, degree of acculturation, knowledge of and preference for care options at the end of life, and beliefs about advanced care planning may all be contributory.[32–37] Although 74% of immigrants in our study had resided in Canada for over 10 years prior to death, challenges encountered in settling in a new country on arrival may persist or be exacerbated when near death. With almost half of immigrants lacking English or French language ability when applying for immigration, their understanding of medical terms and care options, and capacity or readiness to communicate care wishes may influence the care they receive. As immigrants are generally healthier on arrival to Canada (the healthy immigrant effect), when compared to non-immigrants, they may also be less familiar with the health care system and services available at the end of life.[38–40]

Beyond the scope of this study, was the study of beliefs and preferences about end-of-life care. Although many studies have reported patients with cancer prefer to die at home, the generalizability of these studies to immigrant populations is unknown. In the US, a greater proportion of Blacks and Hispanics with cancer have consistently been found to prefer aggressive care near death when compared with Whites.[27,33,37,41] Differences between ethnic groups and long-term residents in care preferences and circumstances that would enable end-of-life care at home may thus influence care accessed and received, especially when residing in a country with less familiarity and potentially fewer social supports than their country of origin.[42–45]

Also unclear is the relationship between aggressive and supportive care. Many previous studies have found that supportive care, including physician continuity and greater and earlier use of palliative and home care services is associated with lower use of acute care services at the end of life.[16–20,46–48] This supports our finding of White-Western Europeans' high rates of receipt of supportive care and low rates of aggressive care. However, this pattern was not consistently observed among other ethnic groups, and other factors need consideration. Although much effort has been dedicated to increasing access to palliative and home care services in Ontario and Canada, it may still be insufficient for some immigrants to manage at home when near death even when preferred.[12,14,15] Particularly, whether economic class immigrants or refugees have adequate family or social supports and prefer to be cared for at home requires further study.

This study is limited by our inability to classify the long-term resident cohort into similar ethnic groups as immigrants or identify people who immigrated to Ontario prior to 1985. However, we estimate that over 95% are of White ethnicity and approximately 17 % are immigrants who arrived prior to 1985.[49] Our results may also be influenced by the salmon bias which hypothesizes that when immigrants get older or sick, they return to their region of origin, and thus are not captured in population health studies.[50–52] Although this bias has been shown to contribute to the mortality advantage among some immigrants in the UK, Hispanics in the US and internal migrants in China, its effect on differences in end-of-life care is unknown, and is likely to vary between ethnic groups.[51–53] We also did not control for stage of cancer at diagnosis. With some belief that immigrants present at later stages, this delay impact patient preferences for treatment and time for advanced care planning. Lastly, whether our findings are generalizable to immigrants in other provinces or countries also requires further investigation.

**Conclusions**

This study highlights differences in care between long-term residents and immigrants with cancer near death. Although immigrants overall were more likely to receive aggressive care and less likely to receive supportive care than long-term residents after accounting for differences in sociodemographic characteristics and comorbidities, the care received varied by ethnicity. The relationship between aggressive and supportive care within ethnic groups was also unclear, and further study is required to better understand contributors to these differences and whether their needs at the end of life are being met.

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**Author contributions:** AC conceived the study, participated in the study design and interpretation of results, and drafted the manuscript. HS and LB conceived the study, participated in the study coordination, study design, acquisition of data and interpretation of results, and provided feedback on the manuscript. RS participated in the study design and interpretation of results, and provided feedback on the manuscript. UEO participated in the study design, performed the analysis, and provided feedback on the manuscript. EO participated in the study design and study coordination, and provided feedback on the manuscript. All authors read approved the final manuscript. HS and UEO had full access to all the

data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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**Competing interests:** None

**Ethnics approval:** This study was approved by the Hamilton Integrated Research Ethics Board, a joint board of St. Joseph's Healthcare Hamilton, Hamilton Health Sciences and McMaster University's Faculty of Health Sciences; and follows the STROBE guidelines for the reporting of observational studies.

**Data sharing statement:** The data set from this study is held securely in coded form at ICES. While data sharing agreements prohibit ICES from making the data set publicly available, access may be granted to those who meet pre-specified criteria for confidential access, available at www.ices.on.ca/DAS. The full data set creation plan and underlying analytic code are available from the authors upon request, understanding that the programs may rely upon coding templates or macros that are unique to ICES.

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**Table 1.** Baseline characteristics of study population, 2004-2015

| Characteristic | Ethnic Group | | | | | | | | *All immigrants** | *Long-term residents* | Std diff† |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | White-Eastern European | White-Western European | Latin American | East Asian | Black | South Asian | Southeast Asian | West Asian/ Arab | | | |
| Population size, N | N=2499 | N=1418 | N=670 | N=2987 | N=1052 | N=2180 | N=1129 | N=1028 | *N=13 085* | *N=229 471* | |
| Age, mean (SD), years | 65.4 (14.3) | 68.0 (15.0) | 63.9 (15.3) | 69.5 (14.9) | 61.7 (16.6) | 65.9 (14.3) | 63.5 (14.6) | 65.1 (14.8) | *66.2 (15.0)* | *72.2 (12.5)* | 0.43 |
| Female, n (%) | 1234 (49.4) | 649 (45.8) | 355 (53.0) | 1369 (45.8) | 593 (56.4) | 1034 (47.4) | 609 (53.9) | 470 (45.7) | *6373 (48.7)* | *107 411 (46.8)* | 0.04 |
| Income quintile‡, n (%) | | | | | | | | | | | |
| 1 (lowest) | 780 (31.2) | 297 (20.9) | 240 (35.8) | 753 (25.2) | 423 (40.2) | 615 (28.2) | 339 (30.0) | 319 (31.0) | *3802 (29.1)* | *47 724 (20.8)* | 0.19 |
| 5 (highest) | 337 (13.5) | 256 (18.1) | 53 (7.9) | 365 (12.2) | 66 (6.3) | 179 (8.2) | 101 (8.9) | 148 (14.4) | *1524 (11.6)* | *42 858 (18.7)* | 0.20 |
| Community size >1 500 000‡, n (%) | 1742 (69.7) | 682 (48.1) | 505 (75.4) | 2677 (89.6) | 838 (79.7) | 1932 (88.6) | 936 (82.9) | 709 (69.0) | *10 116 (77.3)* | *70 397 (30.7)* | 1.06 |
| Cancer type, n (%) | | | | | | | | | | | |
| Breast | 237 (9.5) | 128 (9.0) | 83 (12.4) | 158 (5.3) | 153 (14.5) | 237 (10.9) | 112 (9.9) | 109 (10.6) | *1224 (9.4)* | *17 684 (7.7)* | 0.06 |
| Colorectal | 339 (13.6) | 170 (12.0) | 46 (6.9) | 356 (11.9) | 110 (10.5) | 135 (6.2) | 100 (8.9) | 95 (9.2) | *1365 (10.4)* | *29 032 (12.7)* | 0.07 |
| Lung | 515 (20.6) | 308 (21.7) | 101 (15.1) | 835 (28.0) | 135 (12.8) | 324 (14.9) | 300 (26.6) | 190 (18.5) | *2733 (20.9)* | *64 051 (27.9)* | 0.16 |
| Prostate | 92 (3.7) | 78 (5.5) | 50 (7.5) | 91 (3.0) | 56 (5.3) | 120 (5.5) | 37 (3.3) | 50 (4.9) | *582 (4.4)* | *15 166 (6.6)* | 0.09 |
| Other | 1316 (52.7) | 734 (51.8) | 390 (58.2) | 1547 (51.8) | 598 (56.8) | 1364 (62.6) | 580 (51.4) | 584 (56.8) | *7181 (54.9)* | *103 538 (45.1)* | 0.20 |
| Charlson score ≥ 1§, n (%) | 229 (9.2) | 149 (10.5) | 77 (11.5) | 320 (10.7) | 113 (10.7) | 309 (14.2) | 139 (12.3) | 144 (14.0) | *1486 (11.4)* | *32 159 (14.0)* | 0.08 |
| **Among immigrants** | | | | | | | | | | | |
| Secondary school education or less§, n (%) | 988 (39.5) | 899 (64.0) | 482 (71.9) | 2014 (67.4) | 773 (72.5) | 1490 (68.7) | 583 (51.9) | 603 (59.1) | *7884 (60.6)* | NA | NA |
| Neither English or French§, n (%) | 1626 (65.1) | 364 (25.7) | 255 (38.1) | 2082 (69.7) | 89 (8.5) | 960 (44.0) | 323 (28.6) | 497 (48.3) | *6226 (47.6)* | | |
| Time since immigration, n (%) | | | | | | | | | | | |
| < 5 years | 239 (9.6) | 144 (10.2) | 54 (8.1) | 259 (8.7) | 114 (10.8) | 286 (13.1) | 114 (10.1) | 153 (14.9) | *1387 (10.6)* | NA | NA |
| 5-10 years | 407 (16.3) | 160 (11.3) | 78 (11.6) | 401 (13.4) | 148 (14.1) | 416 (19.1) | 156 (13.8) | 198 (19.3) | *1997 (15.3)* | | |
| > 10 years | 1853 (74.1) | 1114 (78.6) | 538 (80.3) | 2327 (77.9) | 790 (75.1) | 1478 (67.8) | 859 (76.1) | 677 (65.9) | *9701 (74.1)* | | |
| Immigration category‡, n (%) | | | | | | | | | | | |
| Economic | 551 (22.0) | 505 (35.6) | 146 (21.8) | 745 (24.9) | 245 (23.3) | 501 (23.0) | 393 (34.8) | 234 (22.8) | *3354 (25.6)* | NA | NA |
| Family | 1146 (45.9) | 825 (58.2) | 360 (53.7) | 1901 (63.6) | 580 (55.1) | 1390 (63.8) | 631 (55.9) | 435 (42.3) | *7329 (56.0)* | | |
| Refugee | 753 (30.1) | 1-5 (<0.4) | 150 (22.4) | 127 (4.3) | 195 (18.5) | 251 (11.5) | 88 (7.8) | 322 (31.3) | *1900 (14.5)* | | |

Ethnic groups are ordered by increasing adjusted risk of the composite indicator for aggressive care (defined as having at least two emergency department visits, two new hospitalizations or an ICU admission within 30 days of death).

* Includes 122 immigrants for whom ethnicity is unknown.

† Reported standardized differences are for comparisons of all immigrants versus long-term residents. P-value < 0.001 for comparison of all characteristics between individual ethnic groups.

‡ Due to space limitations, proportions for income quintiles 2 to 4 and non-economic/family/refugee immigration categories are not shown. Thus, categories shown do not add up to 100%. Missing data for immigrants and long-term residents, respectively (n): 47/1112 for income quintile, 10/172 for community size.

§ Charlson score is determined from hospitalizations in the 12 to 24 months prior to death (3741 immigrants and 68 514 long-term residents had no hospitalization and are grouped with patients with score=0). Education and language ability are at the time of application for immigration.

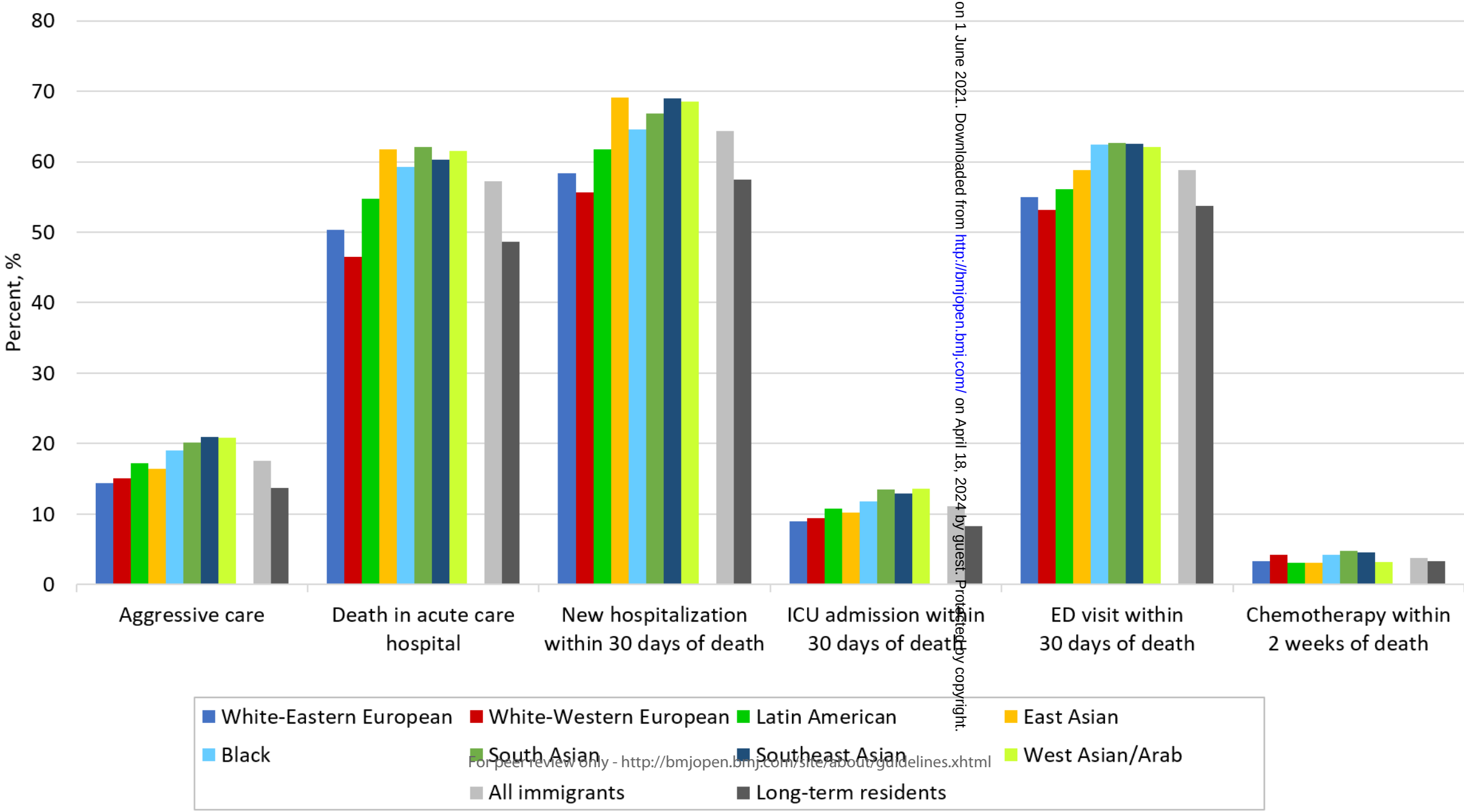
NA, not applicable.

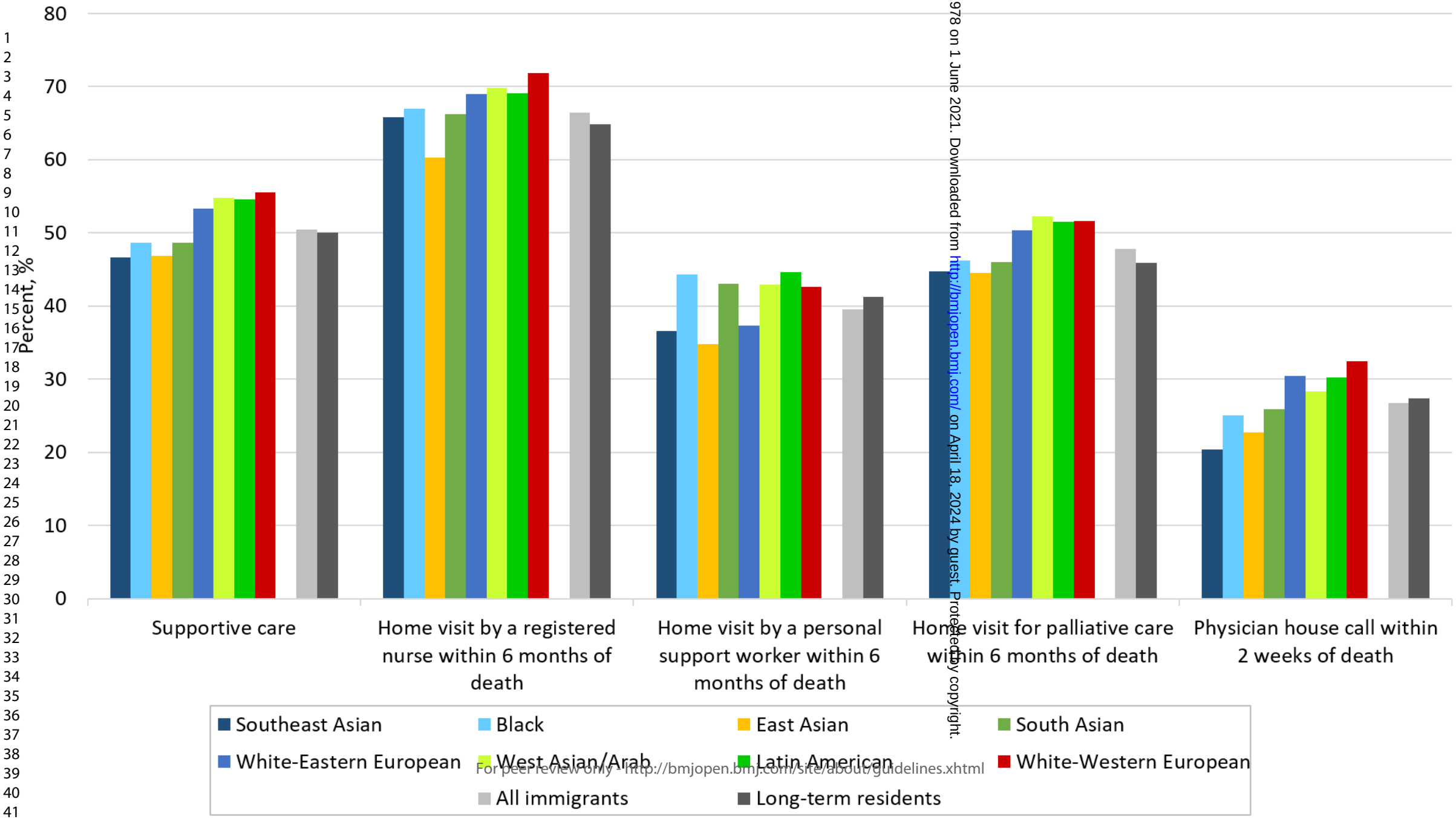
**Figure 1.** Aggressive care quality indicator rates by ethnicity and immigrant status, 2004-2015. The composite aggressive care indicator is defined as receipt of ≥2 emergency department visits, ≥2 new hospitalizations or an ICU admission within 30 days of death. Ethnic groups are ordered by increasing adjusted risk of the composite indicator for aggressive care. ED, emergency department; ICU, intensive care unit.

**Figure 2.** Odds ratios for receiving aggressive care. Ethnic groups are listed in order of increasing adjusted risk of receiving aggressive care versus long-term residents, defined as having ≥2 emergency department visits, ≥2 new hospitalizations or an intensive care unit admission within 30 days of death. Models for all immigrants versus long-term residents were computed separately from individual ethnic groups versus long-term residents. Immigrants of unknown ethnicity are excluded from analyses. Covariates included in adjusted models for immigrants versus long-term residents were age, sex, Charlson score, cancer type, neighbourhood income quintile, community size, health region and year of death. Adjusted models for ethnic groups only additionally adjusted for education, language ability, time since immigration and immigration category.

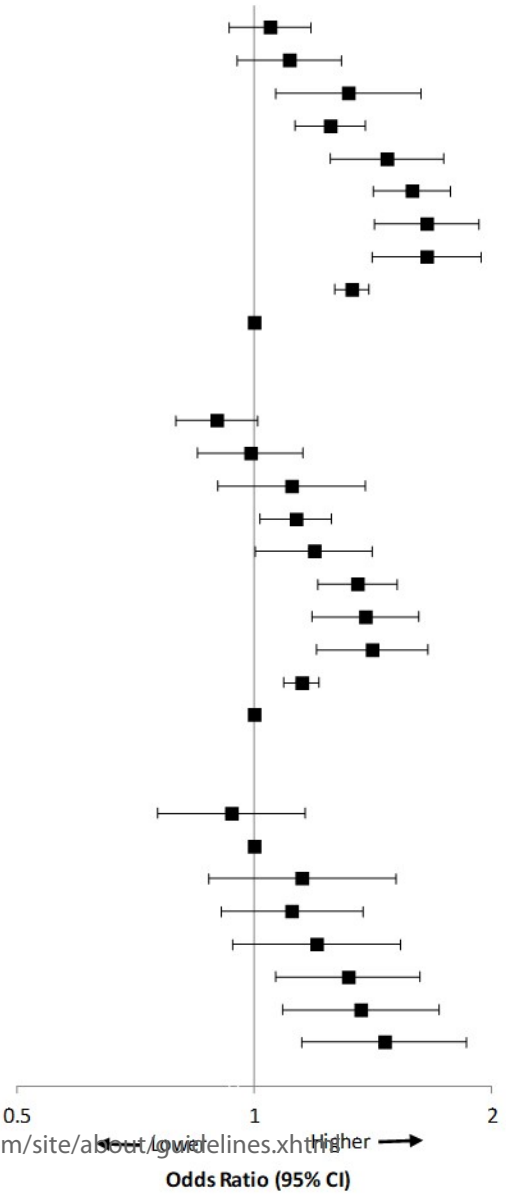
**Figure 3.** Supportive care quality indicator rates by ethnicity and immigrant status, 2004-2015. The composite supportive care indicator is defined as receipt of ≥1 physician house call within 2 weeks of death, or ≥1 palliative nursing or personal support worker home visit within 6 months of death. Ethnic groups are ordered by increasing adjusted risk of the composite indicator for supportive care.

**Figure 4.** Odds ratios for receiving supportive care. Ethnic groups are listed in order of increasing adjusted risk of receiving supportive care versus long-term residents, defined as having ≥1 physician house call within 2 weeks of death, or ≥ 1 palliative nursing or personal support worker home visit within 6 months of death. Models for all immigrants versus long-term residents were computed separately from individual ethnic groups versus long-term residents. Immigrants of unknown ethnicity are excluded from analyses. Covariates included in adjusted models for immigrants versus long-term residents were age, sex, Charlson score, cancer type, neighbourhood income quintile, community size, health region and year of death. Adjusted models for ethnic groups only additionally adjusted for education, language ability, time since immigration and immigration category.

