Association of patient sex with access to palliative care: a population-based study in Ontario, Canada

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Abstract:	Background: Palliative care improves end-of-life outcomes. It is unclear if there are sex-based differences in access to palliative care near the end of life. Therefore, the objective of this study is to measure the association between sex and access to palliative care. Methods: Population-based retrospective cohort study using linked health administrative data of adults ≥18 year in their last year of life who died in Ontario, Canada between 2010 and 2018. Primary exposure was patient sex (male, female). The primary outcome was receipt of physician delivered palliative care; secondary outcomes were approach to in-hospital palliative care, and concordance of physician-patient sex in referral to palliative care. Multivariable modified Poisson regression was used to measure the association between sex and receipt of palliative care, as well as patient-physician sex concordance . Results: There were 706,722 adults (median age 80 years, IQR 69-87; 50.2% female) in the study cohort, 53.4% of whom received physician delivered palliative care in the last year of life (n=192,022 (54.1%)

	female; n=185,476 (52.7%) male). Female sex was associated with a 9% higher likelihood of receiving physician delivered palliative care (adjusted RR [aRR] 1.09 95% CI 1.08 to 1.09), a 16% higher likelihood of having a palliative approach to care (aRR:1.16, RR 95% CI 1.14 to 1.18), and a 17% higher likelihood of referral to a palliative care physician by a female physician (aRR 1.17 95% CI 1.16 to 1.18), compared to male counterparts. Intepretation: Sex-based differences in access to palliative care may represent potential health inequities, or divergent preferences for end-of-life care between male and female patients. A better delineation of these differences will help inform the design of health policy interventions aimed at minimizing potential disparities in access to high-quality end-of-life care.

Association of patient sex with access to palliative care: a population-based study in Ontario, Canada

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Key Points

Question: Does access to palliative care differ between males and females at their end-of-life?

Findings: In this cohort study of 706,722 adults who died in the province of Ontario, female patients were 9% more likely to receive physician delivered palliative care within the last year of their life, compared to male patients. Female patients were also 19% more likely to take a palliative approach to care during hospitalization. Furthermore, of those receiving palliative care, female patients were 17% more likely to have had a female physician referring them to palliative care, compared to their male counterparts.

Meaning: Sex-based differences in access to palliative care may represent potential health inequities, or divergent preferences between male and female patients at their end-of-life. Further understanding of these differences will help inform the design of health policy interventions aimed at minimizing potential disparities in access to high-quality end-of-life care.

ABSTRACT

Background: Palliative care improves end-of-life outcomes. It is unclear if there are sex-based differences in access to palliative care near the end of life. Therefore, the objective of this study is to measure the association between sex and access to palliative care.

Methods: Population-based retrospective cohort study using linked health administrative data of adults ≥18 year in their last year of life who died in Ontario, Canada between 2010 and 2018. Primary exposure was patient sex (male, female). The primary outcome was receipt of physician delivered palliative care; secondary outcomes were approach to in-hospital palliative care, and concordance of physician-patient sex in referral to palliative care. Multivariable modified Poisson regression was used to measure the association between sex and receipt of palliative care, as well as patient-physician sex concordance .

Results: There were 706,722 adults (median age 80 years, IQR 69-87; 50.2% female) in the study cohort, 53.4% of whom received physician delivered palliative care in the last year of life (n=192,022 (54.1%) female; n=185,476 (52.7%) male). Female sex was associated with a 9% higher likelihood of receiving physician delivered palliative care (adjusted RR [aRR] 1.09 95% CI 1.08 to 1.09), a 16% higher likelihood of having a palliative approach to care (aRR:1.16, RR 95% CI 1.14 to 1.18), and a 17% higher likelihood of referral to a palliative care physician by a female physician (aRR 1.17 95% CI 1.16 to 1.18), compared to male counterparts.

Intepretation: Sex-based differences in access to palliative care may represent potential health inequities, or divergent preferences for end-of-life care between male and female

patients. A better delineation of these differences will help inform the design of health policy interventions aimed at minimizing potential disparities in access to high-quality end-of-life care.