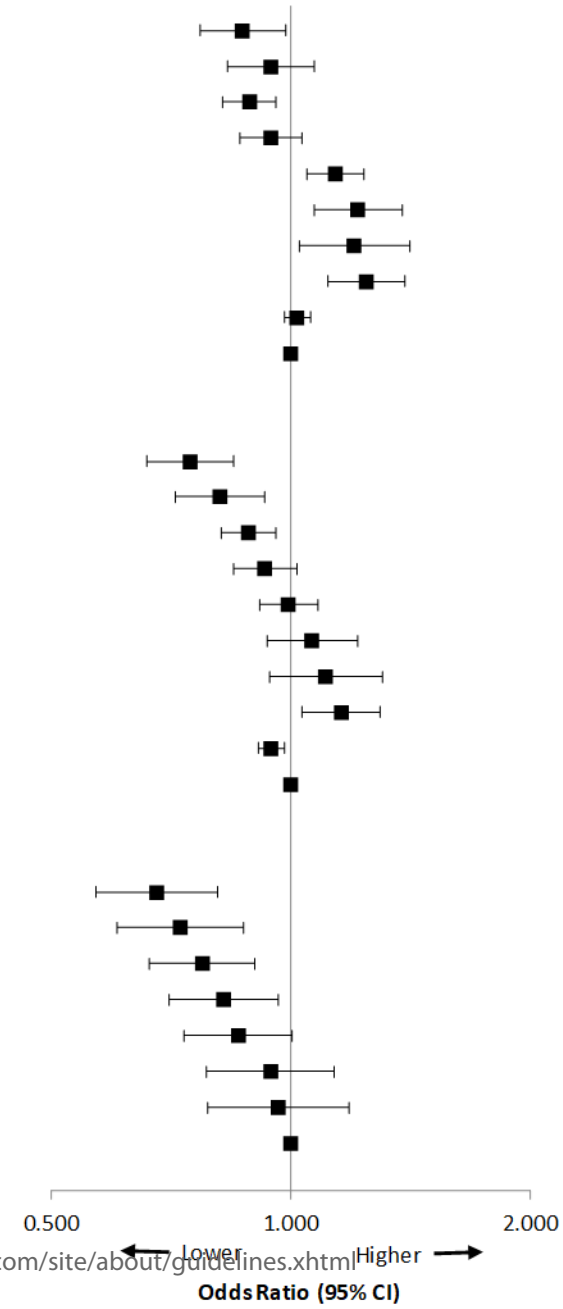




| Ethnic group | OR | 95% LCI | 95% UCI |
|---|---|---|---|
| **Unadjusted** | | | |
| White-Eastern European | 1.05 | 0.93 | 1.18 |
| White-Western European | 1.11 | 0.95 | 1.29 |
| Latin American | 1.32 | 1.06 | 1.63 |
| East Asian | 1.25 | 1.13 | 1.38 |
| Black | 1.47 | 1.25 | 1.74 |
| South Asian | 1.58 | 1.42 | 1.77 |
| Southeast Asian | 1.65 | 1.42 | 1.92 |
| West Asian/Arab | 1.66 | 1.41 | 1.94 |
| All immigrants | 1.33 | 1.27 | 1.40 |
| Long-term residents | Ref | - | - |
| | | | |
| **Adjusted - Immigrants vs. Long-term residents** | | | |
| White-Eastern European | 0.90 | 0.79 | 1.01 |
| White-Western European | 0.99 | 0.85 | 1.15 |
| Latin American | 1.12 | 0.90 | 1.38 |
| East Asian | 1.13 | 1.02 | 1.25 |
| Black | 1.19 | 1.00 | 1.41 |
| South Asian | 1.35 | 1.20 | 1.52 |
| Southeast Asian | 1.38 | 1.19 | 1.62 |
| West Asian/Arab | 1.41 | 1.20 | 1.66 |
| All immigrants | 1.15 | 1.09 | 1.21 |
| Long-term residents | Ref | - | - |
| | | | |
| **Adjusted - Ethnic groups only** | | | |
| White-Eastern European | 0.94 | 0.75 | 1.16 |
| White-Western European | Ref | - | - |
| Latin American | 1.15 | 0.87 | 1.51 |
| East Asian | 1.12 | 0.91 | 1.37 |
| Black | 1.20 | 0.94 | 1.53 |
| South Asian | 1.31 | 1.07 | 1.62 |
| Southeast Asian | 1.37 | 1.08 | 1.72 |
| West Asian/Arab | 1.46 | 1.15 | 1.85 |



| Ethnic group | OR | 95% LCI | 95% UCI |
|---|---|---|---|
| **Unadjusted** | | | |
| Southeast Asian | 0.87 | 0.77 | 0.99 |
| Black | 0.94 | 0.83 | 1.07 |
| East Asian | 0.89 | 0.82 | 0.96 |
| South Asian | 0.95 | 0.87 | 1.03 |
| White-Eastern European | 1.14 | 1.05 | 1.24 |
| West Asian/Arab | 1.22 | 1.07 | 1.38 |
| Latin American | 1.20 | 1.03 | 1.41 |
| White-Western European | 1.25 | 1.12 | 1.39 |
| All immigrants | 1.02 | 0.98 | 1.06 |
| Long-term residents | Ref | - | - |
| **Adjusted - Immigrants vs. Long-term residents** | | | |
| Southeast Asian | 0.75 | 0.66 | 0.85 |
| Black | 0.82 | 0.72 | 0.93 |
| East Asian | 0.89 | 0.82 | 0.96 |
| South Asian | 0.93 | 0.85 | 1.02 |
| White-Eastern European | 1.00 | 0.91 | 1.08 |
| West Asian/Arab | 1.07 | 0.93 | 1.22 |
| Latin American | 1.11 | 0.94 | 1.31 |
| White-Western European | 1.16 | 1.03 | 1.30 |
| All immigrants | 0.95 | 0.91 | 0.98 |
| Long-term residents | Ref | - | - |
| **Adjusted - Ethnic groups only** | | | |
| Southeast Asian | 0.68 | 0.57 | 0.81 |
| Black | 0.73 | 0.61 | 0.87 |
| East Asian | 0.78 | 0.67 | 0.90 |
| South Asian | 0.82 | 0.70 | 0.96 |
| White-Eastern European | 0.86 | 0.74 | 1.01 |
| West Asian/Arab | 0.94 | 0.79 | 1.14 |
| Latin American | 0.97 | 0.79 | 1.19 |
| White-Western European | Ref | - | - |



**Supplementary Content**

**End-of-life cancer care: a cohort study of immigrants and long-term residents in Ontario, Canada**

Chu A, Barbera L, Sutradhar R, Erbas Oz U, O'Leary E, Seow H

**Supplementary table 1.** Quality indicator rates by ethnicity and immigrant status, 2004-2015

**Supplementary table 2.** Logistic regression models for aggressive care

**Supplementary table 3.** Logistic regression models for supportive care

**Supplementary table 1.** Quality indicator rates by ethnicity and immigrant status, 2004-2015

| Indicator | Ethnic Group | | | | | | | | All Immigrants* | Long-term Residents | p-value† |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Black | East Asian | Latin American | South Asian | Southeast Asian | West Asian/Arab | White-Eastern European | White-Western European | | | |
| | n (%) | | | | | | | | | | |
| Population size, n | 1052 | 2987 | 670 | 2180 | 1129 | 1028 | 2499 | 1418 | 13 085 | 229 471 | |
| Death in acute care hospital or bed‡ | 623 (59.2) | 1846 (61.8) | 367 (54.8) | 1353 (62.1) | 681 (60.3) | 632 (61.5) | 1259 (50.4) | 659 (46.5) | 7493 (57.3) | 111 544 (48.6) | <0.001 |
| New hospitalization within 30 days of death | 585 (64.6) | 1855 (69.1) | 369 (61.8) | 1269 (66.8) | 695 (68.9) | 632 (68.5) | 1327 (58.4) | 731 (55.6) | 7832 (66.4) | 121 559 (57.4) | <0.001 |
| Eligible, n | 906 | 2686 | 597 | 1899 | 1008 | 922 | 2272 | 1314 | 11 707 | 211 618 | |
| ICU admission within 30 days of death‡ | 124 (11.8) | 306 (10.2) | 72 (10.7) | 293 (13.4) | 146 (12.9) | 140 (13.6) | 223 (8.9) | 134 (9.4) | 1455 (11.1) | 19 097 (8.3) | |
| ≥ 1 ED visit within 30 days of death | 566 (62.5) | 1580 (58.8) | 335 (56.1) | 1189 (62.6) | 631 (62.6) | 573 (62.1) | 1248 (54.9) | 699 (53.2) | 6882 (58.8) | 113 674 (53.7) | <0.001 |
| Eligible, n | 906 | 2686 | 597 | 1899 | 1008 | 922 | 2272 | 1314 | 11 707 | 211 618 | |
| Chemotherapy within 2 weeks of death‡ | 44 (4.2) | 94 (3.1) | 21 (3.1) | 105 (4.8) | 52 (4.6) | 33 (3.2) | 84 (3.4) | 60 (4.2) | 497-502 (3.80-3.84) | 7527 (3.3) | 0.001 |
| Home visit within 6 months of death by a: | | | | | | | | | | | |
| Registered nurse | 697 (67.0) | 1787 (60.3) | 457 (69.1) | 1420 (66.3) | 735 (65.9) | 712 (69.8) | 1712 (69.0) | 1008 (71.8) | 8606 (66.5) | 147 512 (64.8) | <0.001 |
| Personal support worker | 461 (44.3) | 1032 (34.8) | 295 (44.6) | 923 (43.1) | 408 (36.6) | 438 (42.9) | 927 (37.4) | 599 (42.7) | 5226 (39.6) | 93 866 (41.3) | <0.001 |
| Eligible, n | 1040 | 2964 | 661 | 2143 | 1116 | 1020 | 2480 | 1404 | 12 947 | 227 553 | |
| For palliative care (fiscal year 2005+ only) | 446 (46.3) | 1190 (44.5) | 314 (51.5) | 909 (46.0) | 460 (44.7) | 494 (52.2) | 1157 (50.4) | 665 (51.7) | 5685 (47.8) | 92 849 (45.9) | <0.001 |
| Eligible, n | 964 | 2674 | 610 | 1976 | 1028 | 946 | 2297 | 1287 | 11 897 | 202,492 | |
| Physician house call within 2 weeks of death | 187 (25.0) | 517 (22.8) | 147 (30.2) | 412 (25.9) | 170 (20.4) | 220 (28.3) | 603 (30.4) | 380 (32.5) | 2661 (26.7) | 50 860 (27.3) | 0.21 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Eligible, n | 748 | 2271 | 487 | 1591 | 833 | 777 | 1982 | 1169 | 9348 | 186 113 | |
| Aggressive care§ | 172 (19.0) | 442 (16.5) | 103 (17.3) | 383 (20.2) | 211 (20.9) | 192 (20.8) | 326 (14.3) | 198 (15.1) | 2250 (27.5) | 29 087 (13.7) | <0.001 |
| Eligible, n | 906 | 2686 | 597 | 1899 | 1008 | 922 | 2272 | 1314 | 11 707 | 21 1618 | |
| Supportive care‖ | 469 (48.7) | 1252 (46.8) | 333 (54.6) | 962 (48.7) | 479 (46.6) | 518 (54.8) | 1224 (53.3) | 715 (55.6) | 6006 (50.5) | 101 347 (50.0) | 0.36 |
| Eligible, n | 964 | 2674 | 610 | 1976 | 1028 | 946 | 2297 | 1287 | 11 897 | 202 492 | |

* Includes 122 immigrants whose ethnicity could not be classified. A range is reported for chemotherapy within 2 weeks of death to suppress a count of < 6 in the unknown ethnicity group.

†p-value is for all immigrants versus long-term residents.

‡ Eligible population is the entire population.

§ Aggressive care is defined as having ≥2 emergency department visits, ≥2 new hospitalizations or an ICU admission within 30 days of death.

‖ Supportive care is defined as having ≥1 physician house call within 2 weeks of death, or ≥1 palliative nursing or personal support worker home visit within 6 months of death.

ED, emergency department; ICU, intensive care unit.

**Supplementary table 2.** Logistic regression models for aggressive care*

| | | Univariate | | | Ethnic groups vs long-term residents | | | Immigrants vs long-term residents | | | Ethnic groups only | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OR† | 95% CI | | OR† | 95% CI | | OR† | 95% CI | | OR† | 95% CI | |
| | | | Lower | Upper | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| Ethnicity | White-Eastern European | 1.05 | 0.93 | 1.18 | 0.90 | 0.79 | 1.01 | na | na | na | 0.94 | 0.75 | 1.16 |
| | White-Western European | 1.11 | 0.95 | 1.29 | 0.99 | 0.85 | 1.15 | na | na | na | Ref | - | - |
| | Latin American | **1.32** | **1.06** | **1.63** | 1.12 | 0.90 | 1.38 | na | na | na | 1.15 | 0.87 | 1.51 |
| | East Asian | **1.25** | **1.13** | **1.38** | **1.13** | **1.02** | **1.25** | na | na | na | 1.12 | 0.91 | 1.37 |
| | Black | **1.47** | **1.25** | **1.74** | 1.19 | 1.00 | 1.41 | na | na | na | 1.20 | 0.94 | 1.53 |
| | South Asian | **1.58** | **1.42** | **1.77** | **1.35** | **1.20** | **1.52** | na | na | na | **1.31** | **1.07** | **1.62** |
| | Southeast Asian | **1.65** | **1.42** | **1.92** | **1.38** | **1.19** | **1.62** | na | na | na | **1.37** | **1.08** | **1.72** |
| | West Asian/Arab | **1.66** | **1.41** | **1.94** | **1.41** | **1.20** | **1.66** | na | na | na | **1.46** | **1.15** | **1.85** |
| | All immigrants | **1.33** | **1.27** | **1.40** | na | na | na | **1.15** | **1.09** | **1.21** | na | na | na |
| | Long-term residents | Ref | - | - | Ref | - | - | Ref | - | - | na | na | na |
| Age (per year) | | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** |
| Sex | Men | **1.30** | **1.27** | **1.33** | **1.31** | **1.28** | **1.35** | **1.31** | **1.28** | **1.35** | **1.24** | **1.11** | **1.38** |
| | Women | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Charlson score | 1+ | **0.94** | **0.91** | **0.97** | 1.00 | 0.96 | 1.04 | 1.00 | 0.97 | 1.04 | 0.95 | 0.81 | 1.11 |
| | 0 or missing | Ref | - | - | Ref | - | - | Ref | - | - | 1.00 | - | - |
| Cancer type | Breast | **0.70** | **0.67** | **0.74** | **0.77** | **0.72** | **0.81** | **0.77** | **0.73** | **0.81** | **0.78** | **0.63** | **0.96** |
| | Colorectal | **0.93** | **0.89** | **0.97** | 0.98 | 0.94 | 1.02 | 0.98 | 0.94 | 1.02 | **0.82** | **0.67** | **0.99** |
| | Prostate | **0.62** | **0.59** | **0.66** | **0.67** | **0.63** | **0.71** | **0.67** | **0.63** | **0.71** | **0.51** | **0.37** | **0.70** |
| | Other | **1.03** | **1.01** | **1.06** | 1.03 | 1.00 | 1.06 | 1.03 | 1.00 | 1.06 | 1.02 | 0.90 | 1.16 |
| | Lung | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Neighbourhood income quintile | 1 (lowest) | **1.08** | **1.04** | **1.12** | **1.05** | **1.01** | **1.10** | **1.06** | **1.01** | **1.10** | 1.05 | 0.88 | 1.26 |
| | 2 | **1.05** | **1.01** | **1.09** | 1.03 | 0.99 | 1.07 | 1.03 | 0.99 | 1.07 | 1.11 | 0.92 | 1.33 |
| | 3 | **1.06** | **1.02** | **1.10** | 1.03 | 0.99 | 1.08 | 1.04 | 0.99 | 1.08 | 1.01 | 0.84 | 1.22 |
| | 4 | **1.04** | **1.003** | **1.09** | 1.02 | 0.98 | 1.06 | 1.02 | 0.98 | 1.06 | 1.03 | 0.85 | 1.25 |
| | 5 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Community size | < 10 000 | **1.20** | **1.16** | **1.24** | **1.25** | **1.20** | **1.30** | **1.25** | **1.20** | **1.30** | 1.04 | 0.67 | 1.62 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10 000-99 999 | **1.17** | **1.13** | **1.21** | **1.25** | **1.20** | **1.30** | **1.25** | **1.19** | **1.30** | 1.27 | 0.82 | 1.98 |
| | ≥ 100 000 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Health region | Erie St.Clair | 1.03 | 0.97 | 1.10 | 0.95 | 0.89 | 1.02 | 0.95 | 0.89 | 1.02 | 0.94 | 0.66 | 1.34 |
| | South West | 1.13 | 1.06 | 1.20 | 1.02 | 0.96 | 1.08 | 1.02 | 0.96 | 1.09 | 0.94 | 0.65 | 1.38 |
| | Waterloo Wellington | 1.05 | 0.98 | 1.12 | 1.01 | 0.94 | 1.08 | 1.01 | 0.95 | 1.08 | 1.16 | 0.86 | 1.56 |
| | Hamilton Niagara Haldimand Brant | **0.94** | **0.89** | **0.99** | **0.94** | **0.89** | **0.99** | **0.94** | **0.89** | **0.99** | 1.12 | 0.87 | 1.44 |
| | Central West | **1.25** | **1.16** | **1.34** | **1.15** | **1.07** | **1.23** | **1.16** | **1.08** | **1.25** | **1.34** | **1.09** | **1.66** |
| | Mississauga Halton | 1.00 | 0.94 | 1.07 | 0.98 | 0.92 | 1.05 | 0.98 | 0.92 | 1.05 | 1.04 | 0.85 | 1.28 |
| | Toronto Central | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| | Central | **1.17** | **1.10** | **1.24** | **1.16** | **1.09** | **1.23** | **1.16** | **1.09** | **1.23** | **1.20** | **1.01** | **1.43** |
| | Central East | **1.10** | **1.04** | **1.16** | 1.03 | 0.97 | 1.09 | 1.04 | 0.98 | 1.10 | **1.30** | **1.08** | **1.57** |
| | South East | **1.14** | **1.07** | **1.22** | 0.98 | 0.91 | 1.05 | 0.98 | 0.92 | 1.06 | 1.17 | 0.59 | 2.32 |
| | Champlain | 0.95 | 0.90 | 1.01 | **0.88** | **0.83** | **0.93** | **0.88** | **0.83** | **0.94** | 1.03 | 0.80 | 1.34 |
| | North Simcoe Muskoka | **1.11** | **1.03** | **1.19** | 0.96 | 0.89 | 1.04 | 0.96 | 0.89 | 1.04 | 1.33 | 0.76 | 2.35 |
| | North East | **1.14** | **1.07** | **1.21** | 0.95 | 0.88 | 1.01 | 0.95 | 0.88 | 1.02 | 1.06 | 0.47 | 2.41 |
| | North West | **0.90** | **0.81** | **0.99** | **0.82** | **0.74** | **0.90** | **0.82** | **0.74** | **0.90** | 1.11 | 0.41 | 2.98 |
| Year of death | 2004 | 1.00 | 0.94 | 1.07 | 0.97 | 0.91 | 1.04 | 0.97 | 0.91 | 1.04 | 0.92 | 0.70 | 1.20 |
| | 2005 | 0.95 | 0.89 | 1.01 | **0.93** | **0.87** | **0.99** | **0.93** | **0.87** | **0.99** | 0.90 | 0.69 | 1.18 |
| | 2006 | 0.95 | 0.89 | 1.01 | **0.92** | **0.87** | **0.98** | **0.92** | **0.87** | **0.98** | 1.05 | 0.82 | 1.35 |
| | 2007 | 0.99 | 0.93 | 1.06 | 0.97 | 0.91 | 1.03 | 0.97 | 0.91 | 1.03 | 1.03 | 0.80 | 1.31 |
| | 2008 | 1.02 | 0.96 | 1.08 | 1.00 | 0.94 | 1.06 | 1.00 | 0.94 | 1.06 | 0.88 | 0.69 | 1.12 |
| | 2009 | 0.99 | 0.93 | 1.05 | 0.97 | 0.91 | 1.03 | 0.97 | 0.91 | 1.03 | 0.96 | 0.76 | 1.22 |
| | 2010 | 0.97 | 0.91 | 1.03 | 0.95 | 0.89 | 1.01 | 0.95 | 0.89 | 1.01 | 0.90 | 0.70 | 1.14 |
| | 2011 | 0.98 | 0.92 | 1.04 | 0.97 | 0.91 | 1.03 | 0.97 | 0.91 | 1.03 | 0.86 | 0.68 | 1.09 |
| | 2012 | 0.99 | 0.93 | 1.06 | 0.97 | 0.92 | 1.04 | 0.97 | 0.92 | 1.04 | 1.04 | 0.83 | 1.30 |
| | 2013 | 0.96 | 0.90 | 1.03 | 0.95 | 0.89 | 1.02 | 0.95 | 0.89 | 1.02 | 0.94 | 0.72 | 1.22 |
| | 2014 | 0.94 | 0.88 | 1.01 | 0.94 | 0.88 | 1.01 | 0.94 | 0.88 | 1.01 | 0.94 | 0.73 | 1.22 |
| | 2015 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Education | > Secondary school | na | na | na | na | na | na | na | na | na | 1.05 | 0.94 | 1.17 |
| | Secondary school or less | na | na | na | na | na | na | na | na | na | Ref | - | - |



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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Language ability | Neither English or French | na | na | na | na | na | na | na | na | na | 0.97 | 0.87 | 1.09 |
| | English and/or French | na | na | na | na | na | na | na | na | na | Ref | - | - |
| Time since immigration | < 5 years | na | na | na | na | na | na | na | na | na | 1.04 | 0.88 | 1.23 |
| | 5-10 years | na | na | na | na | na | na | na | na | na | 0.99 | 0.86 | 1.13 |
| | > 10 years | na | na | na | na | na | na | na | na | na | Ref | - | - |
| Immigration category | Economic | na | na | na | na | na | na | na | na | na | 1.03 | 0.91 | 1.18 |
| | Refugee or other | na | na | na | na | na | na | na | na | na | 0.98 | 0.85 | 1.13 |
| | Family | na | na | na | na | na | na | na | na | na | Ref | - | - |

* Aggressive care is defined as having ≥2 emergency department visits, ≥2 new hospitalizations or an ICU admission within 30 days of death. Ethnic groups are listed in order of increasing receipt of aggressive care versus long-term residents. Immigrants of unknown ethnicity are excluded from analyses.

† Boldface type indicates significant values at p<0.05.

CI=confidence interval, na=not applicable, OR=odds ratio.

**Supplementary table 3.** Logistic regression models for supportive care*

| | | Univariate | | | Ethnic groups vs long-term residents | | | Immigrants vs long-term residents | | | Ethnic groups only | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OR† | 95% CI | | OR† | 95% CI | | OR† | 95% CI | | OR† | 95% CI | |
| | | | Lower | Upper | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| Ethnicity | Southeast Asian | **0.87** | **0.77** | **0.99** | **0.75** | **0.66** | **0.85** | na | na | na | **0.68** | **0.57** | **0.81** |
| | Black | 0.94 | 0.83 | 1.07 | **0.82** | **0.72** | **0.93** | na | na | na | **0.73** | **0.61** | **0.87** |
| | East Asian | **0.89** | **0.82** | **0.96** | **0.89** | **0.82** | **0.96** | na | na | na | **0.78** | **0.67** | **0.90** |
| | South Asian | 0.95 | 0.87 | 1.03 | 0.93 | 0.85 | 1.02 | na | na | na | **0.82** | **0.70** | **0.96** |
| | White-Eastern European | **1.14** | **1.05** | **1.24** | 1.00 | 0.91 | 1.08 | na | na | na | 0.86 | 0.74 | 1.01 |
| | West Asian/Arab | **1.22** | **1.07** | **1.38** | 1.07 | 0.93 | 1.22 | na | na | na | 0.94 | 0.79 | 1.14 |
| | Latin American | **1.20** | **1.03** | **1.41** | 1.11 | 0.94 | 1.31 | na | na | na | 0.97 | 0.79 | 1.19 |
| | White-Western European | **1.25** | **1.12** | **1.39** | **1.16** | **1.03** | **1.30** | na | na | na | Ref | - | - |
| | All immigrants | 1.02 | 0.8 | 1.06 | na | na | na | **0.95** | **0.91** | **0.98** | na | na | na |
| | Long-term residents | Ref | - | - | Ref | - | - | Ref | - | - | na | na | na |
| Age (years) | | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.99** | **0.99** | **0.99** |
| Sex | Men | **0.92** | **0.90** | **0.93** | **0.92** | **0.90** | **0.93** | **0.92** | **0.90** | **0.93** | **0.84** | **0.78** | **0.91** |
| | Women | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Charlson score | 1+ | **0.89** | **0.87** | **0.91** | **0.95** | **0.93** | **0.97** | **0.95** | **0.93** | **0.97** | 1.03 | 0.92 | 1.16 |
| | 0 or missing | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Cancer type | Breast | **1.04** | **1.01** | **1.08** | 0.98 | 0.94 | 1.01 | 0.98 | 0.94 | 1.01 | 1.01 | 0.86 | 1.18 |
| | Colorectal | **0.92** | **0.89** | **0.95** | 0.99 | 0.96 | 1.02 | 0.99 | 0.96 | 1.02 | 1.03 | 0.90 | 1.19 |
| | Prostate | **0.84** | **0.80** | **0.87** | 1.01 | 0.98 | 1.05 | 1.01 | 0.98 | 1.05 | 1.08 | 0.89 | 1.32 |
| | Other | **0.85** | **0.83** | **0.87** | **0.84** | **0.83** | **0.86** | **0.84** | **0.83** | **0.86** | **0.82** | **0.74** | **0.90** |
| | Lung | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Neighbourhood income quintile | 1 (lowest) | **0.74** | **0.72** | **0.76** | **0.74** | **0.72** | **0.76** | **0.74** | **0.72** | **0.76** | **0.84** | **0.74** | **0.96** |
| | 2 | **0.84** | **0.82** | **0.87** | **0.85** | **0.83** | **0.87** | **0.85** | **0.82** | **0.87** | **0.82** | **0.71** | **0.93** |
| | 3 | **0.87** | **0.85** | **0.90** | **0.88** | **0.86** | **0.91** | **0.88** | **0.86** | **0.91** | 0.96 | 0.83 | 1.10 |
| | 4 | **0.93** | **0.91** | **0.96** | **0.93** | **0.90** | **0.95** | **0.93** | **0.90** | **0.95** | 0.91 | 0.79 | 1.05 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Community size | < 10,000 | **0.89** | **0.87** | **0.91** | **0.93** | **0.91** | **0.96** | **0.93** | **0.91** | **0.96** | 1.05 | 0.76 | 1.46 |
| | 10,000-99,999 | **0.95** | **0.93** | **0.98** | 0.99 | 0.96 | 1.02 | 0.99 | 0.96 | 1.02 | 0.94 | 0.67 | 1.32 |
| | ≥ 100,000 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Health region | Erie St.Clair | **1.37** | **1.30** | **1.43** | **1.34** | **1.28** | **1.41** | **1.35** | **1.28** | **1.41** | **1.33** | **1.03** | **1.72** |
| | South West | **0.88** | **0.84** | **0.92** | **0.89** | **0.85** | **0.93** | **0.89** | **0.85** | **0.93** | 0.97 | 0.75 | 1.26 |
| | Waterloo Wellington | **1.84** | **1.75** | **1.93** | **1.83** | **1.74** | **1.92** | **1.83** | **1.74** | **1.92** | **1.79** | **1.42** | **2.26** |
| | Hamilton Niagara Haldimand Brant | **1.24** | **1.19** | **1.28** | **1.24** | **1.19** | **1.29** | **1.24** | **1.19** | **1.29** | 1.18 | 0.97 | 1.42 |
| | Central West | **0.92** | **0.87** | **0.97** | **0.87** | **0.83** | **0.92** | **0.87** | **0.82** | **0.92** | 0.93 | 0.79 | 1.10 |
| | Mississauga Halton | **1.27** | **1.21** | **1.32** | **1.20** | **1.15** | **1.26** | **1.20** | **1.14** | **1.25** | **1.19** | **1.03** | **1.38** |
| | Toronto Central | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| | Central | 1.02 | 0.98 | 1.07 | 1.01 | 0.97 | 1.06 | 1.01 | 0.97 | 1.05 | 1.02 | 0.90 | 1.16 |
| | Central East | 1.02 | 0.98 | 1.06 | 1.03 | 0.99 | 1.07 | 1.03 | 0.99 | 1.07 | 0.96 | 0.83 | 1.10 |
| | South East | **0.88** | **0.84** | **0.93** | 0.90 | 0.86 | 0.95 | **0.91** | **0.86** | **0.95** | 0.65 | 0.39 | 1.08 |
| | Champlain | **1.47** | **1.41** | **1.53** | **1.45** | **1.39** | **1.51** | **1.45** | **1.39** | **1.51** | **1.61** | **1.33** | **1.96** |
| | North Simcoe Muskoka | **1.29** | **1.23** | **1.36** | **1.30** | **1.23** | **1.37** | **1.30** | **1.23** | **1.37** | 1.24 | 0.80 | 1.94 |
| | North East | 0.96 | 0.91 | 1.00 | 0.97 | 0.93 | 1.02 | 0.97 | 0.93 | 1.02 | 1.44 | 0.77 | 2.71 |
| | North West | **0.63** | **0.59** | **0.67** | **0.62** | **0.58** | **0.67** | **0.62** | **0.58** | **0.67** | 1.53 | 0.72 | 3.23 |
| Year of death | 2005 | **0.59** | **0.57** | **0.62** | **0.56** | **0.54** | **0.59** | **0.56** | **0.54** | **0.59** | **0.62** | **0.51** | **0.77** |
| | 2006 | **0.67** | **0.64** | **0.70** | **0.64** | **0.61** | **0.67** | **0.64** | **0.61** | **0.67** | **0.56** | **0.46** | **0.67** |
| | 2007 | **0.67** | **0.65** | **0.70** | **0.65** | **0.62** | **0.67** | **0.65** | **0.62** | **0.67** | **0.62** | **0.51** | **0.74** |
| | 2008 | **0.67** | **0.64** | **0.69** | **0.64** | **0.61** | **0.67** | **0.64** | **0.61** | **0.67** | **0.62** | **0.52** | **0.74** |
| | 2009 | **0.70** | **0.67** | **0.73** | **0.67** | **0.64** | **0.70** | **0.67** | **0.65** | **0.70** | **0.73** | **0.61** | **0.87** |
| | 2010 | **0.74** | **0.71** | **0.77** | **0.72** | **0.69** | **0.75** | **0.72** | **0.69** | **0.75** | **0.77** | **0.64** | **0.91** |
| | 2011 | **0.77** | **0.74** | **0.80** | **0.75** | **0.72** | **0.78** | **0.75** | **0.72** | **0.78** | **0.89** | **0.75** | **1.05** |
| | 2012 | **0.77** | **0.74** | **0.81** | **0.76** | **0.72** | **0.79** | **0.76** | **0.72** | **0.79** | **0.86** | **0.73** | **1.02** |
| | 2013 | **0.85** | **0.81** | **0.89** | **0.85** | **0.81** | **0.89** | **0.85** | **0.81** | **0.89** | **0.73** | **0.60** | **0.88** |
| | 2014 | **0.92** | **0.87** | **0.96** | **0.91** | **0.87** | **0.96** | **0.91** | **0.87** | **0.96** | **0.87** | **0.72** | **1.06** |
| | 2015 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Education | > Secondary school | na | na | na | na | na | na | na | na | na | 1.04 | 0.95 | 1.13 |
| | Secondary school or less | na | na | na | na | na | na | na | na | na | Ref | - | - |
| Language ability | Neither English or French | na | na | na | na | na | na | na | na | na | 1.01 | 0.92 | 1.10 |
| | English and/or French | na | na | na | na | na | na | na | na | na | Ref | - | - |
| Time since immigration | < 5 years | na | na | na | na | na | na | na | na | na | **0.85** | **0.75** | **0.97** |
| | 5-10 years | na | na | na | na | na | na | na | na | na | 0.98 | 0.88 | 1.10 |
| | > 10 years | na | na | na | na | na | na | na | na | na | Ref | - | - |
| Immigration category | Economic | na | na | na | na | na | na | na | na | na | 1.02 | 0.92 | 1.14 |
| | Refugee or other | na | na | na | na | na | na | na | na | na | 1.03 | 0.92 | 1.15 |
| | Family | na | na | na | na | na | na | na | na | na | Ref | - | - |

* Supportive care is defined as ≥1 physician house call within 2 weeks of death, or ≥ 1 palliative nursing or personal support worker home visit within 6 months of death. Ethnic groups are listed in order of increasing receipt of supportive care versus long-term residents. Immigrants of unknown ethnicity are excluded from analyses. Deaths in 2004 are excluded as home care data is only available from April 2005.

† Boldface type indicates significant values at p<0.05.

CI, confidence interval; na, not applicable; OR, odds ratio.

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

| | Item No | Recommendation | Page No |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | 0, 1 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | 1 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 4 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 5 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | 5 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 5-6 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up | 5-6 |
| | | (*b*) For matched studies, give matching criteria and number of exposed and unexposed | NA |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 5-6 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 5-6 |
| Bias | 9 | Describe any efforts to address potential sources of bias | Nil |
| Study size | 10 | Explain how the study size was arrived at | 5 |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 7 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | 7 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | 7 |
| | | (*c*) Explain how missing data were addressed | 7 |
| | | (*d*) If applicable, explain how loss to follow-up was addressed | NA |
| | | (*e*) Describe any sensitivity analyses | NA |
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | 8 |
| | | (b) Give reasons for non-participation at each stage | NA |
| | | (c) Consider use of a flow diagram | NA |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | 8, Tbl 1 |
| | | (b) Indicate number of participants with missing data for each variable of interest | Tbl 1 |
| | | (c) Summarise follow-up time (eg, average and total amount) | NA |
| Outcome data | 15* | Report numbers of outcome events or summary measures over time | Fig 1 & 3, Supple |

| | | | |
|---|---|---|---|
| | | | tbl 1 |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | Fig 2 & 4, Supple tbl 2 & 3 |
| | | (*b*) Report category boundaries when continuous variables were categorized | Supple tbl 2 & 3 |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | NA |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | NA |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 10 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 12 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 13 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 12 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 14 |

*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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# Association between end-of-life cancer care and immigrant status: a retrospective cohort study in Ontario, Canada

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**Association between end-of-life cancer care and immigrant status: a retrospective cohort study in Ontario, Canada**

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## Abstract

**Objective:** To compare recent immigrants and long-term residents in Ontario, Canada on established health service quality indicators of end-of-life cancer care.

**Design:** Retrospective, population-based cohort study of cancer decedents between 2004 and 2015.

**Setting:** Ontario, Canada.

**Participants:** We grouped 13 085 immigrants who arrived in Ontario in 1985 or later into eight major ethnic groups based on birth country, mother tongue and surname, and compared them to 229 471 long-term residents who were ≥18 years at the time of death.

**Primary and secondary outcome measures:** Aggressive care, defined as a composite of ≥2 emergency department visits, ≥2 new hospitalizations, or an intensive care unit admission within 30 days of death; and supportive care, defined as a physician house call within 2 weeks, or palliative nursing or personal support worker home visit within 6 months of death. Multivariable logistic regression was used to examine the association between immigration status and the odds of each main outcome.

**Results:** Compared with long-term residents, immigrants overall and by ethnic group had higher rates of aggressive care (13.7% versus 17.5%, respectively; p<0.001). Among immigrants, Southeast Asians had the highest use while White-Eastern and Western Europeans had the lowest. Supportive care use was similar between long-term residents and immigrants (50.0% versus 50.5%, respectively; p=0.36), though lower among Southeast Asians (46.6%) and higher among White-Western Europeans (55.6%). After adjusting for sociodemographic characteristics and comorbidities, immigrants remained more likely than long-term residents to receive aggressive care (OR: 1.15, 95% CI 1.09 to 1.21), yet were less likely to receive supportive care (OR: 0.95, 95% CI 0.91 to 0.98).

**Conclusions:** Among cancer decedents in Ontario, immigrants are more likely to use aggressive health care services at the end of life than long-term residents, while supportive care varies by ethnicity. Contributors to variation in end-of-life care require further study.

**Keywords:** Immigrants, end of life care, palliative care, cancer

## Article Summary

### Strengths and limitations of this study

- Using health administrative data from a universal health care system, we conducted a population-based study of all cancer decedents in Ontario, Canada between 2004 and 2015.
- Established quality indicators of end-of-life cancer care were compared among long-term residents versus immigrants and among eight different ethnic groups.
- Studying the beliefs and preferences about end-of-life care among immigrants of different ethnic groups are beyond the scope of this study.
- Immigrants who returned to their native country prior to death are not identified by our data sources, and thus, are not included.

## Introduction

Recently, there has been increasing attention to racial and ethnic inequities in many contexts including health and health care, where reports from many countries have documented ethnic groups experiencing greater mortality and risk of some diseases, less access to health care and lower self-reported health.[1–4] For immigrants, additional factors associated with migration, such as language barriers, new environments, limited family and social supports, limited awareness about how to navigate the health care system and diverse expectations and preferences with respect to health care have the potential to further exacerbate health disparities, including at the end of life.

Previous studies of end-of-life (EOL) care have found that immigrants in Canada and the United States are more likely to receive aggressive care, such as admission to an intensive care unit (ICU), mechanical ventilation and feeding tube placement at the end of life compared to non-immigrants.[5,6] Whether these differences extend to immigrants dying of cancer, where arguably prognosis may be more foreseeable and opportunities for advanced care planning greater than with other conditions, is less well studied. Moreover, much of the prior research on ethnic disparities at the end of life focuses on Blacks, Whites, and Latinos in the US, where health care insurance and access is highly variable.[7–9] Research on other ethnicities and immigrants in countries with universal health care is limited.

In Canada, a growing immigrant population makes it one of the world's most ethnically and culturally diverse high-income countries, with 7.5 million (21.9%) Canadians reporting to be foreign-born in the 2016 Census.[10] Cancer also accounts for approximately 30% of all deaths, and with an aging population, the incidence of cancer is expected to rise along with the number of deaths.[11] As such, much effort has been put towards improving and measuring the quality of EOL care of Canadians over the last two decades.[12–16] Palliative care when near death has been associated with less acute health care use and costs, and better quality of life of patients with cancer, including better symptom control, physician communication, emotional support and respectful treatment.[17–21] Together, Canada's ethnic diversity

and universal health care system make it an ideal setting for studying health services in multiethnic populations. Ontario, Canada provides is particularly suited for studying immigrant care because 51.1% of the country's immigrants live in the province.[10]

The objective of this study is to compare immigrants and Canadian-born/long-term residents of Ontario with a cancer cause of death on the use of both aggressive and supportive health care near the time of death. We hypothesized that in our cancer population, immigrants would receive more aggressive care and less supportive care than non-immigrants. As per the Andersen-Newman model of health care utilization, immigrants may be more likely to have socio-cultural predisposing factors that differ from the mostly Westernized biomedical approach found in Ontario's health system (e.g. health beliefs that avoid discussions about death or refuse palliative or supportive care measures), and thus affect their end-of-life care use.[22]

## Methods

### *Study population*

We conducted a population-based retrospective cohort study of residents in Ontario, Canada who died of cancer between 2004 and 2015 and were 18 years or older at the time of death. Cancer decedents were identified from the Registrar General of Ontario Vital Statistics Database, which contains information from the death certificates of all deaths registered in Ontario. The Ontario Cancer Registry, a population-based registry which captures information on over 90% of all incident cancer cases in Ontario was used to determine the cancer diagnosis type.[23] Immigrant status was determined through linkage to the Immigration, Refugees and Citizenship Canada Permanent Resident database (IRCC), which contains sociodemographic information about all immigrants who arrived in Ontario in 1985 or later, referred to as (recent) immigrants from here on. Immigrants identified in the IRCC were then classified into eight major ethnic groups based on previously validated algorithms using their

country of birth, mother tongue and surname.[24,25] Immigrants who landed in Ontario in 1985 or later were compared overall and by ethnic group with individuals born in Canada or who immigrated prior to 1985 (together termed "long-term residents"), on established health service quality indicators of end-of-life cancer care.

*Quality indicators and data sources*

We examined both aggressive and supportive end-of-life quality care indicators previously identified to be important to patients with cancer and which were measurable using health administrative data.[12,14,26] Our primary aggressive care indicator was a composite of ≥2 emergency department (ED) visits, ≥2 new hospitalizations, or an intensive care unit (ICU) admission within 30 days of death. Secondary aggressive care indicators studied were death in an acute care hospital, new hospital admissions, admission to an ICU and ED visits (all in the 30 days prior to death), and receipt of chemotherapy in the two weeks prior to death.

Our primary supportive care indicator was a composite of having ≥1 palliative nursing or personal support worker home visit within 6 months of death or ≥1 physician house call within 2 weeks of death. Prior research show that physician home visits very close to death were for palliative and supportive care purposes.[27] Secondary supportive care indicators studied were the components of this composite indicator, and additionally, home visits in the six months prior to death by a registered nurse and personal support worker, regardless of palliative care intent.

Information about place of death, hospital and ICU admissions was obtained from the Canadian Institute for Health Information Discharge Abstract Database (DAD), which contains information from the discharge abstracts of all hospitals in Canada. ED visits were identified from the National Ambulatory Care Reporting System (NACRS), which captures demographic and clinical information about visits to all EDs in Ontario. Receipt of intravenous chemotherapy and physician house calls were captured using the Ontario Health Insurance Plan (OHIP) Physician Claims database, and home visits identified from

Ontario's Home Care Database. All datasets were linked using unique, encoded identifiers and analyzed at ICES (formerly known as the Institute for Clinical Evaluative Sciences). 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 patient consent, for health system evaluation and improvement.

*Patient and public involvement*

The quality indicators examined in this study are informed by prior research and the datasets used are encoded. Thus, patients were not invited to comment on the study design, consulted to interpret the results, or invited to contribute to the writing or editing of this paper for readability or accuracy.

*Statistical analysis*

Data were summarized using mean (standard deviation) for continuous variables, and frequencies (%) for categorical variables. Characteristics of the study population at the time of death among immigrants and long-term residents were compared using standardized differences. For immigrants overall and by ethnic group, we also examined education and language ability at the time of application for immigration, and immigration category (i.e., economic, family, refugee or other).

Quality indicators were calculated as crude proportions. To account for differences in sociodemographics and comorbidities among ethnic groups and long-term residents, for our primary aggressive and supportive care measures only, we conducted multivariable logistic regression analyses, adjusting for characteristics of clinical significance or shown to be associated with these outcomes in prior studies including age, sex, Charlson score, cancer type, neighbourhood income quintile, community size, health region and year of death.[12] Cancer type was determined at the time of diagnosis, and all remaining covariates were measured at the time of death. Patients with missing income quintile,

community size or health region information (<0.05% of both immigrants and long-term residents) were excluded from the regression analyses. Patients with a missing Charlson score due to no hospital admission during the observation period were grouped with patients with a zero score. Comparing immigrant ethnic groups only, we additionally adjusted for education, language ability, time since immigration and immigration category (economic, family, refugee or other). Since our study included deaths over a 12-year period, we also examined whether the effect of immigration status on receiving aggressive and supportive care changed over time by adding a 2-way interaction term between immigration status and year of death into our regression models.

All analyses were conducted at ICES using SAS version 9.4 (SAS Institute, Cary, NC). Two-sided p-values < 0.05 were considered significant.

**Results**

Between 2004 and 2015, we identified 242 556 individuals with a cancer cause of death, of whom 13 085 (5.4%) were recent immigrants (table 1). East Asians and White-Eastern Europeans made up the largest immigrant ethnic groups (n=2987 (22.8%) and n=2499 (19.1%), respectively), whereas Latin Americans were the smallest (n=670 (5.1%)). Compared with long-term residents, recent immigrants were younger at the time of death, comprised a greater proportion of females, and were more likely to live in low income neighbourhoods and urban communities. Lung cancer was the leading cause of death for both immigrants and long-term residents.

Among recent immigrants, 60.6% (n=7884) had less than secondary school education and 47.6% (n=6226) had neither English or French language ability at the time of applying for immigration, though these varied among ethnic groups. By the time of their death, 74.1% (n=9701) had resided in Canada for over ten years, including 80.3% of Latin Americans and 78.6% White-Western Europeans compared with 65.9% of West Asians/Arabs and 67.6% of South Asians.

*Aggressive care*

Compared with long-term residents, immigrants overall and by ethnic group had generally higher rates of aggressive health care use on both the composite (immigrants overall, 17.5% vs. long-term residents, 13.7%; p<0.001) and individual indicators (p<0.05 for all) (figure 1 and supplementary table 1). Among immigrants, West Asian/Arabs, Southeast Asians and South Asians had the highest composite aggressive care rates (range 20.2% to 21.0%). However, East Asians also had notably high rates of death in an acute care hospital and new hospital admissions within 30 days of death. Overall, White-Eastern and Western Europeans had the lowest rates of aggressive care on the individual and composite indicators (14.3% and 15.1%, respectively).

In unadjusted regression analyses, all ethnic groups except White-Eastern and Western Europeans were at significantly greater risk than long-term residents of receiving aggressive care, defined as our composite indicator (figure 2 and supplementary table 2, p<0.05). After adjustment, immigrants overall, as well as East Asians, South Asians, Southeast Asians and West Asians/Arabs remained more likely than long-term residents to receive aggressive care (odds ratio, OR: 1.15, 95% CI 1.09 to 1.21 for immigrants overall). The effect of immigration status also did not change over time (p=0.54 for interaction with year of death). Among immigrants only, additional adjustment for education, language ability, time since immigration and immigration category resulted in minimal change in ethnic groups' likelihood of receiving aggressive care relative to each other.

Supportive care

Immigrants overall and long-term residents had similar rates of supportive care on both the composite and individual indicators (50.5% versus 50.0%, respectively for composite; p=0.36) (figure 3 and supplementary table 1). By ethnic group, rates of supportive care varied with White-Western Europeans having the highest use on the composite indicator (55.6%) and Southeast Asians having the lowest (46.6%). On the four individual indicators, White-Eastern and Western Europeans, Latin American

and West Asians/Arabs generally had the highest rates, including close to 70% of patients receiving a home visit by a registered nurse during the six months prior to death, while East Asians again had the lowest rates.

Although in unadjusted analyses, the odds of immigrants overall receiving supportive care was not significantly different than long-term residents (OR: 1.02, 95% CI 0.98-1.06), they were less likely to do so after adjustment (OR: 0.95, 95% CI 0.91 to 0.98) (figure 4 and supplementary table 3). Differences after adjustment were attributable to differences in age, sex, neighbourhood income quintile and Charlson score. Furthermore, the effect of immigration status did not change over time (p=0.41 for interaction with year of death). Among ethnic groups, Southeast Asians, Blacks and East Asians were the least likely to receive supportive care (ORs: 0.75, 95% CI 0.66 to 0.85; 0.82, 95% CI 0.72 to 0.93; 0.89, 95% CI 0.82 to 0.96, respectively versus long-term residents), and White-Western European were most likely (OR: 1.16, 95% CI 1.03 to 1.30 versus long-term residents). Similar to aggressive care, the relative likelihood of receiving supportive care among ethnic groups did not change after adjustment for immigration factors.

**Discussion**

In this study of cancer decedents utilization of both aggressive and supportive care at the end of life in Ontario, Canada between 2004 and 2015, we found that after accounting for differences in sociodemographics and comorbidities, compared with long-term residents, recent immigrants were more likely to use aggressive care (defined by emergency department visits and new hospital or ICU admissions) and less likely to receive supportive care (defined by physician house calls and palliative nursing/personal support worker home visits). Among ethnic groups West Asian/Arabs, Southeast Asians and South Asians had the highest rates of aggressive care use. Southeast Asians also had the lowest rates of supportive care, along with Blacks and East Asians. In contrast, White-Western Europeans had one of the lowest rates of aggressive care and the highest rates of supportive care.

Our findings are consistent with studies of patients with any cause of death. Among Ontario residents both with and without cancer, recent immigrants have been reported to be more likely than long-term residents to die in an acute care hospital and be admitted to a hospital and ICU in their last month of life.[6] Additionally, decedents born in Europe were not at significantly different risk of dying in an ICU than long-term residents, while those born in Southeast Asia and South Asia were more likely to do so. In the US, patients of Black, Hispanic and Asian ethnic groups both with and without cancer have also been reported to be more likely to receive aggressive care at the end of life, and less likely to access palliative care, whether at home, in a hospice or elsewhere.[5,28–34] Regarding palliative care, they are also more likely to access it closer to death and more likely to disenroll.[33,34] However, few of these studies differentiate between immigrants and non-immigrants, and our results suggest that even in the context of cancer and in a universal health care system, where ongoing treatment near death is of questionable benefit, immigrants in Ontario are similarly more likely to use aggressive care health services and less likely to receive supportive care at the end of life as patients dying of other causes.