INTRODUCTION

Disparities in access to healthcare have led to increasing calls for research to identify and address health inequities in healthcare delivery.[1] Prior research identified significant sex-based disparities in both the intensity and frequency of health services accessed by male and female patients including hospitalization, access to home-based end-of-life care and use of life-sustaining interventions at the very end of life.[2–4]

Palliative care improves quality of life, reduces symptom burden and is associated with a reduction in healthcare utilization, an increase in quality-adjusted survival, and an overall significant cost-savings among patients with terminal life-limiting conditions.[5–8,910] As populations age globally, so too does the potential for increased suffering and healthcare utilization as a result of increasing multimorbidity.[11] Palliative care may therefore become increasingly important to reduce suffering in the delivery of high-value end-of-life care.[12] However, access to palliative care is limited despite its recognition as an established policy priority at the regional, national and international level[13–16].

There remains significant uncertainty about potential disparities in physician-delivered palliative care between male and female patients at their end of life. Within the province of Ontario, prior research suggests that adult males were less likely to receive palliative care near the end-of-life.[17–20] However, these relatively small studies were limited to exploratory secondary analyses that lacked population-level data and did not examine potential underlying mechanisms to explain their findings.

Given these prior limitations, the objective of this study was to measure the association of patient sex with physician-delivered palliative care near the end of life. It also evaluated several possible mechanisms that may serve to explain potential sex-based differences in palliative care receipt.

METHODS

This study is reported in accordance with guidelines for The Reporting of studies Conducted using Observational Routinely-collected health Data (RECORD).[14]

Study Design, Setting and Data Sources

We conducted a population-based retrospective cohort study in Ontario, Canada, using linked clinical and health administrative databases (Supplementary Tables 1 & 2). The administrative datasets used in this study were linked using encoded identifiers at the patient level and analysed at IC ES (formerly the Institute of Clinical and Evaluative Sciences). Ontario is Canada's most populous province with over 14 million people. All residents of Ontario have access to hospital care and physicians' services, and those aged ≥ 65 years of age are provided prescription drug insurance coverage.

The use of data in this project was authorized under section 45 of Ontario's Personal Health Information Protection Act, which does not require review by a Research Ethics Board.

Study Cohort

We included all adults in Ontario who died between January 2010 and December 2018. People were excluded if 1) they died of sudden death according to the cause of death on their death certificate (Supplementary Table 2); 2) they did not have a valid Ontario health card number within the last 365 days before their death or were not eligible for Ontario health benefits within the last 5 years prior to death and were therefore ineligible to receive healthcare services; 3) they were not Ontario residents at the time of death; 4) there was missing data on sex or date of death; 5) if they were not a new user of palliative care, which was defined as having received 2 or more palliative care visits in the year prior to the last year of life (720 days to 360 days before death) that were less than 180 days apart. This reflects a new user design whose purpose is to reduce the confounding that typically accompanies inclusion of data from prevalent users in observational studies such as this one. [21]

Patient and Physician Characteristics

Beyond sex, this study captured age, income quintile, rurality, comorbidities, frailty and cause of death. Male and female patients were stratified into 3 end-of-life illness trajectories on the basis of their cause of death: cancer (terminal illness) organ failure, and dementia (frailty). (Supplementary Table 3)

Physician demographics

Specific provider demographics captured included: sex, location of training, location of practice, and specialty of practice. These provider level factors have previously been shown to influence end-of-life care delivered by physician[22]

Patient Sex - Exposure

Patient sex was defined as male or female and identified using the Registered Persons Database (RPDB) Database, which contains detailed demographic information on all Ontarians eligible to receive insured health services in the province.