Our findings may be explained by several factors. Communication barriers, degree of acculturation, knowledge of and preference for care options at the end of life, and beliefs about advanced care planning may all be contributory.[8,35–39] Although 74% of immigrants in our study had resided in Canada for over 10 years prior to death, challenges encountered in settling in a new country on arrival may persist or be exacerbated when near death. With almost half of immigrants lacking English or French language ability when applying for immigration, their understanding of medical terms and care options, and capacity or readiness to communicate care wishes may influence the care they receive. As immigrants are generally healthier on arrival to Canada (the healthy immigrant effect), when compared to non-immigrants, they may also be less familiar with the health care system and services available at the end of life.[40–42]

Beyond the scope of this study, was the study of beliefs and preferences about end-of-life care. Although many studies have reported patients with cancer prefer to die at home, the generalizability of these studies to immigrant populations is unknown. In the US, a greater proportion of Blacks and Hispanics with cancer have consistently been found to prefer aggressive care near death when compared with Whites.[30,36,39,43] Differences between ethnic groups and long-term residents in care preferences and circumstances that would enable end-of-life care at home may thus influence care accessed and received, especially when residing in a country with less familiarity and potentially fewer social supports than their country of origin.[44–47]

Also unclear is the relationship between aggressive and supportive care. Many previous studies have found that supportive care, including physician continuity and greater and earlier use of palliative and home care services is associated with lower use of acute care services at the end of life.[17–21,27,48,49] This supports our finding of White-Western Europeans' high rates of receipt of supportive care and low rates of aggressive care. However, this pattern was not consistently observed among other ethnic groups, and other factors need consideration. Although much effort has been dedicated to increasing access to palliative and home care services in Ontario and Canada, it may still be insufficient for some immigrants to manage at home when near death even when preferred.[13,15,16] Particularly, whether economic class immigrants or refugees have adequate family or social supports and prefer to be cared for at home could not be examined using our data sources and thus requires further study. Regardless, health care providers and administrators should be aware of factors that may influence immigrants' use of health services at the end of life, such as language barriers, limited supports and lack of knowledge about services available, such that their interactions with immigrants may facilitate improved quality of life at this time.

This study is limited by our inability to classify the long-term resident cohort into similar ethnic groups as immigrants or identify people who immigrated to Ontario prior to 1985. However, we

estimate that over 95% are of White ethnicity and approximately 17 % are immigrants who arrived prior to 1985.[50] Related, the algorithms used to classify immigrants into ethnic groups also has limitations and it is likely that some immigrants may have been misclassified, though we believe the combining of two algorithms reduced this number. Our results may also be influenced by the salmon bias which hypothesizes that when immigrants get older or sick, they return to their region of origin, and thus are not captured in population health studies.[51–53] Although this bias has been shown to contribute to the mortality advantage among some immigrants in the UK, Hispanics in the US and internal migrants in China, its effect on differences in end-of-life care is unknown, and is likely to vary between ethnic groups.[52–54] We also did not control for stage of cancer at diagnosis. With some belief that immigrants present at later stages, this delay impact patient preferences for treatment and time for advanced care planning. Lastly, whether our findings are generalizable to immigrants in other provinces or countries also requires further investigation.

**Conclusions**

This study highlights differences in care between long-term residents and immigrants with cancer near death. Although immigrants overall were more likely to receive aggressive care and less likely to receive supportive care than long-term residents after accounting for differences in sociodemographic characteristics and comorbidities, the care received varied by ethnicity. The relationship between aggressive and supportive care within ethnic groups was also unclear, and further study is required to better understand contributors to these differences and whether their needs at the end of life are being met.

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Ontario (CCO), Immigration, Refugees and Citizenship Canada (IRCC) and the Canadian Institute for Health Information (CIHI). The original source of information on deaths from the ORG is ServiceOntario. The analyses, opinions, results, and conclusions reported in this article are those of the authors and are independent from the ICES, MOHLTC, the funding sources, ORG, Ministry of Government Services, CCO, IRCC and CIHI. No endorsement by ICES, the Ontario MOHLTC, CCO, IRCC or CIHI is intended or should be inferred.

**Author contributions:** AC conceived the study, participated in the study design and interpretation of results, and drafted the manuscript. HS and LB conceived the study, participated in the study coordination, study design, acquisition of data and interpretation of results, and provided feedback on the manuscript. RS participated in the study design and interpretation of results, and provided feedback on the manuscript. UEO participated in the study design, performed the analysis, and provided feedback on the manuscript. EO participated in the study design and study coordination, and provided feedback on the manuscript. All authors read approved the final manuscript. HS and UEO had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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**Competing interests:** None

**Ethnics approval:** This study was approved by the Hamilton Integrated Research Ethics Board, a joint board of St. Joseph's Healthcare Hamilton, Hamilton Health Sciences and McMaster University's Faculty of Health Sciences; and follows the STROBE guidelines for the reporting of observational studies.

**Data sharing statement:** The data set from this study is held securely in coded form at ICES. While data sharing agreements prohibit ICES from making the data set publicly available, access may be granted to those who meet pre-specified criteria for confidential access, available at www.ices.on.ca/DAS. The full data set creation plan and underlying analytic code are available from the authors upon request, understanding that the programs may rely upon coding templates or macros that are unique to ICES.

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**Table 1.** Baseline characteristics of study population, 2004-2015

| Characteristic | Ethnic Group | | | | | | | | *All immigrants** | *Long-term residents* | Std diff† |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | White-Eastern European | White-Western European | Latin American | East Asian | Black | South Asian | Southeast Asian | West Asian/ Arab | | | |
| Population size, N | N=2499 | N=1418 | N=670 | N=2987 | N=1052 | N=2180 | N=1129 | N=1028 | *N=13 985* | *N=229 471* | |
| Age, mean (SD), years | 65.4 (14.3) | 68.0 (15.0) | 63.9 (15.3) | 69.5 (14.9) | 61.7 (16.6) | 65.9 (14.3) | 63.5 (14.6) | 65.1 (14.8) | *66.2 (15.0)* | *72.2 (12.5)* | 0.43 |
| Female, n (%) | 1234 (49.4) | 649 (45.8) | 355 (53.0) | 1369 (45.8) | 593 (56.4) | 1034 (47.4) | 609 (53.9) | 470 (45.7) | *6373 (45.7)* | *107 411 (46.8)* | 0.04 |
| Community size >1 500 000‡, n (%) | 1742 (69.7) | 682 (48.1) | 505 (75.4) | 2677 (89.6) | 838 (79.7) | 1932 (88.6) | 936 (82.9) | 709 (69.0) | *10 116 (77.3)* | *70 397 (30.7)* | 1.06 |
| Cancer type, n (%) | | | | | | | | | | | |
| Breast | 237 (9.5) | 128 (9.0) | 83 (12.4) | 158 (5.3) | 153 (14.5) | 237 (10.9) | 112 (9.9) | 109 (10.6) | *1224 (9.4)* | *17 684 (7.7)* | 0.06 |
| Colorectal | 339 (13.6) | 170 (12.0) | 46 (6.9) | 356 (11.9) | 110 (10.5) | 135 (6.2) | 100 (8.9) | 95 (9.2) | *1365 (10.4)* | *29 032 (12.7)* | 0.07 |
| Lung | 515 (20.6) | 308 (21.7) | 101 (15.1) | 835 (28.0) | 135 (12.8) | 324 (14.9) | 300 (26.6) | 190 (18.5) | *2733 (20.9)* | *64 051 (27.9)* | 0.16 |
| Prostate | 92 (3.7) | 78 (5.5) | 50 (7.5) | 91 (3.0) | 56 (5.3) | 120 (5.5) | 37 (3.3) | 50 (4.9) | *582 (4.4)* | *15 166 (6.6)* | 0.09 |
| Other | 1316 (52.7) | 734 (51.8) | 390 (58.2) | 1547 (51.8) | 598 (56.8) | 1364 (62.6) | 580 (51.4) | 584 (56.8) | *7181 (54.9)* | *103 538 (45.1)* | 0.20 |
| **Among immigrants** | | | | | | | | | | | |
| Secondary school education or less§, n (%) | 988 (39.5) | 899 (64.0) | 482 (71.9) | 2014 (67.4) | 773 (72.5) | 1490 (68.7) | 583 (51.9) | 603 (59.1) | *7884 (60.6)* | NA | NA |
| Neither English or French§, n (%) | 1626 (65.1) | 364 (25.7) | 255 (38.1) | 2082 (69.7) | 89 (8.5) | 960 (44.0) | 323 (28.6) | 497 (48.3) | *6226 (47.6)* | | |
| Immigration category‡, n (%) | | | | | | | | | | | |
| Economic | 551 (22.0) | 505 (35.6) | 146 (21.8) | 745 (24.9) | 245 (23.3) | 501 (23.0) | 393 (34.8) | 234 (22.8) | *3354 (25.6)* | NA | NA |
| Family | 1146 (45.9) | 825 (58.2) | 360 (53.7) | 1901 (63.6) | 580 (55.1) | 1390 (63.8) | 631 (55.9) | 435 (42.3) | *7329 (56.0)* | | |
| Refugee | 753 (30.1) | 1-5 (<0.4) | 150 (22.4) | 127 (4.3) | 195 (18.5) | 251 (11.5) | 88 (7.8) | 322 (31.3) | *1900 (14.5)* | | |

Ethnic groups are ordered by increasing adjusted risk of the composite indicator for aggressive care (defined as having at least two emergency department visits, two new hospitalizations or an ICU admission within 30 days of death).

* Includes 122 immigrants for whom ethnicity is unknown.

† Reported standardized differences are for comparisons of all immigrants versus long-term residents. P-value < 0.001 for comparison of all characteristics between individual ethnic groups.

‡ Due to space limitations, proportions for income quintiles 2 to 4 and non-economic/family/refugee immigration categories are not shown. Thus, categories shown do not add up to 100%. Missing data for immigrants and long-term residents, respectively (n): 47/1112 for income quintile, 10/172 for community size.

§ Charlson score is determined from hospitalizations in the 12 to 24 months prior to death (3741 immigrants and 68 514 long-term residents had no hospitalization and are grouped with patients with score=0). Education and language ability are at the time of application for immigration.

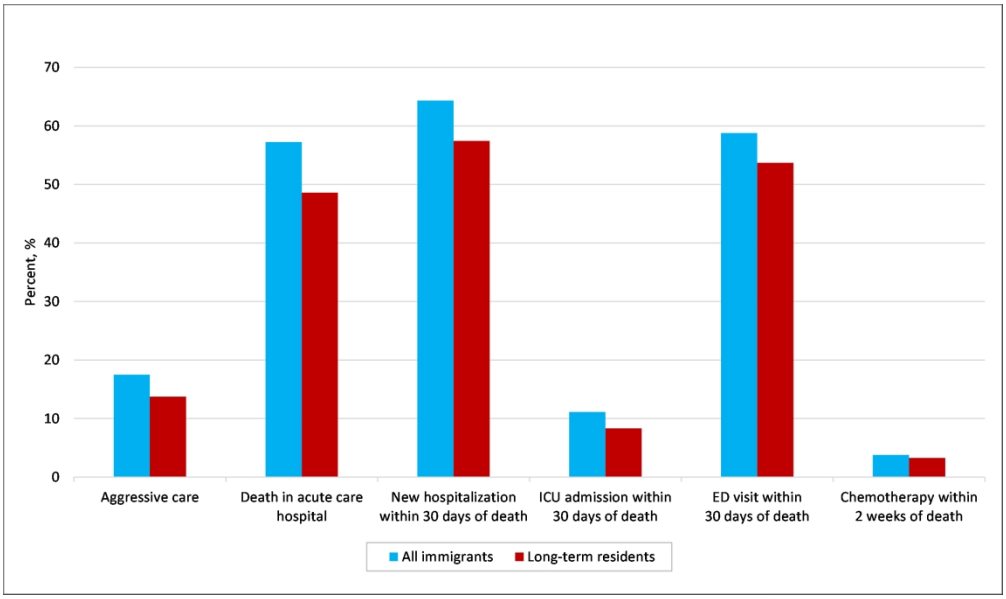
NA, not applicable.

**Figure 1.** Aggressive care quality indicator rates by immigrant status, 2004-2015. The composite aggressive care indicator is defined as receipt of ≥2 emergency department visits, ≥2 new hospitalizations or an ICU admission within 30 days of death.

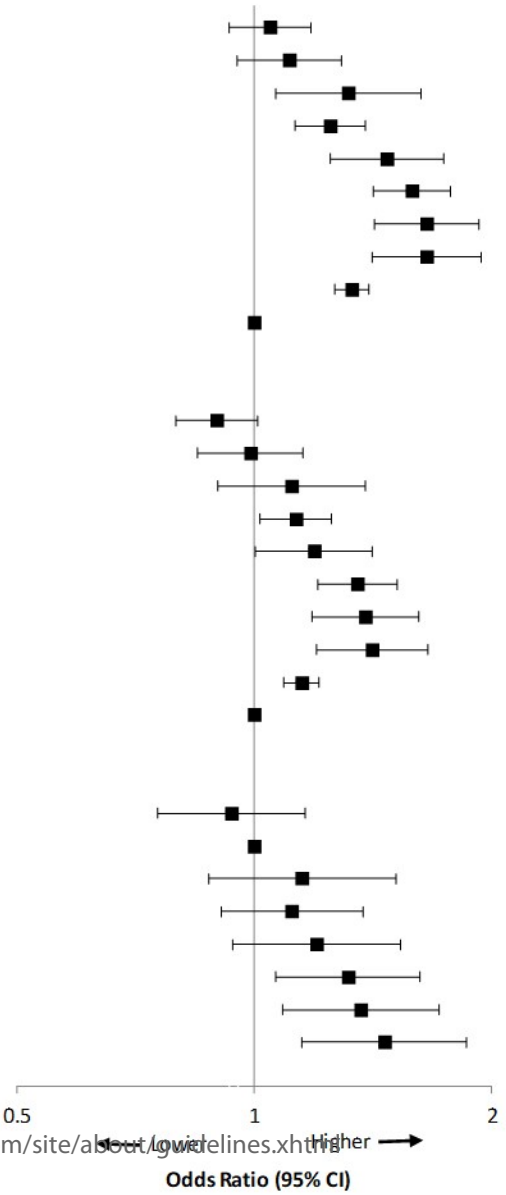
**Figure 2.** Odds ratios for receiving aggressive care. Ethnic groups are listed in order of increasing adjusted risk of receiving aggressive care versus long-term residents, defined as having ≥2 emergency department visits, ≥2 new hospitalizations or an intensive care unit admission within 30 days of death. Models for all immigrants versus long-term residents were computed separately from individual ethnic groups versus long-term residents. Immigrants of unknown ethnicity are excluded from analyses. Covariates included in adjusted models for immigrants versus long-term residents were age, sex, Charlson score, cancer type, neighbourhood income quintile, community size, health region and year of death. Adjusted models for ethnic groups only additionally adjusted for education, language ability, time since immigration and immigration category.

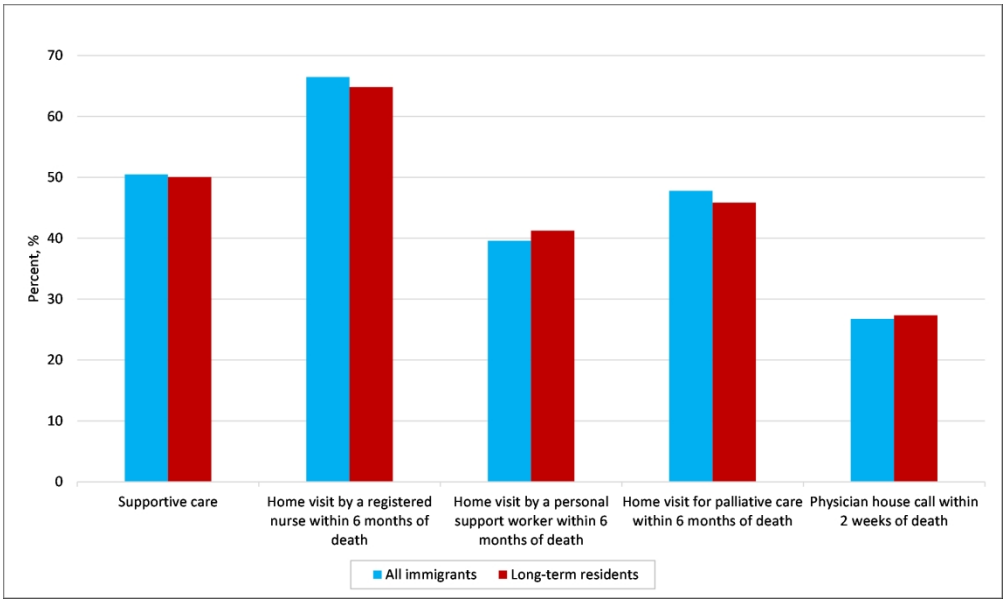
**Figure 3.** Supportive care quality indicator rates by immigrant status, 2004-2015. The composite supportive care indicator is defined as receipt of ≥1 physician house call within 2 weeks of death, or ≥1 palliative nursing or personal support worker home visit within 6 months of death.

**Figure 4.** Odds ratios for receiving supportive care. Ethnic groups are listed in order of increasing adjusted risk of receiving supportive care versus long-term residents, defined as having ≥1 physician house call within 2 weeks of death, or ≥ 1 palliative nursing or personal support worker home visit within 6 months of death. Models for all immigrants versus long-term residents were computed separately from individual ethnic groups versus long-term residents. Immigrants of unknown ethnicity are excluded from analyses. Covariates included in adjusted models for immigrants versus long-term residents were age, sex, Charlson score, cancer type, neighbourhood income quintile, community size, health region and year of death. Adjusted models for ethnic groups only additionally adjusted for education, language ability, time since immigration and immigration category.

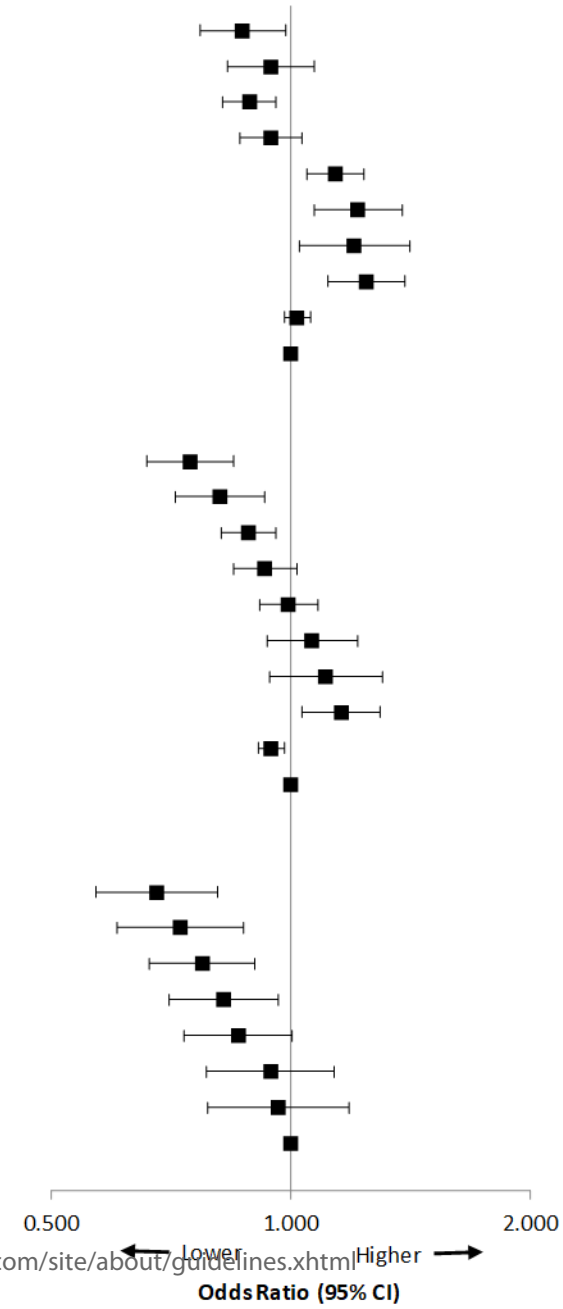


| Ethnic group | OR | 95% LCI | 95% UCI |
|---|---|---|---|
| **Unadjusted** | | | |
| White-Eastern European | 1.05 | 0.93 | 1.18 |
| White-Western European | 1.11 | 0.95 | 1.29 |
| Latin American | 1.32 | 1.06 | 1.63 |
| East Asian | 1.25 | 1.13 | 1.38 |
| Black | 1.47 | 1.25 | 1.74 |
| South Asian | 1.58 | 1.42 | 1.77 |
| Southeast Asian | 1.65 | 1.42 | 1.92 |
| West Asian/Arab | 1.66 | 1.41 | 1.94 |
| All immigrants | 1.33 | 1.27 | 1.40 |
| Long-term residents | Ref | - | - |
| **Adjusted - Immigrants vs. Long-term residents** | | | |
| White-Eastern European | 0.90 | 0.79 | 1.01 |
| White-Western European | 0.99 | 0.85 | 1.15 |
| Latin American | 1.12 | 0.90 | 1.38 |
| East Asian | 1.13 | 1.02 | 1.25 |
| Black | 1.19 | 1.00 | 1.41 |
| South Asian | 1.35 | 1.20 | 1.52 |
| Southeast Asian | 1.38 | 1.19 | 1.62 |
| West Asian/Arab | 1.41 | 1.20 | 1.66 |
| All immigrants | 1.15 | 1.09 | 1.21 |
| Long-term residents | Ref | - | - |
| **Adjusted - Ethnic groups only** | | | |
| White-Eastern European | 0.94 | 0.75 | 1.16 |
| White-Western European | Ref | - | - |
| Latin American | 1.15 | 0.87 | 1.51 |
| East Asian | 1.12 | 0.91 | 1.37 |
| Black | 1.20 | 0.94 | 1.53 |
| South Asian | 1.31 | 1.07 | 1.62 |
| Southeast Asian | 1.37 | 1.08 | 1.72 |
| West Asian/Arab | 1.46 | 1.15 | 1.85 |





| Ethnic group | OR | 95% LCI | 95% UCI |
|---|---|---|---|
| **Unadjusted** | | | |
| Southeast Asian | 0.87 | 0.77 | 0.99 |
| Black | 0.94 | 0.83 | 1.07 |
| East Asian | 0.89 | 0.82 | 0.96 |
| South Asian | 0.95 | 0.87 | 1.03 |
| White-Eastern European | 1.14 | 1.05 | 1.24 |
| West Asian/Arab | 1.22 | 1.07 | 1.38 |
| Latin American | 1.20 | 1.03 | 1.41 |
| White-Western European | 1.25 | 1.12 | 1.39 |
| All immigrants | 1.02 | 0.98 | 1.06 |
| Long-term residents | Ref | - | - |
| **Adjusted - Immigrants vs. Long-term residents** | | | |
| Southeast Asian | 0.75 | 0.66 | 0.85 |
| Black | 0.82 | 0.72 | 0.93 |
| East Asian | 0.89 | 0.82 | 0.96 |
| South Asian | 0.93 | 0.85 | 1.02 |
| White-Eastern European | 1.00 | 0.91 | 1.08 |
| West Asian/Arab | 1.07 | 0.93 | 1.22 |
| Latin American | 1.11 | 0.94 | 1.31 |
| White-Western European | 1.16 | 1.03 | 1.30 |
| All immigrants | 0.95 | 0.91 | 0.98 |
| Long-term residents | Ref | - | - |
| **Adjusted - Ethnic groups only** | | | |
| Southeast Asian | 0.68 | 0.57 | 0.81 |
| Black | 0.73 | 0.61 | 0.87 |
| East Asian | 0.78 | 0.67 | 0.90 |
| South Asian | 0.82 | 0.70 | 0.96 |
| White-Eastern European | 0.86 | 0.74 | 1.01 |
| West Asian/Arab | 0.94 | 0.79 | 1.14 |
| Latin American | 0.97 | 0.79 | 1.19 |
| White-Western European | Ref | - | - |



**Supplementary Content**

**End-of-life cancer care: a cohort study of immigrants and long-term residents in Ontario, Canada**

Chu A, Barbera L, Sutradhar R, Erbas Oz U, O'Leary E, Seow H

**Supplementary table 1.** Quality indicator rates by ethnicity and immigrant status, 2004-2015

**Supplementary table 2.** Logistic regression models for aggressive care

**Supplementary table 3.** Logistic regression models for supportive care

**Supplementary table 1.** Quality indicator rates by ethnicity and immigrant status, 2004-2015

| Indicator | Ethnic Group | | | | | | | | All Immigrants* | Long-term Residents | p-value† |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Black | East Asian | Latin American | South Asian | Southeast Asian | West Asian/Arab | White-Eastern European | White-Western European | | | |
| | n (%) | | | | | | | | | | |
| Population size, n | 1052 | 2987 | 670 | 2180 | 1129 | 1028 | 2499 | 1418 | 13 085 | 229 471 | |
| Death in acute care hospital or bed‡ | 623 (59.2) | 1846 (61.8) | 367 (54.8) | 1353 (62.1) | 681 (60.3) | 632 (61.5) | 1259 (50.4) | 659 (46.5) | 7493 (57.3) | 111 544 (48.6) | <0.001 |
| New hospitalization within 30 days of death | 585 (64.6) | 1855 (69.1) | 369 (61.8) | 1269 (66.8) | 695 (68.9) | 632 (68.5) | 1327 (58.4) | 731 (55.6) | 7832 (66.4) | 121 559 (57.4) | <0.001 |
| Eligible, n | 906 | 2686 | 597 | 1899 | 1008 | 922 | 2272 | 1314 | 11 707 | 211 618 | |
| ICU admission within 30 days of death‡ | 124 (11.8) | 306 (10.2) | 72 (10.7) | 293 (13.4) | 146 (12.9) | 140 (13.6) | 223 (8.9) | 134 (9.4) | 1455 (11.1) | 19 097 (8.3) | |
| ≥ 1 ED visit within 30 days of death | 566 (62.5) | 1580 (58.8) | 335 (56.1) | 1189 (62.6) | 631 (62.6) | 573 (62.1) | 1248 (54.9) | 699 (53.2) | 6882 (58.8) | 113 674 (53.7) | <0.001 |
| Eligible, n | 906 | 2686 | 597 | 1899 | 1008 | 922 | 2272 | 1314 | 11 707 | 211 618 | |
| Chemotherapy within 2 weeks of death‡ | 44 (4.2) | 94 (3.1) | 21 (3.1) | 105 (4.8) | 52 (4.6) | 33 (3.2) | 84 (3.4) | 60 (4.2) | 497-502 (3.80-3.84) | 7527 (3.3) | 0.001 |
| Home visit within 6 months of death by a: | | | | | | | | | | | |
| Registered nurse | 697 (67.0) | 1787 (60.3) | 457 (69.1) | 1420 (66.3) | 735 (65.9) | 712 (69.8) | 1712 (69.0) | 1008 (71.8) | 8606 (66.5) | 147 512 (64.8) | <0.001 |
| Personal support worker | 461 (44.3) | 1032 (34.8) | 295 (44.6) | 923 (43.1) | 408 (36.6) | 438 (42.9) | 927 (37.4) | 599 (42.7) | 5226 (39.6) | 93 866 (41.3) | <0.001 |
| Eligible, n | 1040 | 2964 | 661 | 2143 | 1116 | 1020 | 2480 | 1404 | 12 947 | 227 553 | |
| For palliative care (fiscal year 2005+ only) | 446 (46.3) | 1190 (44.5) | 314 (51.5) | 909 (46.0) | 460 (44.7) | 494 (52.2) | 1157 (50.4) | 665 (51.7) | 5685 (47.8) | 92 849 (45.9) | <0.001 |
| Eligible, n | 964 | 2674 | 610 | 1976 | 1028 | 946 | 2297 | 1287 | 11 897 | 202,492 | |
| Physician house call within 2 weeks of death | 187 (25.0) | 517 (22.8) | 147 (30.2) | 412 (25.9) | 170 (20.4) | 220 (28.3) | 603 (30.4) | 380 (32.5) | 2661 (26.7) | 50 860 (27.3) | 0.21 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Eligible, n | 748 | 2271 | 487 | 1591 | 833 | 777 | 1982 | 1169 | 9348 | 186 113 | |
| Aggressive care§ | 172 (19.0) | 442 (16.5) | 103 (17.3) | 383 (20.2) | 211 (20.9) | 192 (20.8) | 326 (14.3) | 198 (15.1) | 2250 (27.5) | 29 087 (13.7) | <0.001 |
| Eligible, n | 906 | 2686 | 597 | 1899 | 1008 | 922 | 2272 | 1314 | 11 707 | 21 1618 | |
| Supportive care‖ | 469 (48.7) | 1252 (46.8) | 333 (54.6) | 962 (48.7) | 479 (46.6) | 518 (54.8) | 1224 (53.3) | 715 (55.6) | 6006 (50.5) | 101 347 (50.0) | 0.36 |
| Eligible, n | 964 | 2674 | 610 | 1976 | 1028 | 946 | 2297 | 1287 | 11 897 | 202 492 | |

* Includes 122 immigrants whose ethnicity could not be classified. A range is reported for chemotherapy within 2 weeks of death to suppress a count of < 6 in the unknown ethnicity group.

†p-value is for all immigrants versus long-term residents.

‡ Eligible population is the entire population.

§ Aggressive care is defined as having ≥2 emergency department visits, ≥2 new hospitalizations or an ICU admission within 30 days of death.

‖ Supportive care is defined as having ≥1 physician house call within 2 weeks of death, or ≥1 palliative nursing or personal support worker home visit within 6 months of death.

ED, emergency department; ICU, intensive care unit.

**Supplementary table 2.** Logistic regression models for aggressive care*

| | | Univariate | | | Ethnic groups vs long-term residents | | | Immigrants vs long-term residents | | | Ethnic groups only | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OR† | 95% CI | | OR† | 95% CI | | OR† | 95% CI | | OR† | 95% CI | |
| | | | Lower | Upper | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| Ethnicity | White-Eastern European | 1.05 | 0.93 | 1.18 | 0.90 | 0.79 | 1.01 | na | na | na | 0.94 | 0.75 | 1.16 |
| | White-Western European | 1.11 | 0.95 | 1.29 | 0.99 | 0.85 | 1.15 | na | na | na | Ref | - | - |
| | Latin American | **1.32** | **1.06** | **1.63** | 1.12 | 0.90 | 1.38 | na | na | na | 1.15 | 0.87 | 1.51 |
| | East Asian | **1.25** | **1.13** | **1.38** | **1.13** | **1.02** | **1.25** | na | na | na | 1.12 | 0.91 | 1.37 |
| | Black | **1.47** | **1.25** | **1.74** | 1.19 | 1.00 | 1.41 | na | na | na | 1.20 | 0.94 | 1.53 |
| | South Asian | **1.58** | **1.42** | **1.77** | **1.35** | **1.20** | **1.52** | na | na | na | **1.31** | **1.07** | **1.62** |
| | Southeast Asian | **1.65** | **1.42** | **1.92** | **1.38** | **1.19** | **1.62** | na | na | na | **1.37** | **1.08** | **1.72** |
| | West Asian/Arab | **1.66** | **1.41** | **1.94** | **1.41** | **1.20** | **1.66** | na | na | na | **1.46** | **1.15** | **1.85** |
| | All immigrants | **1.33** | **1.27** | **1.40** | na | na | na | **1.15** | **1.09** | **1.21** | na | na | na |
| | Long-term residents | Ref | - | - | Ref | - | - | Ref | - | - | na | na | na |
| Age (per year) | | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** |
| Sex | Men | **1.30** | **1.27** | **1.33** | **1.31** | **1.28** | **1.35** | **1.31** | **1.28** | **1.35** | **1.24** | **1.11** | **1.38** |
| | Women | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Charlson score | 1+ | **0.94** | **0.91** | **0.97** | 1.00 | 0.96 | 1.04 | 1.00 | 0.97 | 1.04 | 0.95 | 0.81 | 1.11 |
| | 0 or missing | Ref | - | - | Ref | - | - | Ref | - | - | 1.00 | - | - |
| Cancer type | Breast | **0.70** | **0.67** | **0.74** | **0.77** | **0.72** | **0.81** | **0.77** | **0.73** | **0.81** | **0.78** | **0.63** | **0.96** |
| | Colorectal | **0.93** | **0.89** | **0.97** | 0.98 | 0.94 | 1.02 | 0.98 | 0.94 | 1.02 | **0.82** | **0.67** | **0.99** |
| | Prostate | **0.62** | **0.59** | **0.66** | **0.67** | **0.63** | **0.71** | **0.67** | **0.63** | **0.71** | **0.51** | **0.37** | **0.70** |
| | Other | **1.03** | **1.01** | **1.06** | 1.03 | 1.00 | 1.06 | 1.03 | 1.00 | 1.06 | 1.02 | 0.90 | 1.16 |
| | Lung | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Neighbourhood income quintile | 1 (lowest) | **1.08** | **1.04** | **1.12** | **1.05** | **1.01** | **1.10** | **1.06** | **1.01** | **1.10** | 1.05 | 0.88 | 1.26 |
| | 2 | **1.05** | **1.01** | **1.09** | 1.03 | 0.99 | 1.07 | 1.03 | 0.99 | 1.07 | 1.11 | 0.92 | 1.33 |
| | 3 | **1.06** | **1.02** | **1.10** | 1.03 | 0.99 | 1.08 | 1.04 | 0.99 | 1.08 | 1.01 | 0.84 | 1.22 |
| | 4 | **1.04** | **1.003** | **1.09** | 1.02 | 0.98 | 1.06 | 1.02 | 0.98 | 1.06 | 1.03 | 0.85 | 1.25 |
| | 5 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Community size | < 10 000 | **1.20** | **1.16** | **1.24** | **1.25** | **1.20** | **1.30** | **1.25** | **1.20** | **1.30** | 1.04 | 0.67 | 1.62 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10 000-99 999 | **1.17** | **1.13** | **1.21** | **1.25** | **1.20** | **1.30** | **1.25** | **1.19** | **1.30** | 1.27 | 0.82 | 1.98 |
| | ≥ 100 000 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Health region | Erie St.Clair | 1.03 | 0.97 | 1.10 | 0.95 | 0.89 | 1.02 | 0.95 | 0.89 | 1.02 | 0.94 | 0.66 | 1.34 |
| | South West | 1.13 | 1.06 | 1.20 | 1.02 | 0.96 | 1.08 | 1.02 | 0.96 | 1.09 | 0.94 | 0.65 | 1.38 |
| | Waterloo Wellington | 1.05 | 0.98 | 1.12 | 1.01 | 0.94 | 1.08 | 1.01 | 0.95 | 1.08 | 1.16 | 0.86 | 1.56 |
| | Hamilton Niagara Haldimand Brant | **0.94** | **0.89** | **0.99** | **0.94** | **0.89** | **0.99** | **0.94** | **0.89** | **0.99** | 1.12 | 0.87 | 1.44 |
| | Central West | **1.25** | **1.16** | **1.34** | **1.15** | **1.07** | **1.23** | **1.16** | **1.08** | **1.25** | **1.34** | **1.09** | **1.66** |
| | Mississauga Halton | 1.00 | 0.94 | 1.07 | 0.98 | 0.92 | 1.05 | 0.98 | 0.92 | 1.05 | 1.04 | 0.85 | 1.28 |
| | Toronto Central | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| | Central | **1.17** | **1.10** | **1.24** | **1.16** | **1.09** | **1.23** | **1.16** | **1.09** | **1.23** | **1.20** | **1.01** | **1.43** |
| | Central East | **1.10** | **1.04** | **1.16** | 1.03 | 0.97 | 1.09 | 1.04 | 0.98 | 1.10 | **1.30** | **1.08** | **1.57** |
| | South East | **1.14** | **1.07** | **1.22** | 0.98 | 0.91 | 1.05 | 0.98 | 0.92 | 1.06 | 1.17 | 0.59 | 2.32 |
| | Champlain | 0.95 | 0.90 | 1.01 | **0.88** | **0.83** | **0.93** | **0.88** | **0.83** | **0.94** | 1.03 | 0.80 | 1.34 |
| | North Simcoe Muskoka | **1.11** | **1.03** | **1.19** | 0.96 | 0.89 | 1.04 | 0.96 | 0.89 | 1.04 | 1.33 | 0.76 | 2.35 |
| | North East | **1.14** | **1.07** | **1.21** | 0.95 | 0.88 | 1.01 | 0.95 | 0.88 | 1.02 | 1.06 | 0.47 | 2.41 |
| | North West | **0.90** | **0.81** | **0.99** | **0.82** | **0.74** | **0.90** | **0.82** | **0.74** | **0.90** | 1.11 | 0.41 | 2.98 |
| Year of death | 2004 | 1.00 | 0.94 | 1.07 | 0.97 | 0.91 | 1.04 | 0.97 | 0.91 | 1.04 | 0.92 | 0.70 | 1.20 |
| | 2005 | 0.95 | 0.89 | 1.01 | **0.93** | **0.87** | **0.99** | **0.93** | **0.87** | **0.99** | 0.90 | 0.69 | 1.18 |
| | 2006 | 0.95 | 0.89 | 1.01 | **0.92** | **0.87** | **0.98** | **0.92** | **0.87** | **0.98** | 1.05 | 0.82 | 1.35 |
| | 2007 | 0.99 | 0.93 | 1.06 | 0.97 | 0.91 | 1.03 | 0.97 | 0.91 | 1.03 | 1.03 | 0.80 | 1.31 |
| | 2008 | 1.02 | 0.96 | 1.08 | 1.00 | 0.94 | 1.06 | 1.00 | 0.94 | 1.06 | 0.88 | 0.69 | 1.12 |
| | 2009 | 0.99 | 0.93 | 1.05 | 0.97 | 0.91 | 1.03 | 0.97 | 0.91 | 1.03 | 0.96 | 0.76 | 1.22 |
| | 2010 | 0.97 | 0.91 | 1.03 | 0.95 | 0.89 | 1.01 | 0.95 | 0.89 | 1.01 | 0.90 | 0.70 | 1.14 |
| | 2011 | 0.98 | 0.92 | 1.04 | 0.97 | 0.91 | 1.03 | 0.97 | 0.91 | 1.03 | 0.86 | 0.68 | 1.09 |
| | 2012 | 0.99 | 0.93 | 1.06 | 0.97 | 0.92 | 1.04 | 0.97 | 0.92 | 1.04 | 1.04 | 0.83 | 1.30 |
| | 2013 | 0.96 | 0.90 | 1.03 | 0.95 | 0.89 | 1.02 | 0.95 | 0.89 | 1.02 | 0.94 | 0.72 | 1.22 |
| | 2014 | 0.94 | 0.88 | 1.01 | 0.94 | 0.88 | 1.01 | 0.94 | 0.88 | 1.01 | 0.94 | 0.73 | 1.22 |
| | 2015 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Education | > Secondary school | na | na | na | na | na | na | na | na | na | 1.05 | 0.94 | 1.17 |
| | Secondary school or less | na | na | na | na | na | na | na | na | na | Ref | - | - |



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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Language ability | Neither English or French | na | na | na | na | na | na | na | na | na | 0.97 | 0.87 | 1.09 |
| | English and/or French | na | na | na | na | na | na | na | na | na | Ref | - | - |
| Time since immigration | < 5 years | na | na | na | na | na | na | na | na | na | 1.04 | 0.88 | 1.23 |
| | 5-10 years | na | na | na | na | na | na | na | na | na | 0.99 | 0.86 | 1.13 |
| | > 10 years | na | na | na | na | na | na | na | na | na | Ref | - | - |
| Immigration category | Economic | na | na | na | na | na | na | na | na | na | 1.03 | 0.91 | 1.18 |
| | Refugee or other | na | na | na | na | na | na | na | na | na | 0.98 | 0.85 | 1.13 |
| | Family | na | na | na | na | na | na | na | na | na | Ref | - | - |

* Aggressive care is defined as having ≥2 emergency department visits, ≥2 new hospitalizations or an ICU admission within 30 days of death. Ethnic groups are listed in order of increasing receipt of aggressive care versus long-term residents. Immigrants of unknown ethnicity are excluded from analyses.

† Boldface type indicates significant values at p<0.05.

CI=confidence interval, na=not applicable, OR=odds ratio.

**Supplementary table 3.** Logistic regression models for supportive care*

| | | Univariate | | | Ethnic groups vs long-term residents | | | Immigrants vs long-term residents | | | Ethnic groups only | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OR† | 95% CI | | OR† | 95% CI | | OR† | 95% CI | | OR† | 95% CI | |
| | | | Lower | Upper | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| Ethnicity | Southeast Asian | **0.87** | **0.77** | **0.99** | **0.75** | **0.66** | **0.85** | na | na | na | **0.68** | **0.57** | **0.81** |
| | Black | 0.94 | 0.83 | 1.07 | **0.82** | **0.72** | **0.93** | na | na | na | **0.73** | **0.61** | **0.87** |
| | East Asian | **0.89** | **0.82** | **0.96** | **0.89** | **0.82** | **0.96** | na | na | na | **0.78** | **0.67** | **0.90** |
| | South Asian | 0.95 | 0.87 | 1.03 | 0.93 | 0.85 | 1.02 | na | na | na | **0.82** | **0.70** | **0.96** |
| | White-Eastern European | **1.14** | **1.05** | **1.24** | 1.00 | 0.91 | 1.08 | na | na | na | 0.86 | 0.74 | 1.01 |
| | West Asian/Arab | **1.22** | **1.07** | **1.38** | 1.07 | 0.93 | 1.22 | na | na | na | 0.94 | 0.79 | 1.14 |
| | Latin American | **1.20** | **1.03** | **1.41** | 1.11 | 0.94 | 1.31 | na | na | na | 0.97 | 0.79 | 1.19 |
| | White-Western European | **1.25** | **1.12** | **1.39** | **1.16** | **1.03** | **1.30** | na | na | na | Ref | - | - |
| | All immigrants | 1.02 | 0.8 | 1.06 | na | na | na | **0.95** | **0.91** | **0.98** | na | na | na |
| | Long-term residents | Ref | - | - | Ref | - | - | Ref | - | - | na | na | na |
| Age (years) | | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.99** | **0.99** | **0.99** |
| Sex | Men | **0.92** | **0.90** | **0.93** | **0.92** | **0.90** | **0.93** | **0.92** | **0.90** | **0.93** | **0.84** | **0.78** | **0.91** |
| | Women | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Charlson score | 1+ | **0.89** | **0.87** | **0.91** | **0.95** | **0.93** | **0.97** | **0.95** | **0.93** | **0.97** | 1.03 | 0.92 | 1.16 |
| | 0 or missing | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Cancer type | Breast | **1.04** | **1.01** | **1.08** | 0.98 | 0.94 | 1.01 | 0.98 | 0.94 | 1.01 | 1.01 | 0.86 | 1.18 |
| | Colorectal | **0.92** | **0.89** | **0.95** | 0.99 | 0.96 | 1.02 | 0.99 | 0.96 | 1.02 | 1.03 | 0.90 | 1.19 |
| | Prostate | **0.84** | **0.80** | **0.87** | 1.01 | 0.98 | 1.05 | 1.01 | 0.98 | 1.05 | 1.08 | 0.89 | 1.32 |
| | Other | **0.85** | **0.83** | **0.87** | **0.84** | **0.83** | **0.86** | **0.84** | **0.83** | **0.86** | **0.82** | **0.74** | **0.90** |
| | Lung | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Neighbourhood income quintile | 1 (lowest) | **0.74** | **0.72** | **0.76** | **0.74** | **0.72** | **0.76** | **0.74** | **0.72** | **0.76** | **0.84** | **0.74** | **0.96** |
| | 2 | **0.84** | **0.82** | **0.87** | **0.85** | **0.83** | **0.87** | **0.85** | **0.82** | **0.87** | **0.82** | **0.71** | **0.93** |
| | 3 | **0.87** | **0.85** | **0.90** | **0.88** | **0.86** | **0.91** | **0.88** | **0.86** | **0.91** | 0.96 | 0.83 | 1.10 |
| | 4 | **0.93** | **0.91** | **0.96** | **0.93** | **0.90** | **0.95** | **0.93** | **0.90** | **0.95** | 0.91 | 0.79 | 1.05 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Community size | < 10,000 | **0.89** | **0.87** | **0.91** | **0.93** | **0.91** | **0.96** | **0.93** | **0.91** | **0.96** | 1.05 | 0.76 | 1.46 |
| | 10,000-99,999 | **0.95** | **0.93** | **0.98** | 0.99 | 0.96 | 1.02 | 0.99 | 0.96 | 1.02 | 0.94 | 0.67 | 1.32 |
| | ≥ 100,000 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Health region | Erie St.Clair | **1.37** | **1.30** | **1.43** | **1.34** | **1.28** | **1.41** | **1.35** | **1.28** | **1.41** | **1.33** | **1.03** | **1.72** |
| | South West | **0.88** | **0.84** | **0.92** | **0.89** | **0.85** | **0.93** | **0.89** | **0.85** | **0.93** | 0.97 | 0.75 | 1.26 |
| | Waterloo Wellington | **1.84** | **1.75** | **1.93** | **1.83** | **1.74** | **1.92** | **1.83** | **1.74** | **1.92** | **1.79** | **1.42** | **2.26** |
| | Hamilton Niagara Haldimand Brant | **1.24** | **1.19** | **1.28** | **1.24** | **1.19** | **1.29** | **1.24** | **1.19** | **1.29** | 1.18 | 0.97 | 1.42 |
| | Central West | **0.92** | **0.87** | **0.97** | **0.87** | **0.83** | **0.92** | **0.87** | **0.82** | **0.92** | 0.93 | 0.79 | 1.10 |
| | Mississauga Halton | **1.27** | **1.21** | **1.32** | **1.20** | **1.15** | **1.26** | **1.20** | **1.14** | **1.25** | **1.19** | **1.03** | **1.38** |
| | Toronto Central | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| | Central | 1.02 | 0.98 | 1.07 | 1.01 | 0.97 | 1.06 | 1.01 | 0.97 | 1.05 | 1.02 | 0.90 | 1.16 |
| | Central East | 1.02 | 0.98 | 1.06 | 1.03 | 0.99 | 1.07 | 1.03 | 0.99 | 1.07 | 0.96 | 0.83 | 1.10 |
| | South East | **0.88** | **0.84** | **0.93** | 0.90 | 0.86 | 0.95 | **0.91** | **0.86** | **0.95** | 0.65 | 0.39 | 1.08 |
| | Champlain | **1.47** | **1.41** | **1.53** | **1.45** | **1.39** | **1.51** | **1.45** | **1.39** | **1.51** | **1.61** | **1.33** | **1.96** |
| | North Simcoe Muskoka | **1.29** | **1.23** | **1.36** | **1.30** | **1.23** | **1.37** | **1.30** | **1.23** | **1.37** | 1.24 | 0.80 | 1.94 |
| | North East | 0.96 | 0.91 | 1.00 | 0.97 | 0.93 | 1.02 | 0.97 | 0.93 | 1.02 | 1.44 | 0.77 | 2.71 |
| | North West | **0.63** | **0.59** | **0.67** | **0.62** | **0.58** | **0.67** | **0.62** | **0.58** | **0.67** | 1.53 | 0.72 | 3.23 |
| Year of death | 2005 | **0.59** | **0.57** | **0.62** | **0.56** | **0.54** | **0.59** | **0.56** | **0.54** | **0.59** | **0.62** | **0.51** | **0.77** |
| | 2006 | **0.67** | **0.64** | **0.70** | **0.64** | **0.61** | **0.67** | **0.64** | **0.61** | **0.67** | **0.56** | **0.46** | **0.67** |
| | 2007 | **0.67** | **0.65** | **0.70** | **0.65** | **0.62** | **0.67** | **0.65** | **0.62** | **0.67** | **0.62** | **0.51** | **0.74** |
| | 2008 | **0.67** | **0.64** | **0.69** | **0.64** | **0.61** | **0.67** | **0.64** | **0.61** | **0.67** | **0.62** | **0.52** | **0.74** |
| | 2009 | **0.70** | **0.67** | **0.73** | **0.67** | **0.64** | **0.70** | **0.67** | **0.65** | **0.70** | **0.73** | **0.61** | **0.87** |
| | 2010 | **0.74** | **0.71** | **0.77** | **0.72** | **0.69** | **0.75** | **0.72** | **0.69** | **0.75** | **0.77** | **0.64** | **0.91** |
| | 2011 | **0.77** | **0.74** | **0.80** | **0.75** | **0.72** | **0.78** | **0.75** | **0.72** | **0.78** | **0.89** | **0.75** | **1.05** |
| | 2012 | **0.77** | **0.74** | **0.81** | **0.76** | **0.72** | **0.79** | **0.76** | **0.72** | **0.79** | **0.86** | **0.73** | **1.02** |
| | 2013 | **0.85** | **0.81** | **0.89** | **0.85** | **0.81** | **0.89** | **0.85** | **0.81** | **0.89** | **0.73** | **0.60** | **0.88** |
| | 2014 | **0.92** | **0.87** | **0.96** | **0.91** | **0.87** | **0.96** | **0.91** | **0.87** | **0.96** | **0.87** | **0.72** | **1.06** |
| | 2015 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Education | > Secondary school | na | na | na | na | na | na | na | na | na | 1.04 | 0.95 | 1.13 |
| | Secondary school or less | na | na | na | na | na | na | na | na | na | Ref | - | - |
| Language ability | Neither English or French | na | na | na | na | na | na | na | na | na | 1.01 | 0.92 | 1.10 |
| | English and/or French | na | na | na | na | na | na | na | na | na | Ref | - | - |
| Time since immigration | < 5 years | na | na | na | na | na | na | na | na | na | **0.85** | **0.75** | **0.97** |
| | 5-10 years | na | na | na | na | na | na | na | na | na | 0.98 | 0.88 | 1.10 |
| | > 10 years | na | na | na | na | na | na | na | na | na | Ref | - | - |
| Immigration category | Economic | na | na | na | na | na | na | na | na | na | 1.02 | 0.92 | 1.14 |
| | Refugee or other | na | na | na | na | na | na | na | na | na | 1.03 | 0.92 | 1.15 |
| | Family | na | na | na | na | na | na | na | na | na | Ref | - | - |

* Supportive care is defined as ≥1 physician house call within 2 weeks of death, or ≥ 1 palliative nursing or personal support worker home visit within 6 months of death. Ethnic groups are listed in order of increasing receipt of supportive care versus long-term residents. Immigrants of unknown ethnicity are excluded from analyses. Deaths in 2004 are excluded as home care data is only available from April 2005.