Access to Palliative Care - Outcome

The primary outcome was receipt of physician-delivered palliative care. This was identified using a specific set of palliative care physician fee codes that have been widely used in prior palliative care research (Supplementary Table 4).[12,17,19,20,23–32]

Secondary outcomes included 1) approach to palliative care during the first hospitalization in the last year of life using a method from previously published work, which was categorized as palliative intent likely, palliative intent unlikely, and no palliative intent (Supplementary Table 5);[33–36] Briefly, this categorization takes into account the patients primary reason for admission, status of their most responsible provider as a palliative practitioner, and in-hospital palliative care consultations. 2) Concordance of patient-physician sex among the physician who referred the patient to palliative care was also measured

Statistical Analysis

Multivariable modified Poisson regression was used to measure the association between patient sex and receipt of palliative care, and separately to measure the association between patient sex and concordance of patient-physician sex in referral to palliative care. This analysis was also completed on subgroups defined according to a patient's cause of death (cancer, chronic organ failure, dementia) to examine for potential differences in the magnitude of sex-based differences in access to palliative care by disease type. Multivariable multinomial regression was used to measure the association between patient sex and approach to care during the first hospitalization in the last year of life. Lastly, in adult patients who received palliative care in the last year of their lives, a generalized Poisson regression was used to measure the association between patient sex, and likelihood of the physician providing palliative care referral being female. Patient models were adjusted for age, the presence of chronic conditions including cancer, chronic kidney disease, cirrhosis, coronary artery disease, dementia, diabetes, hypertension, and non-psychotic mental health conditions (e.g. depression, anxiety).

Physician related models were adjusted for physician age, specialty, location of practice and location of training. Balance across baseline characteristics at index date was assessed using standardised differences (SD), where and SD ≤0.1 indicates good balance.[52]All analyses were performed using SAS version 9.4 (SAS Institute, Cary, North Carolina).

RESULTS

Characteristic of Study cohort

The study cohort consisted of 706,722 adults who died within the study period (Figure 1). There were 31% of patients categorized as having cancer as their cause of death, with 32% having dementia and 38% as organ failure. This is consistent with previous estimates of the Ontario population.[17] Male and female patients were equally represented in all three cause-of-death categories.

Access to Palliative Care

Overall, 53.4% of patients received palliative care within the last year of their life. 54.1% of female patients received palliative care and in comparison, 52.7% of male counterparts received palliative care. (Table 2)

Compared to males counterpart, female patients were 9% more likely (adjusted RR: 1.09, 95% CI 1.08 to 1.09) to receive physician delivered palliative care after controlling for age and comorbidities. There was a gradient of sex-differences in palliative care delivery on the basis of cause of death, with the largest difference seen in adults dying of organ failure, and then dementia and cancer respectively. (Figure 2/Supplementary Table 6)

Multivariate analysis of approach to palliative care

Compared to male counterparts, female patients were 16% more likely to have (aRR:1.16, RR 95% CI 1.14 to 1.18) their first hospitalization in their final year of life categorized as having a likely palliative care intent when similarly controlling for age and comorbidities. There was no difference between males and females in their likelihood of their hospitalizations being categorized as palliative care unlikely. Female patients were 5% less likely (aRR:0.95, RR 95% CI 0.95 to 0.96) to have hospitalizations categorized as having no palliative care intent compared to male counterparts. (Figure 3/Supplementary Table 7)

Multivariate analysis of physician sex for patients referred for palliative care.

Female patients were more likely to have been referred to a palliative care physician by a female physician compared to males. The magnitude of this difference was most pronounced in adults dying of cancer, followed by organ failure and dementia respectively. (Figure 4/Supplementary Table 8)

DISCUSSION

This population level cohort study of 706,722 adults in the last year of life found that female patients were 10% more likely to access palliative care compared to their male counterparts. When protracted through the study period, this was a difference of nearly 7,000 male patients who may have benefitted from palliative care but otherwise did not receive it. This sex difference was observed consistently amongst patients with varying causes of death, but most prominently in those who died from organ failure, and dementia whilst being less pronounced amongst those dying of cancer.

There are several possible reasons to explain why we found associated sex-based differences in access to palliative care. First, the magnitude of these differences were larger when looking at patient who died from organ failure or dementia compared to those with cancer. This may reflect routine integration of palliative care in the care of patients with cancer and less so in patients with dementia, which may increase palliative care opportunities for cancer patients. [12,32] Second, our data suggest that female patients at their end-of-life were more likely to pursue a palliative approach to care during acute care hospitalization which may ultimately trigger palliative care referrals and may also hint at a general sex difference in overall approach and preferences for end-of-life care. Third, the concordance between patient and physician sex appeared to influence receipt of palliative care. Female patients receiving palliative care were more likely to have been referred by female physicians.