† Boldface type indicates significant values at p<0.05.

CI, confidence interval; na, not applicable; OR, odds ratio.

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

| | Item No | Recommendation | Page No |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | 0, 1 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | 1 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 4 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 5 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | 5 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 5-6 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up | 5-6 |
| | | (*b*) For matched studies, give matching criteria and number of exposed and unexposed | NA |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 5-6 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 5-6 |
| Bias | 9 | Describe any efforts to address potential sources of bias | Nil |
| Study size | 10 | Explain how the study size was arrived at | 5 |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 7 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | 7 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | 7 |
| | | (*c*) Explain how missing data were addressed | 7 |
| | | (*d*) If applicable, explain how loss to follow-up was addressed | NA |
| | | (*e*) Describe any sensitivity analyses | NA |
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | 8 |
| | | (b) Give reasons for non-participation at each stage | NA |
| | | (c) Consider use of a flow diagram | NA |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | 8, Tbl 1 |
| | | (b) Indicate number of participants with missing data for each variable of interest | Tbl 1 |
| | | (c) Summarise follow-up time (eg, average and total amount) | NA |
| Outcome data | 15* | Report numbers of outcome events or summary measures over time | Fig 1 & 3, Supple |

| | | | |
|---|---|---|---|
| | | | tbl 1 |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | Fig 2 & 4, Supple tbl 2 & 3 |
| | | (*b*) Report category boundaries when continuous variables were categorized | Supple tbl 2 & 3 |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | NA |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | NA |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 10 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 12 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 13 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 12 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 14 |

*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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# Association between end-of-life cancer care and immigrant status: a retrospective cohort study in Ontario, Canada



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# Association between end-of-life cancer care and immigrant status: a retrospective cohort study in Ontario, Canada

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## Abstract

**Objective:** To compare recent immigrants and long-term residents in Ontario, Canada on established health service quality indicators of end-of-life cancer care.

**Design:** Retrospective, population-based cohort study of cancer decedents between 2004 and 2015.

**Setting:** Ontario, Canada.

**Participants:** We grouped 13 085 immigrants who arrived in Ontario in 1985 or later into eight major ethnic groups based on birth country, mother tongue and surname, and compared them to 229 471 long-term residents who were ≥18 years at the time of death.

**Primary and secondary outcome measures:** Aggressive care, defined as a composite of ≥2 emergency department visits, ≥2 new hospitalizations, or an intensive care unit admission within 30 days of death; and supportive care, defined as a physician house call within 2 weeks, or palliative nursing or personal support worker home visit within 6 months of death. Multivariable logistic regression was used to examine the association between immigration status and the odds of each main outcome.

**Results:** Compared with long-term residents, immigrants overall and by ethnic group had higher rates of aggressive care (13.7% versus 17.5%, respectively; p<0.001). Among immigrants, Southeast Asians had the highest use while White-Eastern and Western Europeans had the lowest. Supportive care use was similar between long-term residents and immigrants (50.0% versus 50.5%, respectively; p=0.36), though lower among Southeast Asians (46.6%) and higher among White-Western Europeans (55.6%). After adjusting for sociodemographic characteristics and comorbidities, immigrants remained more likely than long-term residents to receive aggressive care (OR: 1.15, 95% CI 1.09 to 1.21), yet were less likely to receive supportive care (OR: 0.95, 95% CI 0.91 to 0.98).

**Conclusions:** Among cancer decedents in Ontario, immigrants are more likely to use aggressive health care services at the end of life than long-term residents, while supportive care varies by ethnicity. Contributors to variation in end-of-life care require further study.

**Keywords:** Immigrants, end of life care, palliative care, cancer

## Article Summary

### Strengths and limitations of this study

- Using health administrative data from a universal health care system, we conducted a population-based study of all cancer decedents in Ontario, Canada between 2004 and 2015.
- Established quality indicators of end-of-life cancer care were compared among long-term residents versus immigrants and among eight different ethnic groups.
- Studying the beliefs and preferences about end-of-life care among immigrants of different ethnic groups are beyond the scope of this study.
- Immigrants who returned to their native country prior to death are not identified by our data sources, and thus, are not included.

## Introduction

Recently, there has been increasing attention to racial and ethnic inequities in many contexts including health and health care, where reports from many countries have documented ethnic groups experiencing greater mortality and risk of some diseases, less access to health care and lower self-reported health.[1–4] For immigrants, additional factors associated with migration, such as language barriers, new environments, limited family and social supports, limited awareness about how to navigate the health care system and diverse expectations and preferences with respect to health care have the potential to further exacerbate health disparities, including at the end of life.

Previous studies of end-of-life (EOL) care have found that immigrants in Canada and the United States are more likely to receive aggressive care, such as admission to an intensive care unit (ICU), mechanical ventilation and feeding tube placement at the end of life compared to non-immigrants.[5,6] Whether these differences extend to immigrants dying of cancer, where arguably prognosis may be more foreseeable and opportunities for advanced care planning greater than with other conditions, is less well studied. Moreover, much of the prior research on ethnic disparities at the end of life focuses on Blacks, Whites, and Latinos in the US, where health care insurance and access is highly variable.[7,8] Research on other ethnicities and immigrants in countries with universal health care is limited.

In Canada, a growing immigrant population makes it one of the world's most ethnically and culturally diverse high-income countries, with 7.5 million (21.9%) Canadians reporting to be foreign-born in the 2016 Census.[9] Cancer also accounts for approximately 30% of all deaths, and with an aging population, the incidence of cancer is expected to rise along with the number of deaths.[10] As such, much effort has been put towards improving and measuring the quality of EOL care of Canadians over the last two decades.[11–15] Palliative care when near death has been associated with less acute health care use and costs, and better quality of life of patients with cancer, including better symptom control, physician communication, emotional support and respectful treatment.[16–20] Together, Canada's ethnic diversity

and universal health care system make it an ideal setting for studying health services in multiethnic populations. Ontario, Canada provides is particularly suited for studying immigrant care because 51.1% of the country's immigrants live in the province.[9]

The objective of this study is to compare immigrants and Canadian-born/long-term residents of Ontario with a cancer cause of death on the use of both aggressive and supportive health care near the time of death. We hypothesized that in our cancer population, immigrants would receive more aggressive care and less supportive care than non-immigrants. As per the Andersen-Newman model of health care utilization, use is explained by predisposing characteristics (e.g., demographics, social structure, health beliefs), enabling resources (e.g., community structure, personal means) and need. For our study, immigrants may have socio-cultural predisposing factors that differ from the mostly Westernized biomedical approach found in Ontario's health system (e.g., health beliefs that avoid discussions about death or refuse palliative or supportive care measures), which may affect their end-of-life care use.[21]

## Methods

### *Study population*

We conducted a population-based retrospective cohort study of residents in Ontario, Canada who died of cancer between 2004 and 2015 and were 18 years or older at the time of death. Cancer decedents were identified from the Registrar General of Ontario Vital Statistics Database, which contains information from the death certificates of all deaths registered in Ontario. The Ontario Cancer Registry, a population-based registry which captures information on over 90% of all incident cancer cases in Ontario was used to determine the cancer diagnosis type.[22] Immigrant status was determined through linkage to the Immigration, Refugees and Citizenship Canada Permanent Resident database (IRCC), which began in 1985 and thus only contains sociodemographic information about all immigrants who arrived in Ontario in 1985 or later, referred to as (recent) immigrants from here on. Immigrants

identified in the IRCC were then classified into eight major ethnic groups based on previously validated algorithms using their country of birth, mother tongue and surname.[23,24] Immigrants who landed in Ontario in 1985 or later were compared overall and by ethnic group with individuals born in Canada or who immigrated prior to 1985 (together termed "long-term residents"), on established health service quality indicators of end-of-life cancer care.

*Quality indicators and data sources*

We examined both aggressive and supportive end-of-life quality care indicators previously identified to be important to patients with cancer and which were measurable using health administrative data.[11,13,25] Our primary aggressive care indicator was a composite of ≥2 emergency department (ED) visits, ≥2 new hospitalizations, or an intensive care unit (ICU) admission within 30 days of death. Secondary aggressive care indicators studied were death in an acute care hospital, new hospital admissions, admission to an ICU and ED visits (all in the 30 days prior to death), and receipt of chemotherapy in the two weeks prior to death.

Our primary supportive care indicator was a composite of having ≥1 palliative nursing or personal support worker home visit within 6 months of death or ≥1 physician house call within 2 weeks of death. Prior research show that physician home visits very close to death were for palliative and supportive care purposes.[26] Secondary supportive care indicators studied were the components of this composite indicator, and additionally, home visits in the six months prior to death by a registered nurse and personal support worker, regardless of palliative care intent.

Information about place of death, hospital and ICU admissions was obtained from the Canadian Institute for Health Information Discharge Abstract Database (DAD), which contains information from the discharge abstracts of all hospitals in Canada. ED visits were identified from the National Ambulatory Care Reporting System (NACRS), which captures demographic and clinical information about visits to all EDs in Ontario. Receipt of intravenous chemotherapy and physician house calls were captured using the

Ontario Health Insurance Plan (OHIP) Physician Claims database, and home visits identified from Ontario's Home Care Database. A summary of data sources for our study population and indicators is provided in supplementary table 1. All datasets were linked using unique, encoded identifiers and analyzed at ICES (formerly known as the Institute for Clinical Evaluative Sciences). 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 patient consent, for health system evaluation and improvement.

*Patient and public involvement*

The quality indicators examined in this study are informed by prior research and the datasets used are encoded. Thus, patients were not invited to comment on the study design, consulted to interpret the results, or invited to contribute to the writing or editing of this paper for readability or accuracy.

*Statistical analysis*

Data were summarized using mean (standard deviation) for continuous variables, and frequencies (%) for categorical variables. Characteristics of the study population at the time of death among immigrants and long-term residents were compared using standardized differences. For immigrants overall and by ethnic group, we also examined education and language ability at the time of application for immigration, and immigration category (i.e., economic, family, refugee or other).

Quality indicators were calculated as crude proportions. To account for differences in sociodemographics and comorbidities among ethnic groups and long-term residents, for our primary aggressive and supportive care measures only, we conducted multivariable logistic regression analyses, adjusting for characteristics of clinical significance or shown to be associated with these outcomes in prior studies including age, sex, Charlson score, cancer type, neighbourhood income quintile, community

size, health region and year of death.[11] Cancer type was determined at the time of diagnosis, and all remaining covariates were measured at the time of death. Patients with missing income quintile, community size or health region information (<0.05% of both immigrants and long-term residents) were excluded from the regression analyses. Patients with a missing Charlson score due to no hospital admission during the observation period were grouped with patients with a zero score. Comparing immigrant ethnic groups only, we additionally adjusted for education, language ability, time since immigration and immigration category (economic, family, refugee or other). Since our study included deaths over a 12-year period, we also examined whether the effect of immigration status on receiving aggressive and supportive care changed over time by adding a 2-way interaction term between immigration status and year of death into our regression models.

All analyses were conducted at ICES using SAS version 9.4 (SAS Institute, Cary, NC). Two-sided p-values < 0.05 were considered significant.

**Results**

Between 2004 and 2015, we identified 242 556 individuals with a cancer cause of death, of whom 13 085 (5.4%) were recent immigrants (table 1). East Asians and White-Eastern Europeans made up the largest immigrant ethnic groups (n=2987 (22.8%) and n=2499 (19.1%), respectively), whereas Latin Americans were the smallest (n=670 (5.1%)). Compared with long-term residents, recent immigrants were younger at the time of death, comprised a greater proportion of females, and were more likely to live in low income neighbourhoods and urban communities. Lung cancer was the leading cause of death for both immigrants and long-term residents.

Among recent immigrants, 60.6% (n=7884) had less than secondary school education and 47.6% (n=6226) had neither English or French language ability at the time of applying for immigration, though these varied among ethnic groups. By the time of their death, 74.1% (n=9701) had resided in Canada for

over ten years, including 80.3% of Latin Americans and 78.6% White-Western Europeans compared with 65.9% of West Asians/Arabs and 67.6% of South Asians.

*Aggressive care*

Compared with long-term residents, immigrants overall and by ethnic group had generally higher rates of aggressive health care use on both the composite (immigrants overall, 17.5% vs. long-term residents, 13.7%; p<0.001) and individual indicators (p<0.05 for all) (figure 1 and supplementary table 2). Among immigrants, West Asian/Arabs, Southeast Asians and South Asians had the highest composite aggressive care rates (range 20.2% to 21.0%). However, East Asians also had high rates of death in an acute care hospital and new hospital admissions within 30 days of death. Overall, White-Eastern and Western Europeans had the lowest rates of aggressive care on the individual and composite indicators (14.3% and 15.1%, respectively).

In unadjusted regression analyses, all ethnic groups except White-Eastern and Western Europeans were at significantly greater risk than long-term residents of receiving aggressive care, defined as our composite indicator (figure 2 and supplementary table 3, p<0.05). After adjustment, immigrants overall, as well as East Asians, South Asians, Southeast Asians and West Asians/Arabs remained more likely than long-term residents to receive aggressive care (odds ratio, OR: 1.15, 95% CI 1.09 to 1.21 for immigrants overall). The effect of immigration status also did not change over time (p=0.54 for interaction with year of death). Among immigrants only, additional adjustment for education, language ability, time since immigration and immigration category resulted in minimal change in ethnic groups' likelihood of receiving aggressive care relative to each other.

Supportive care

Immigrants overall and long-term residents had similar rates of supportive care on both the composite and individual indicators (50.5% versus 50.0%, respectively for composite; p=0.36) (figure 3

and supplementary table 2). By ethnic group, rates of supportive care varied with White-Western Europeans having the highest use on the composite indicator (55.6%) and Southeast Asians having the lowest (46.6%). On the four individual indicators, White-Eastern and Western Europeans, Latin American and West Asians/Arabs generally had the highest rates, including close to 70% of patients receiving a home visit by a registered nurse during the six months prior to death, while East Asians again had the lowest rates.

Although in unadjusted analyses, the odds of immigrants overall receiving supportive care was not significantly different than long-term residents (OR: 1.02, 95% CI 0.98-1.06), they were less likely to do so after adjustment (OR: 0.95, 95% CI 0.91 to 0.98) (figure 4 and supplementary table 4). Differences after adjustment were attributable to differences in age, sex, neighbourhood income quintile and Charlson score. Furthermore, the effect of immigration status did not change over time (p=0.41 for interaction with year of death). Among ethnic groups, Southeast Asians, Blacks and East Asians were the least likely to receive supportive care (ORs: 0.75, 95% CI 0.66 to 0.85; 0.82, 95% CI 0.72 to 0.93; 0.89, 95% CI 0.82 to 0.96, respectively versus long-term residents), and White-Western European were most likely (OR: 1.16, 95% CI 1.03 to 1.30 versus long-term residents). Similar to aggressive care, the relative likelihood of receiving supportive care among ethnic groups did not change after adjustment for immigration factors.

**Discussion**

In this study of cancer decedents' utilization of both aggressive and supportive care at the end of life in Ontario, Canada between 2004 and 2015, we found that after accounting for differences in sociodemographics and comorbidities, recent immigrants were 15% more likely to use aggressive care (defined by emergency department visits and new hospital or ICU admissions) and 5% less likely to receive supportive care (defined by physician house calls and palliative nursing/personal support worker home visits) than long-term residents. Although overall differences in supportive care may not be

clinically significant, care also varied among ethnic groups with Southeast Asians having a 25% lower and White-Western Europeans having a 16% higher likelihood of receiving supportive care.

Our findings are consistent with studies of patients with any cause of death. Among Ontario residents both with and without cancer, recent immigrants have been reported to be more likely than long-term residents to die in an acute care hospital and be admitted to a hospital and ICU in their last month of life.[6] Additionally, decedents born in Europe were not at significantly different risk of dying in an ICU than long-term residents, while those born in Southeast Asia and South Asia were more likely to do so. In the US, patients of Black, Hispanic and Asian ethnic groups both with and without cancer have also been reported to be more likely to receive aggressive care at the end of life, including death in a hospital, hospital and ICU admission, and use of mechanical ventilation, cardiopulmonary resuscitation and feeding tubes.[5,27–32] They are also less likely to access palliative care, particularly hospice care, and are more likely to access it closer to death and to disenroll.[8,31–34] Non-hospice palliative care is less well studied and has focused on beliefs, discussions about end-of-life care and advanced care planning.[7,8] Additionally, few of these studies differentiate between immigrants and non-immigrants, and may be influenced by the ability to pay for care. Our results suggest that in the context of cancer and in a universal health care system, where ongoing treatment near death is of questionable benefit, immigrants in Ontario are similarly more likely to use aggressive care health services and less likely to receive supportive care at the end of life as patients dying of other causes.

Several factors may explain our findings. Communication barriers, degree of acculturation, knowledge of and preference for care options at the end of life, and beliefs about advanced care planning may all be contributory.[29,35–39] Although 74% of immigrants in our study had resided in Canada for over 10 years prior to death, challenges encountered in settling in a new country on arrival may persist or be exacerbated when near death. With almost half of immigrants lacking English or French language ability when applying for immigration, their understanding of medical terms and care options,

and capacity or readiness to communicate care wishes may influence the care they receive. As immigrants are generally healthier on arrival to Canada (the healthy immigrant effect), when compared to non-immigrants, they may also be less familiar with the health care system and services available at the end of life.[40–42]

Beyond the scope of this study, was the study of beliefs and preferences about end-of-life care. Although many studies have reported patients with cancer prefer to die at home, the generalizability of these studies to immigrant populations is unknown. In the US, a greater proportion of Blacks and Hispanics with cancer have consistently been found to prefer aggressive care near death when compared with Whites.[7,28,36,39] Differences between ethnic groups and long-term residents in care preferences and circumstances that would enable end-of-life care at home may thus influence care accessed and received, especially when residing in a country with less familiarity and potentially fewer social supports than their country of origin.[43–46]

Also unclear is the relationship between aggressive and supportive care. Many previous studies have found that supportive care, including physician continuity and greater and earlier use of palliative and home care services is associated with lower use of acute care services at the end of life.[16–20,26,47,48] This supports our finding of White-Western Europeans' high rates of receipt of supportive care and low rates of aggressive care. However, this pattern was not consistently observed among other ethnic groups, and other factors need consideration. Although much effort has been dedicated to increasing access to palliative and home care services in Ontario and Canada, it may still be insufficient for some immigrants to manage at home when near death even when preferred.[12,14,15] Particularly, whether economic class immigrants or refugees have adequate family or social supports and prefer to be cared for at home could not be examined using our data sources and thus requires further study. Regardless, health care providers and administrators should be aware of factors that may influence immigrants' use of health services at the end of life, such as language barriers, culture, available social supports and

knowledge about care options including their risks and benefits, such that their interactions with immigrants and their caregivers may facilitate informed decision-making and improved quality of life at this time.

This study is limited by our inability to classify the long-term resident cohort into similar ethnic groups as immigrants or identify people who immigrated to Ontario prior to 1985. However, we estimate that over 95% are of White ethnicity and approximately 17 % are immigrants who arrived prior to 1985.[49] Related, the algorithms used to classify immigrants into ethnic groups also has limitations and it is likely that some immigrants may have been misclassified, though we believe the combining of two algorithms reduced this number. Our results may also be influenced by the salmon bias which hypothesizes that when immigrants get older or sick, they return to their region of origin, and thus are not captured in population health studies.[50–52] Although this bias has been shown to contribute to the mortality advantage among some immigrants in the UK, Hispanics in the US and internal migrants in China, its effect on differences in end-of-life care is unknown, and is likely to vary between ethnic groups.[51–53] We also did not control for stage of cancer at diagnosis. With some belief that immigrants present at later stages, this delay impact patient preferences for treatment and time for advanced care planning. Lastly, whether our findings are generalizable to immigrants in other provinces or countries also requires further investigation.

**Conclusions**

This study highlights differences in care between long-term residents and immigrants with cancer near death. Although immigrants overall were more likely to receive aggressive care and less likely to receive supportive care than long-term residents after accounting for differences in sociodemographic characteristics and comorbidities, the care received varied by ethnicity. The relationship between aggressive and supportive care within ethnic groups was also unclear, and further

study is required to better understand contributors to these differences and whether their needs at the end of life are being met.

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**Author contributions:** AC conceived the study, participated in the study design and interpretation of results, and drafted the manuscript. HS and LB conceived the study, participated in the study coordination, study design, acquisition of data and interpretation of results, and provided feedback on the manuscript. RS participated in the study design and interpretation of results, and provided feedback on the manuscript. UEO participated in the study design, performed the analysis, and provided feedback on the manuscript. EO participated in the study design and study coordination, and provided feedback on the manuscript. All authors read approved the final manuscript. HS and UEO had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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**Competing interests:** None

**Ethnics approval:** This study was approved by the Hamilton Integrated Research Ethics Board, a joint board of St. Joseph's Healthcare Hamilton, Hamilton Health Sciences and McMaster University's Faculty of Health Sciences; and follows the STROBE guidelines for the reporting of observational studies.

**Data sharing statement:** The data set from this study is held securely in coded form at ICES. While data sharing agreements prohibit ICES from making the data set publicly available, access may be granted to those who meet pre-specified criteria for confidential access, available at www.ices.on.ca/DAS. The full data set creation plan and underlying analytic code are available from the authors upon request, understanding that the programs may rely upon coding templates or macros that are unique to ICES.

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**Table 1.** Baseline characteristics of study population, 2004-2015

| Characteristic | Ethnic Group | | | | | | | | *All immigrants** | *Long-term residents* | Std diff† |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | White-Eastern European | White-Western European | Latin American | East Asian | Black | South Asian | Southeast Asian | West Asian/ Arab | | | |
| Population size, N | N=2499 | N=1418 | N=670 | N=2987 | N=1052 | N=2180 | N=1129 | N=1028 | *N=13 085* | *N=229 471* | |
| Age, mean (SD), years | 65.4 (14.3) | 68.0 (15.0) | 63.9 (15.3) | 69.5 (14.9) | 61.7 (16.6) | 65.9 (14.3) | 63.5 (14.6) | 65.1 (14.8) | *66.2 (15.0)* | *72.2 (12.5)* | 0.43 |
| Female, n (%) | 1234 (49.4) | 649 (45.8) | 355 (53.0) | 1369 (45.8) | 593 (56.4) | 1034 (47.4) | 609 (53.9) | 470 (45.7) | *6323 (48.7)* | *107 411 (46.8)* | 0.04 |
| Community size >1 500 000‡, n (%) | 1742 (69.7) | 682 (48.1) | 505 (75.4) | 2677 (89.6) | 838 (79.7) | 1932 (88.6) | 936 (82.9) | 709 (69.0) | *10 116 (77.3)* | *70 397 (30.7)* | 1.06 |
| Cancer type, n (%) | | | | | | | | | | | |
| Breast | 237 (9.5) | 128 (9.0) | 83 (12.4) | 158 (5.3) | 153 (14.5) | 237 (10.9) | 112 (9.9) | 109 (10.6) | *1224 (9.4)* | *17 684 (7.7)* | 0.06 |
| Colorectal | 339 (13.6) | 170 (12.0) | 46 (6.9) | 356 (11.9) | 110 (10.5) | 135 (6.2) | 100 (8.9) | 95 (9.2) | *1365 (10.4)* | *29 032 (12.7)* | 0.07 |
| Lung | 515 (20.6) | 308 (21.7) | 101 (15.1) | 835 (28.0) | 135 (12.8) | 324 (14.9) | 300 (26.6) | 190 (18.5) | *2733 (20.9)* | *64 051 (27.9)* | 0.16 |
| Prostate | 92 (3.7) | 78 (5.5) | 50 (7.5) | 91 (3.0) | 56 (5.3) | 120 (5.5) | 37 (3.3) | 50 (4.9) | *582 (4.4)* | *15 166 (6.6)* | 0.09 |
| Other | 1316 (52.7) | 734 (51.8) | 390 (58.2) | 1547 (51.8) | 598 (56.8) | 1364 (62.6) | 580 (51.4) | 584 (56.8) | *7181 (54.9)* | *103 538 (45.1)* | 0.20 |
| **Among immigrants** | | | | | | | | | | | |
| Secondary school education or less§, n (%) | 988 (39.5) | 899 (64.0) | 482 (71.9) | 2014 (67.4) | 773 (72.5) | 1490 (68.7) | 583 (51.9) | 603 (59.1) | *7884 (60.6)* | NA | NA |
| Neither English or French§, n (%) | 1626 (65.1) | 364 (25.7) | 255 (38.1) | 2082 (69.7) | 89 (8.5) | 960 (44.0) | 323 (28.6) | 497 (48.3) | *6226 (47.6)* | | |
| Immigration category‡, n (%) | | | | | | | | | | | |
| Economic | 551 (22.0) | 505 (35.6) | 146 (21.8) | 745 (24.9) | 245 (23.3) | 501 (23.0) | 393 (34.8) | 234 (22.8) | *3354 (25.6)* | NA | NA |
| Family | 1146 (45.9) | 825 (58.2) | 360 (53.7) | 1901 (63.6) | 580 (55.1) | 1390 (63.8) | 631 (55.9) | 435 (42.3) | *7329 (56.0)* | | |
| Refugee | 753 (30.1) | 1-5 (<0.4) | 150 (22.4) | 127 (4.3) | 195 (18.5) | 251 (11.5) | 88 (7.8) | 322 (31.3) | *1900 (14.5)* | | |

Ethnic groups are ordered by increasing adjusted risk of the composite indicator for aggressive care (defined as having at least two emergency department visits, two new hospitalizations or an ICU admission within 30 days of death).

* Includes 122 immigrants for whom ethnicity is unknown.

† Reported standardized differences are for comparisons of all immigrants versus long-term residents. P-value < 0.001 for comparison of all characteristics between individual ethnic groups.

‡ Due to space limitations, proportions for neighbourhood income quintile, smaller community sizes, non-economic/family/refugee immigration categories and Charlson score are not shown. Thus, categories shown do not add up to 100%. Information on community size is missing for 10 immigrants and 172 long-term residents.

§ Education and language ability are at the time of application for immigration.

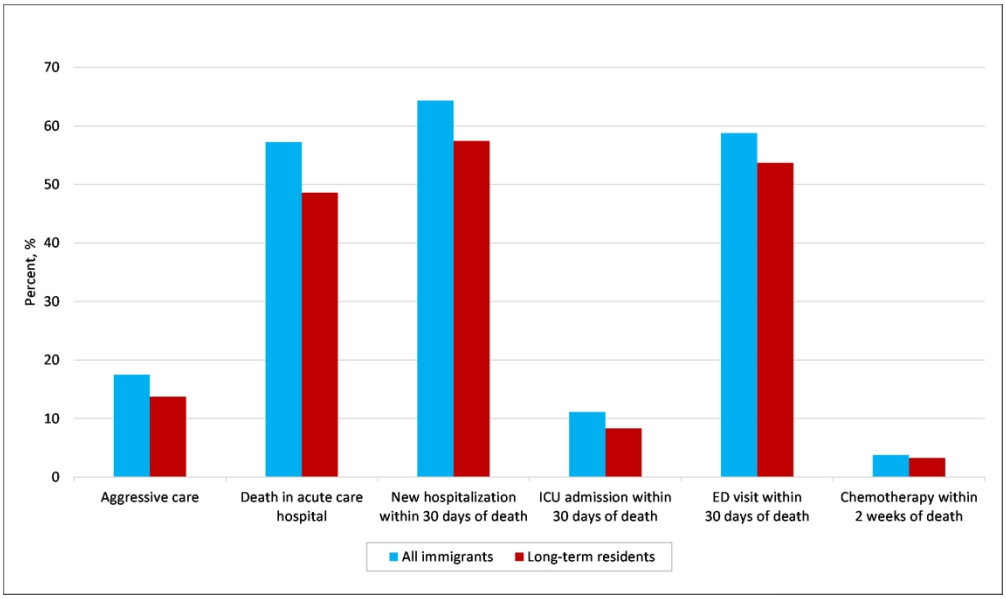
NA, not applicable.

**Figure 1.** Aggressive care quality indicator rates by immigrant status, 2004-2015. The composite aggressive care indicator is defined as receipt of ≥2 emergency department visits, ≥2 new hospitalizations or an ICU admission within 30 days of death.

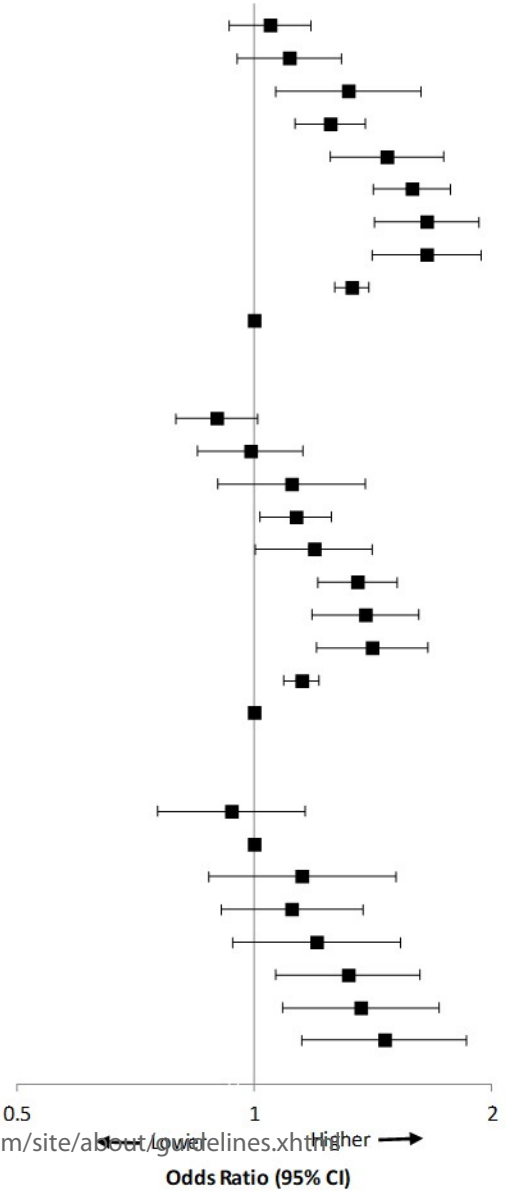
**Figure 2.** Odds ratios for receiving aggressive care. Ethnic groups are listed in order of increasing adjusted risk of receiving aggressive care versus long-term residents, defined as having ≥2 emergency department visits, ≥2 new hospitalizations or an intensive care unit admission within 30 days of death. Models for all immigrants versus long-term residents were computed separately from individual ethnic groups versus long-term residents. Immigrants of unknown ethnicity are excluded from analyses. Covariates included in adjusted models for immigrants versus long-term residents were age, sex, Charlson score, cancer type, neighbourhood income quintile, community size, health region and year of death. Adjusted models for ethnic groups only additionally adjusted for education, language ability, time since immigration and immigration category.

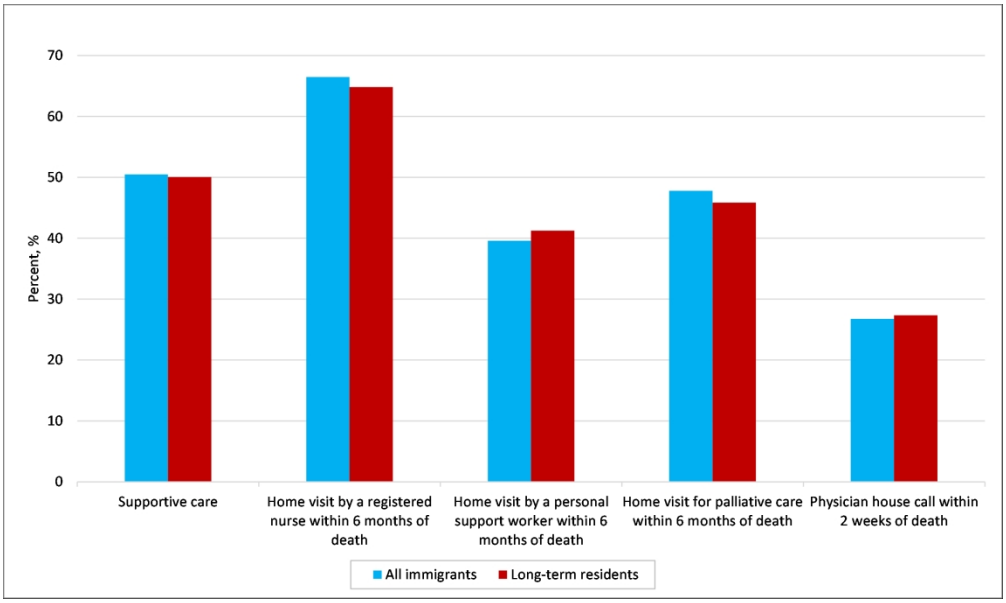
**Figure 3.** Supportive care quality indicator rates by immigrant status, 2004-2015. The composite supportive care indicator is defined as receipt of ≥1 physician house call within 2 weeks of death, or ≥1 palliative nursing or personal support worker home visit within 6 months of death.

**Figure 4.** Odds ratios for receiving supportive care. Ethnic groups are listed in order of increasing adjusted risk of receiving supportive care versus long-term residents, defined as having ≥1 physician house call within 2 weeks of death, or ≥ 1 palliative nursing or personal support worker home visit within 6 months of death. Models for all immigrants versus long-term residents were computed separately from individual ethnic groups versus long-term residents. Immigrants of unknown ethnicity are excluded from analyses. Covariates included in adjusted models for immigrants versus long-term residents were age, sex, Charlson score, cancer type, neighbourhood income quintile, community size, health region and year of death. Adjusted models for ethnic groups only additionally adjusted for education, language ability, time since immigration and immigration category.

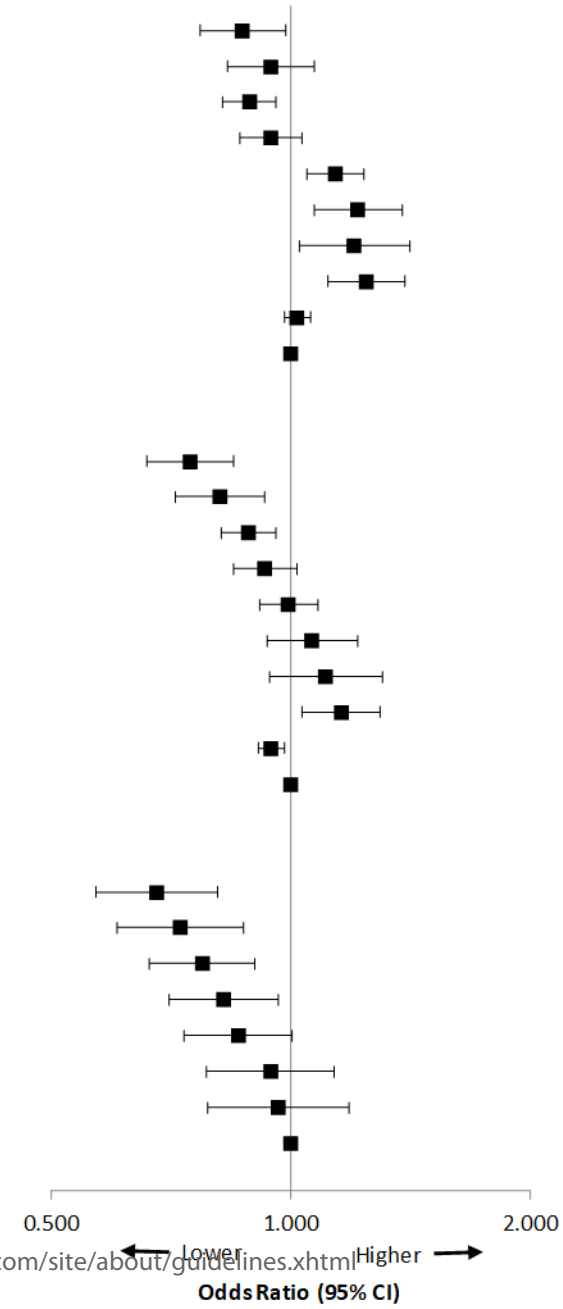


| Ethnic group | OR | 95% LCI | 95% UCI |
|---|---|---|---|
| **Unadjusted** | | | |
| White-Eastern European | 1.05 | 0.93 | 1.18 |
| White-Western European | 1.11 | 0.95 | 1.29 |
| Latin American | 1.32 | 1.06 | 1.63 |
| East Asian | 1.25 | 1.13 | 1.38 |
| Black | 1.47 | 1.25 | 1.74 |
| South Asian | 1.58 | 1.42 | 1.77 |
| Southeast Asian | 1.65 | 1.42 | 1.92 |
| West Asian/Arab | 1.66 | 1.41 | 1.94 |
| All immigrants | 1.33 | 1.27 | 1.40 |
| Long-term residents | Ref | - | - |
| **Adjusted - Immigrants vs. Long-term residents** | | | |
| White-Eastern European | 0.90 | 0.79 | 1.01 |
| White-Western European | 0.99 | 0.85 | 1.15 |
| Latin American | 1.12 | 0.90 | 1.38 |
| East Asian | 1.13 | 1.02 | 1.25 |
| Black | 1.19 | 1.00 | 1.41 |
| South Asian | 1.35 | 1.20 | 1.52 |
| Southeast Asian | 1.38 | 1.19 | 1.62 |
| West Asian/Arab | 1.41 | 1.20 | 1.66 |
| All immigrants | 1.15 | 1.09 | 1.21 |
| Long-term residents | Ref | - | - |
| **Adjusted - Ethnic groups only** | | | |
| White-Eastern European | 0.94 | 0.75 | 1.16 |
| White-Western European | Ref | - | - |
| Latin American | 1.15 | 0.87 | 1.51 |
| East Asian | 1.12 | 0.91 | 1.37 |
| Black | 1.20 | 0.94 | 1.53 |
| South Asian | 1.31 | 1.07 | 1.62 |
| Southeast Asian | 1.37 | 1.08 | 1.72 |
| West Asian/Arab | 1.46 | 1.15 | 1.85 |





| Ethnic group | OR | 95% LCI | 95% UCI |
|---|---|---|---|
| **Unadjusted** | | | |
| Southeast Asian | 0.87 | 0.77 | 0.99 |
| Black | 0.94 | 0.83 | 1.07 |
| East Asian | 0.89 | 0.82 | 0.96 |
| South Asian | 0.95 | 0.87 | 1.03 |
| White-Eastern European | 1.14 | 1.05 | 1.24 |
| West Asian/Arab | 1.22 | 1.07 | 1.38 |
| Latin American | 1.20 | 1.03 | 1.41 |
| White-Western European | 1.25 | 1.12 | 1.39 |
| All immigrants | 1.02 | 0.98 | 1.06 |
| Long-term residents | Ref | - | - |
| **Adjusted - Immigrants vs. Long-term residents** | | | |
| Southeast Asian | 0.75 | 0.66 | 0.85 |
| Black | 0.82 | 0.72 | 0.93 |
| East Asian | 0.89 | 0.82 | 0.96 |
| South Asian | 0.93 | 0.85 | 1.02 |
| White-Eastern European | 1.00 | 0.91 | 1.08 |
| West Asian/Arab | 1.07 | 0.93 | 1.22 |
| Latin American | 1.11 | 0.94 | 1.31 |
| White-Western European | 1.16 | 1.03 | 1.30 |
| All immigrants | 0.95 | 0.91 | 0.98 |
| Long-term residents | Ref | - | - |
| **Adjusted - Ethnic groups only** | | | |
| Southeast Asian | 0.68 | 0.57 | 0.81 |
| Black | 0.73 | 0.61 | 0.87 |
| East Asian | 0.78 | 0.67 | 0.90 |
| South Asian | 0.82 | 0.70 | 0.96 |
| White-Eastern European | 0.86 | 0.74 | 1.01 |
| West Asian/Arab | 0.94 | 0.79 | 1.14 |
| Latin American | 0.97 | 0.79 | 1.19 |
| White-Western European | Ref | - | - |



**Supplementary Content**

**End-of-life cancer care: a cohort study of immigrants and long-term residents in Ontario, Canada**

Chu A, Barbera L, Sutradhar R, Erbas Oz U, O'Leary E, Seow H

**Supplementary table 1.** Data sources

| Data element | Data source |
|---|---|
| **Baseline characteristics** | |
| Study population | Registrar General of Ontario Vital Statistics Database |
| Immigrant status and related data | Immigration, Refugees and Citizenship Canada Permanent Resident Database |
| Age, sex, community of residence | Registered Persons Database |
| Community size, neighbourhood income quintile | Statistics Canada Postal Code Conversion File |
| Cancer type | Ontario Cancer Registry |
| Charlson score | Canadian Institute for Health Information Discharge Abstract Database |
| **Indicators** | |
| Death in acute care hospital or bed | Canadian Institute for Health Information Discharge Abstract Database |
| New hospitalization within 30 days of death | Canadian Institute for Health Information Discharge Abstract Database |
| ICU admission within 30 days of death | Canadian Institute for Health Information Discharge Abstract Database |
| ≥ 1 ED visit within 30 days of death | National Ambulatory Care Reporting System |
| Chemotherapy within 2 weeks of death | Ontario Health Insurance Plan Physician Claims database |
| Home visits within 6 months of death | Ontario's Home Care Database |
| Physician house call within 2 weeks of death | Ontario Health Insurance Plan Physician Claims database |

**Supplementary table 2.** Quality indicator rates by ethnicity and immigrant status, 2004-2015

| Indicator | Ethnic Group | | | | | | | | All Immigrants* | Long-term Residents | p-value† |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Black | East Asian | Latin American | South Asian | Southeast Asian | West Asian/Arab | White-Eastern European | White-Western European | | | |
| | n (%) | | | | | | | | | | |
| Population size, n | 1052 | 2987 | 670 | 2180 | 1129 | 1028 | 2499 | 1418 | 13 085 | 229 471 | |
| Death in acute care hospital or bed‡ | 623 (59.2) | 1846 (61.8) | 367 (54.8) | 1353 (62.1) | 681 (60.3) | 632 (61.5) | 1259 (50.4) | 659 (46.5) | 7493 (57.3) | 111 544 (48.6) | <0.001 |
| New hospitalization within 30 days of death | 585 (64.6) | 1855 (69.1) | 369 (61.8) | 1269 (66.8) | 695 (68.9) | 632 (68.5) | 1327 (58.4) | 731 (55.6) | 7832 (66.4) | 121 559 (57.4) | <0.001 |
| Eligible, n | 906 | 2686 | 597 | 1899 | 1008 | 922 | 2272 | 1314 | 11 707 | 211 618 | |
| ICU admission within 30 days of death‡ | 124 (11.8) | 306 (10.2) | 72 (10.7) | 293 (13.4) | 146 (12.9) | 140 (13.6) | 223 (8.9) | 134 (9.4) | 1455 (11.1) | 19 097 (8.3) | |
| ≥ 1 ED visit within 30 days of death | 566 (62.5) | 1580 (58.8) | 335 (56.1) | 1189 (62.6) | 631 (62.6) | 573 (62.1) | 1248 (54.9) | 699 (53.2) | 6882 (58.8) | 113 674 (53.7) | <0.001 |
| Eligible, n | 906 | 2686 | 597 | 1899 | 1008 | 922 | 2272 | 1314 | 11 707 | 211 618 | |
| Chemotherapy within 2 weeks of death‡ | 44 (4.2) | 94 (3.1) | 21 (3.1) | 105 (4.8) | 52 (4.6) | 33 (3.2) | 84 (3.4) | 60 (4.2) | 497-502 (3.80-3.84) | 7527 (3.3) | 0.001 |
| Home visit within 6 months of death by a: | | | | | | | | | | | |
| Registered nurse | 697 (67.0) | 1787 (60.3) | 457 (69.1) | 1420 (66.3) | 735 (65.9) | 712 (69.8) | 1712 (69.0) | 1008 (71.8) | 8606 (66.5) | 147 512 (64.8) | <0.001 |
| Personal support worker | 461 (44.3) | 1032 (34.8) | 295 (44.6) | 923 (43.1) | 408 (36.6) | 438 (42.9) | 927 (37.4) | 599 (42.7) | 5226 (39.6) | 93 866 (41.3) | <0.001 |
| Eligible, n | 1040 | 2964 | 661 | 2143 | 1116 | 1020 | 2480 | 1404 | 12 947 | 227 553 | |
| For palliative care (fiscal year 2005+ only) | 446 (46.3) | 1190 (44.5) | 314 (51.5) | 909 (46.0) | 460 (44.7) | 494 (52.2) | 1157 (50.4) | 665 (51.7) | 5685 (47.8) | 92 849 (45.9) | <0.001 |
| Eligible, n | 964 | 2674 | 610 | 1976 | 1028 | 946 | 2297 | 1287 | 11 897 | 202,492 | |
| Physician house call within 2 weeks of death | 187 (25.0) | 517 (22.8) | 147 (30.2) | 412 (25.9) | 170 (20.4) | 220 (28.3) | 603 (30.4) | 380 (32.5) | 2661 (26.7) | 50 860 (27.3) | 0.21 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Eligible, n | 748 | 2271 | 487 | 1591 | 833 | 777 | 1982 | 1169 | 9348 | 186 113 | |
| Aggressive care§ | 172 (19.0) | 442 (16.5) | 103 (17.3) | 383 (20.2) | 211 (20.9) | 192 (20.8) | 326 (14.3) | 198 (15.1) | 2450 (27.5) | 29 087 (13.7) | <0.001 |
| Eligible, n | 906 | 2686 | 597 | 1899 | 1008 | 922 | 2272 | 1314 | 11 707 | 21 1618 | |
| Supportive care‖ | 469 (48.7) | 1252 (46.8) | 333 (54.6) | 962 (48.7) | 479 (46.6) | 518 (54.8) | 1224 (53.3) | 715 (55.6) | 6006 (50.5) | 101 347 (50.0) | 0.36 |
| Eligible, n | 964 | 2674 | 610 | 1976 | 1028 | 946 | 2297 | 1287 | 11 897 | 202 492 | |

* Includes 122 immigrants whose ethnicity could not be classified. A range is reported for chemotherapy within 2 weeks of death to suppress a count of < 6 in the unknown ethnicity group.

†p-value is for all immigrants versus long-term residents.

‡ Eligible population is the entire population.

§ Aggressive care is defined as having ≥2 emergency department visits, ≥2 new hospitalizations or an ICU admission within 30 days of death.

‖ Supportive care is defined as having ≥1 physician house call within 2 weeks of death, or ≥1 palliative nursing or personal support worker home visit within 6 months of death.

ED, emergency department; ICU, intensive care unit.

**Supplementary table 3.** Logistic regression models for aggressive care*

| | | Univariate | | | Ethnic groups vs long-term residents | | | Immigrants vs long-term residents | | | Ethnic groups only | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OR† | 95% CI | | OR† | 95% CI | | OR† | 95% CI | | OR† | 95% CI | |
| | | | Lower | Upper | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| Ethnicity | White-Eastern European | 1.05 | 0.93 | 1.18 | 0.90 | 0.79 | 1.01 | na | na | na | 0.94 | 0.75 | 1.16 |
| | White-Western European | 1.11 | 0.95 | 1.29 | 0.99 | 0.85 | 1.15 | na | na | na | Ref | - | - |
| | Latin American | **1.32** | **1.06** | **1.63** | 1.12 | 0.90 | 1.38 | na | na | na | 1.15 | 0.87 | 1.51 |
| | East Asian | **1.25** | **1.13** | **1.38** | **1.13** | **1.02** | **1.25** | na | na | na | 1.12 | 0.91 | 1.37 |
| | Black | **1.47** | **1.25** | **1.74** | 1.19 | 1.00 | 1.41 | na | na | na | 1.20 | 0.94 | 1.53 |
| | South Asian | **1.58** | **1.42** | **1.77** | **1.35** | **1.20** | **1.52** | na | na | na | **1.31** | **1.07** | **1.62** |
| | Southeast Asian | **1.65** | **1.42** | **1.92** | **1.38** | **1.19** | **1.62** | na | na | na | **1.37** | **1.08** | **1.72** |
| | West Asian/Arab | **1.66** | **1.41** | **1.94** | **1.41** | **1.20** | **1.66** | na | na | na | **1.46** | **1.15** | **1.85** |
| | All immigrants | **1.33** | **1.27** | **1.40** | na | na | na | **1.15** | **1.09** | **1.21** | na | na | na |
| | Long-term residents | Ref | - | - | Ref | - | - | Ref | - | - | na | na | na |
| Age (per year) | | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** |
| Sex | Men | **1.30** | **1.27** | **1.33** | **1.31** | **1.28** | **1.35** | **1.31** | **1.28** | **1.35** | **1.24** | **1.11** | **1.38** |
| | Women | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Charlson score | 1+ | **0.94** | **0.91** | **0.97** | 1.00 | 0.96 | 1.04 | 1.00 | 0.97 | 1.04 | 0.95 | 0.81 | 1.11 |
| | 0 or missing | Ref | - | - | Ref | - | - | Ref | - | - | 1.00 | - | - |
| Cancer type | Breast | **0.70** | **0.67** | **0.74** | **0.77** | **0.72** | **0.81** | **0.77** | **0.73** | **0.81** | **0.78** | **0.63** | **0.96** |
| | Colorectal | **0.93** | **0.89** | **0.97** | 0.98 | 0.94 | 1.02 | 0.98 | 0.94 | 1.02 | **0.82** | **0.67** | **0.99** |
| | Prostate | **0.62** | **0.59** | **0.66** | **0.67** | **0.63** | **0.71** | **0.67** | **0.63** | **0.71** | **0.51** | **0.37** | **0.70** |
| | Other | **1.03** | **1.01** | **1.06** | 1.03 | 1.00 | 1.06 | 1.03 | 1.00 | 1.06 | 1.02 | 0.90 | 1.16 |
| | Lung | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Neighbourhood income quintile | 1 (lowest) | **1.08** | **1.04** | **1.12** | **1.05** | **1.01** | **1.10** | **1.06** | **1.01** | **1.10** | 1.05 | 0.88 | 1.26 |
| | 2 | **1.05** | **1.01** | **1.09** | 1.03 | 0.99 | 1.07 | 1.03 | 0.99 | 1.07 | 1.11 | 0.92 | 1.33 |
| | 3 | **1.06** | **1.02** | **1.10** | 1.03 | 0.99 | 1.08 | 1.04 | 0.99 | 1.08 | 1.01 | 0.84 | 1.22 |
| | 4 | **1.04** | **1.003** | **1.09** | 1.02 | 0.98 | 1.06 | 1.02 | 0.98 | 1.06 | 1.03 | 0.85 | 1.25 |
| | 5 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Community size | < 10 000 | **1.20** | **1.16** | **1.24** | **1.25** | **1.20** | **1.30** | **1.25** | **1.20** | **1.30** | 1.04 | 0.67 | 1.62 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10 000-99 999 | **1.17** | **1.13** | **1.21** | **1.25** | **1.20** | **1.30** | **1.25** | **1.19** | **1.30** | 1.27 | 0.82 | 1.98 |
| | ≥ 100 000 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Health region | Erie St.Clair | 1.03 | 0.97 | 1.10 | 0.95 | 0.89 | 1.02 | 0.95 | 0.89 | 1.02 | 0.94 | 0.66 | 1.34 |
| | South West | 1.13 | 1.06 | 1.20 | 1.02 | 0.96 | 1.08 | 1.02 | 0.96 | 1.09 | 0.94 | 0.65 | 1.38 |
| | Waterloo Wellington | 1.05 | 0.98 | 1.12 | 1.01 | 0.94 | 1.08 | 1.01 | 0.95 | 1.08 | 1.16 | 0.86 | 1.56 |
| | Hamilton Niagara Haldimand Brant | **0.94** | **0.89** | **0.99** | **0.94** | **0.89** | **0.99** | **0.94** | **0.89** | **0.99** | 1.12 | 0.87 | 1.44 |
| | Central West | **1.25** | **1.16** | **1.34** | **1.15** | **1.07** | **1.23** | **1.16** | **1.08** | **1.25** | **1.34** | **1.09** | **1.66** |
| | Mississauga Halton | 1.00 | 0.94 | 1.07 | 0.98 | 0.92 | 1.05 | 0.98 | 0.92 | 1.05 | 1.04 | 0.85 | 1.28 |
| | Toronto Central | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| | Central | **1.17** | **1.10** | **1.24** | **1.16** | **1.09** | **1.23** | **1.16** | **1.09** | **1.23** | **1.20** | **1.01** | **1.43** |
| | Central East | **1.10** | **1.04** | **1.16** | 1.03 | 0.97 | 1.09 | 1.04 | 0.98 | 1.10 | **1.30** | **1.08** | **1.57** |
| | South East | **1.14** | **1.07** | **1.22** | 0.98 | 0.91 | 1.05 | 0.98 | 0.92 | 1.06 | 1.17 | 0.59 | 2.32 |
| | Champlain | 0.95 | 0.90 | 1.01 | **0.88** | **0.83** | **0.93** | **0.88** | **0.83** | **0.94** | 1.03 | 0.80 | 1.34 |
| | North Simcoe Muskoka | **1.11** | **1.03** | **1.19** | 0.96 | 0.89 | 1.04 | 0.96 | 0.89 | 1.04 | 1.33 | 0.76 | 2.35 |
| | North East | **1.14** | **1.07** | **1.21** | 0.95 | 0.88 | 1.01 | 0.95 | 0.88 | 1.02 | 1.06 | 0.47 | 2.41 |
| | North West | **0.90** | **0.81** | **0.99** | **0.82** | **0.74** | **0.90** | **0.82** | **0.74** | **0.90** | 1.11 | 0.41 | 2.98 |
| Year of death | 2004 | 1.00 | 0.94 | 1.07 | 0.97 | 0.91 | 1.04 | 0.97 | 0.91 | 1.04 | 0.92 | 0.70 | 1.20 |
| | 2005 | 0.95 | 0.89 | 1.01 | **0.93** | **0.87** | **0.99** | **0.93** | **0.87** | **0.99** | 0.90 | 0.69 | 1.18 |
| | 2006 | 0.95 | 0.89 | 1.01 | **0.92** | **0.87** | **0.98** | **0.92** | **0.87** | **0.98** | 1.05 | 0.82 | 1.35 |
| | 2007 | 0.99 | 0.93 | 1.06 | 0.97 | 0.91 | 1.03 | 0.97 | 0.91 | 1.03 | 1.03 | 0.80 | 1.31 |
| | 2008 | 1.02 | 0.96 | 1.08 | 1.00 | 0.94 | 1.06 | 1.00 | 0.94 | 1.06 | 0.88 | 0.69 | 1.12 |
| | 2009 | 0.99 | 0.93 | 1.05 | 0.97 | 0.91 | 1.03 | 0.97 | 0.91 | 1.03 | 0.96 | 0.76 | 1.22 |
| | 2010 | 0.97 | 0.91 | 1.03 | 0.95 | 0.89 | 1.01 | 0.95 | 0.89 | 1.01 | 0.90 | 0.70 | 1.14 |
| | 2011 | 0.98 | 0.92 | 1.04 | 0.97 | 0.91 | 1.03 | 0.97 | 0.91 | 1.03 | 0.86 | 0.68 | 1.09 |
| | 2012 | 0.99 | 0.93 | 1.06 | 0.97 | 0.92 | 1.04 | 0.97 | 0.92 | 1.04 | 1.04 | 0.83 | 1.30 |
| | 2013 | 0.96 | 0.90 | 1.03 | 0.95 | 0.89 | 1.02 | 0.95 | 0.89 | 1.02 | 0.94 | 0.72 | 1.22 |
| | 2014 | 0.94 | 0.88 | 1.01 | 0.94 | 0.88 | 1.01 | 0.94 | 0.88 | 1.01 | 0.94 | 0.73 | 1.22 |
| | 2015 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Education | > Secondary school | na | na | na | na | na | na | na | na | na | 1.05 | 0.94 | 1.17 |
| | Secondary school or less | na | na | na | na | na | na | na | na | na | Ref | - | - |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Language ability | Neither English or French | na | na | na | na | na | na | na | na | na | 0.97 | 0.87 | 1.09 |
| | English and/or French | na | na | na | na | na | na | na | na | na | Ref | - | - |
| Time since immigration | < 5 years | na | na | na | na | na | na | na | na | na | 1.04 | 0.88 | 1.23 |
| | 5-10 years | na | na | na | na | na | na | na | na | na | 0.99 | 0.86 | 1.13 |
| | > 10 years | na | na | na | na | na | na | na | na | na | Ref | - | - |
| Immigration category | Economic | na | na | na | na | na | na | na | na | na | 1.03 | 0.91 | 1.18 |
| | Refugee or other | na | na | na | na | na | na | na | na | na | 0.98 | 0.85 | 1.13 |
| | Family | na | na | na | na | na | na | na | na | na | Ref | - | - |

* Aggressive care is defined as having ≥2 emergency department visits, ≥2 new hospitalizations or an ICU admission within 30 days of death. Ethnic groups are listed in order of increasing receipt of aggressive care versus long-term residents. Immigrants of unknown ethnicity are excluded from analyses.

† Boldface type indicates significant values at p<0.05.

CI=confidence interval, na=not applicable, OR=odds ratio.

**Supplementary table 4.** Logistic regression models for supportive care*

| | | Univariate | | | Ethnic groups vs long-term residents | | | Immigrants vs long-term residents | | | Ethnic groups only | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | OR† | 95% CI | | OR† | 95% CI | | OR† | 95% CI | | OR† | 95% CI | |
| | | | Lower | Upper | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| Ethnicity | Southeast Asian | **0.87** | **0.77** | **0.99** | **0.75** | **0.66** | **0.85** | na | na | na | **0.68** | **0.57** | **0.81** |
| | Black | 0.94 | 0.83 | 1.07 | **0.82** | **0.72** | **0.93** | na | na | na | **0.73** | **0.61** | **0.87** |
| | East Asian | **0.89** | **0.82** | **0.96** | **0.89** | **0.82** | **0.96** | na | na | na | **0.78** | **0.67** | **0.90** |
| | South Asian | 0.95 | 0.87 | 1.03 | 0.93 | 0.85 | 1.02 | na | na | na | **0.82** | **0.70** | **0.96** |
| | White-Eastern European | **1.14** | **1.05** | **1.24** | 1.00 | 0.91 | 1.08 | na | na | na | 0.86 | 0.74 | 1.01 |
| | West Asian/Arab | **1.22** | **1.07** | **1.38** | 1.07 | 0.93 | 1.22 | na | na | na | 0.94 | 0.79 | 1.14 |
| | Latin American | **1.20** | **1.03** | **1.41** | 1.11 | 0.94 | 1.31 | na | na | na | 0.97 | 0.79 | 1.19 |
| | White-Western European | **1.25** | **1.12** | **1.39** | **1.16** | **1.03** | **1.30** | na | na | na | Ref | - | - |
| | All immigrants | 1.02 | 0.8 | 1.06 | na | na | na | **0.95** | **0.91** | **0.98** | na | na | na |
| | Long-term residents | Ref | - | - | Ref | - | - | Ref | - | - | na | na | na |
| Age (years) | | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.98** | **0.99** | **0.99** | **0.99** |
| Sex | Men | **0.92** | **0.90** | **0.93** | **0.92** | **0.90** | **0.93** | **0.92** | **0.90** | **0.93** | **0.84** | **0.78** | **0.91** |
| | Women | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Charlson score | 1+ | **0.89** | **0.87** | **0.91** | **0.95** | **0.93** | **0.97** | **0.95** | **0.93** | **0.97** | 1.03 | 0.92 | 1.16 |
| | 0 or missing | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Cancer type | Breast | **1.04** | **1.01** | **1.08** | 0.98 | 0.94 | 1.01 | 0.98 | 0.94 | 1.01 | 1.01 | 0.86 | 1.18 |
| | Colorectal | **0.92** | **0.89** | **0.95** | 0.99 | 0.96 | 1.02 | 0.99 | 0.96 | 1.02 | 1.03 | 0.90 | 1.19 |
| | Prostate | **0.84** | **0.80** | **0.87** | 1.01 | 0.98 | 1.05 | 1.01 | 0.98 | 1.05 | 1.08 | 0.89 | 1.32 |
| | Other | **0.85** | **0.83** | **0.87** | **0.84** | **0.83** | **0.86** | **0.84** | **0.83** | **0.86** | **0.82** | **0.74** | **0.90** |
| | Lung | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Neighbourhood income quintile | 1 (lowest) | **0.74** | **0.72** | **0.76** | **0.74** | **0.72** | **0.76** | **0.74** | **0.72** | **0.76** | **0.84** | **0.74** | **0.96** |
| | 2 | **0.84** | **0.82** | **0.87** | **0.85** | **0.83** | **0.87** | **0.85** | **0.82** | **0.87** | **0.82** | **0.71** | **0.93** |
| | 3 | **0.87** | **0.85** | **0.90** | **0.88** | **0.86** | **0.91** | **0.88** | **0.86** | **0.91** | 0.96 | 0.83 | 1.10 |
| | 4 | **0.93** | **0.91** | **0.96** | **0.93** | **0.90** | **0.95** | **0.93** | **0.90** | **0.95** | 0.91 | 0.79 | 1.05 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Community size | < 10,000 | **0.89** | **0.87** | **0.91** | **0.93** | **0.91** | **0.96** | **0.93** | **0.91** | **0.96** | 1.05 | 0.76 | 1.46 |
| | 10,000-99,999 | **0.95** | **0.93** | **0.98** | 0.99 | 0.96 | 1.02 | 0.99 | 0.96 | 1.02 | 0.94 | 0.67 | 1.32 |
| | ≥ 100,000 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| Health region | Erie St.Clair | **1.37** | **1.30** | **1.43** | **1.34** | **1.28** | **1.41** | **1.35** | **1.28** | **1.41** | **1.33** | **1.03** | **1.72** |
| | South West | **0.88** | **0.84** | **0.92** | **0.89** | **0.85** | **0.93** | **0.89** | **0.85** | **0.93** | 0.97 | 0.75 | 1.26 |
| | Waterloo Wellington | **1.84** | **1.75** | **1.93** | **1.83** | **1.74** | **1.92** | **1.83** | **1.74** | **1.92** | **1.79** | **1.42** | **2.26** |
| | Hamilton Niagara Haldimand Brant | **1.24** | **1.19** | **1.28** | **1.24** | **1.19** | **1.29** | **1.24** | **1.19** | **1.29** | 1.18 | 0.97 | 1.42 |
| | Central West | **0.92** | **0.87** | **0.97** | **0.87** | **0.83** | **0.92** | **0.87** | **0.82** | **0.92** | 0.93 | 0.79 | 1.10 |
| | Mississauga Halton | **1.27** | **1.21** | **1.32** | **1.20** | **1.15** | **1.26** | **1.20** | **1.14** | **1.25** | **1.19** | **1.03** | **1.38** |
| | Toronto Central | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |
| | Central | 1.02 | 0.98 | 1.07 | 1.01 | 0.97 | 1.06 | 1.01 | 0.97 | 1.05 | 1.02 | 0.90 | 1.16 |
| | Central East | 1.02 | 0.98 | 1.06 | 1.03 | 0.99 | 1.07 | 1.03 | 0.99 | 1.07 | 0.96 | 0.83 | 1.10 |
| | South East | **0.88** | **0.84** | **0.93** | 0.90 | 0.86 | 0.95 | **0.91** | **0.86** | **0.95** | 0.65 | 0.39 | 1.08 |
| | Champlain | **1.47** | **1.41** | **1.53** | **1.45** | **1.39** | **1.51** | **1.45** | **1.39** | **1.51** | **1.61** | **1.33** | **1.96** |
| | North Simcoe Muskoka | **1.29** | **1.23** | **1.36** | **1.30** | **1.23** | **1.37** | **1.30** | **1.23** | **1.37** | 1.24 | 0.80 | 1.94 |
| | North East | 0.96 | 0.91 | 1.00 | 0.97 | 0.93 | 1.02 | 0.97 | 0.93 | 1.02 | 1.44 | 0.77 | 2.71 |
| | North West | **0.63** | **0.59** | **0.67** | **0.62** | **0.58** | **0.67** | **0.62** | **0.58** | **0.67** | 1.53 | 0.72 | 3.23 |
| Year of death | 2005 | **0.59** | **0.57** | **0.62** | **0.56** | **0.54** | **0.59** | **0.56** | **0.54** | **0.59** | **0.62** | **0.51** | **0.77** |
| | 2006 | **0.67** | **0.64** | **0.70** | **0.64** | **0.61** | **0.67** | **0.64** | **0.61** | **0.67** | **0.56** | **0.46** | **0.67** |
| | 2007 | **0.67** | **0.65** | **0.70** | **0.65** | **0.62** | **0.67** | **0.65** | **0.62** | **0.67** | **0.62** | **0.51** | **0.74** |
| | 2008 | **0.67** | **0.64** | **0.69** | **0.64** | **0.61** | **0.67** | **0.64** | **0.61** | **0.67** | **0.62** | **0.52** | **0.74** |
| | 2009 | **0.70** | **0.67** | **0.73** | **0.67** | **0.64** | **0.70** | **0.67** | **0.65** | **0.70** | **0.73** | **0.61** | **0.87** |
| | 2010 | **0.74** | **0.71** | **0.77** | **0.72** | **0.69** | **0.75** | **0.72** | **0.69** | **0.75** | **0.77** | **0.64** | **0.91** |
| | 2011 | **0.77** | **0.74** | **0.80** | **0.75** | **0.72** | **0.78** | **0.75** | **0.72** | **0.78** | **0.89** | **0.75** | **1.05** |
| | 2012 | **0.77** | **0.74** | **0.81** | **0.76** | **0.72** | **0.79** | **0.76** | **0.72** | **0.79** | **0.86** | **0.73** | **1.02** |
| | 2013 | **0.85** | **0.81** | **0.89** | **0.85** | **0.81** | **0.89** | **0.85** | **0.81** | **0.89** | **0.73** | **0.60** | **0.88** |
| | 2014 | **0.92** | **0.87** | **0.96** | **0.91** | **0.87** | **0.96** | **0.91** | **0.87** | **0.96** | **0.87** | **0.72** | **1.06** |
| | 2015 | Ref | - | - | Ref | - | - | Ref | - | - | Ref | - | - |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Education | > Secondary school | na | na | na | na | na | na | na | na | na | 1.04 | 0.95 | 1.13 |
| | Secondary school or less | na | na | na | na | na | na | na | na | na | Ref | - | - |
| Language ability | Neither English or French | na | na | na | na | na | na | na | na | na | 1.01 | 0.92 | 1.10 |
| | English and/or French | na | na | na | na | na | na | na | na | na | Ref | - | - |
| Time since immigration | < 5 years | na | na | na | na | na | na | na | na | na | **0.85** | **0.75** | **0.97** |
| | 5-10 years | na | na | na | na | na | na | na | na | na | 0.98 | 0.88 | 1.10 |
| | > 10 years | na | na | na | na | na | na | na | na | na | Ref | - | - |
| Immigration category | Economic | na | na | na | na | na | na | na | na | na | 1.02 | 0.92 | 1.14 |
| | Refugee or other | na | na | na | na | na | na | na | na | na | 1.03 | 0.92 | 1.15 |
| | Family | na | na | na | na | na | na | na | na | na | Ref | - | - |

* Supportive care is defined as ≥1 physician house call within 2 weeks of death, or ≥ 1 palliative nursing or personal support worker home visit within 6 months of death. Ethnic groups are listed in order of increasing receipt of supportive care versus long-term residents. Immigrants of unknown ethnicity are excluded from analyses. Deaths in 2004 are excluded as home care data is only available from April 2005.

† Boldface type indicates significant values at p<0.05.

CI, confidence interval; na, not applicable; OR, odds ratio.

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

| | Item No | Recommendation | Page No |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | 0, 1 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | 1 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 4 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 5 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | 5 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 5-6 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up | 5-6 |
| | | (*b*) For matched studies, give matching criteria and number of exposed and unexposed | NA |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 5-6 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 5-6 |
| Bias | 9 | Describe any efforts to address potential sources of bias | Nil |
| Study size | 10 | Explain how the study size was arrived at | 5 |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 7 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | 7 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | 7 |
| | | (*c*) Explain how missing data were addressed | 7 |
| | | (*d*) If applicable, explain how loss to follow-up was addressed | NA |
| | | (*e*) Describe any sensitivity analyses | NA |
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | 8 |
| | | (b) Give reasons for non-participation at each stage | NA |
| | | (c) Consider use of a flow diagram | NA |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | 8, Tbl 1 |
| | | (b) Indicate number of participants with missing data for each variable of interest | Tbl 1 |
| | | (c) Summarise follow-up time (eg, average and total amount) | NA |
| Outcome data | 15* | Report numbers of outcome events or summary measures over time | Fig 1 & 3, Supple |

| | | | |
|---|---|---|---|
| | | | tbl 1 |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | Fig 2 & 4, Supple tbl 2 & 3 |
| | | (*b*) Report category boundaries when continuous variables were categorized | Supple tbl 2 & 3 |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | NA |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | NA |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 10 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 12 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 13 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 12 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 14 |

*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.