The primary finding of this study is in keeping with prior exploratory literature that suggested a sex-difference in physician delivered palliative care may exist. [17,19,20,40] Our study builds on this work, but is also unique as it not only explicitly quantifies this difference at a population level within a large multicultural health system but also identifies two potential explanatory mechanisms. Several studies have identified sex-based differences in end-of-life decision making.[41,42] Although these have largely been small regional studies, they have demonstrated a consistent preference amongst patients and their caregivers towards more aggressive end-of-life interventions for male patients compared to female patients. The results of this study suggest that such sex differences in overall approach and/or preferences for end-of -life care may exist at a population level. To evaluate these differences, further studies are required to better correlate in-hospital palliative care involvement, with overall patient/caregiver reported preferences for care. With regards to sex difference in referring providers, the broader health services research literature is replete with examples of how provider demographics such as sex can play a major role in patient's overall health. [43,44] More specifically, several studies have demonstrated that patient-provider sex concordance can significantly affect health outcomes in areas such as cancer screening as well as management of cardiovascular disease.[45–47] This study demonstrated that female patients who received palliative care were far more likely to have been referred for palliative care by a female provider. What remains unclear is whether patient-provider sex concordance is a major driver of the sex differences in palliative care delivery identified in this study, whether the sex concordance identified in this study is driven by patient or physician related factors, and broadly whether sex concordance has an effect on important downstream end-of-life outcomes.

There have been renewed calls to identify and address health inequities within the healthcare system as a result of the disparities highlighted during the CoVID-19 pandemic.[1,37,38] Policymakers, especially within a Canadian context, can typically use tools such as quality-based funding models [39] that incentivize hospitals and health units to prioritize important health and system outcomes as part of care delivery. Such interventions depend on a delineation between health differences that arise from differing patient preferences for care and health inequities relating to system level factors. It is not clear if our results reflect a health inequity or a fundamental difference in overall approaches or preferences between male and females at their end-of-life. Before policies can be developed to address this health difference, further studies are required to delineate between these possibilities. Similarly, further work is required to evaluate the nature and magnitude of patient-provider sex concordance and its effect on receipt of palliative care.

Limitations

Several limitations exist in interpreting the results of this study. First, given this study's retrospective observational nature its results reflect associations and are not causal. This study does systematically adjust for a comprehensive list of important confounding variables; , the possibility of residual confounding remains. Secondly, within the confines of health services research, it is not possible to capture details on individual patient preferences for care, especially at their end of life. We describe a method within this paper that may allow some insight into a patients' approach to palliative care within an acute hospitalization; however, further work is required to correlate various levels of inpatient palliative care involvement with overall patient/care-givers' reported preferences for care. Thirdly, this study does not capture palliative care delivery by other important healthcare providers such as nurse practitioners, spiritual care and social work, and any potential sex-based differences in access to palliative care delivered by these providers remain unknown. This reflects a limitation of the administrative health data captured in Ontario. Furthermore, it is possible that this study does not identify palliative care delivered by physicians under alternative fee codes not included in our analysis. However, the method employed within this study for identifying physician delivered palliative care is widely used in the literature.[12,17,19,20,23–32] Finally, our study reflects palliative care practice patterns that may not apply to other jurisdictions, especially those without a single-payer health insurance system. However, given the population-level nature of this study, we believe that our findings remain broadly generalizable to other large healthcare systems around the world

CONCLUSIONS

This study identified that male patients were less likely to receive physician delivered palliative care in the final year of their life. It remains unclear if this reflects a difference between male and female patients in their overall end-of-life care preferences or whether this represents a health inequity driven by system and provider level factors. Addressing these potential inequities will be vital in ensuring that the right patient receives the right care at the right time.

ARTICLE INFORMATION

Acknowledgements

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Data Sharing

The dataset from this study is held securely in coded form at ICES. While data sharing agreements prohibit ICES from making the dataset 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 dataset creation plan and underlying analytic code are available from the authors upon request, understanding that the computer programs may rely upon coding templates or macros that are unique to ICES and are therefore either inaccessible or may require modification.

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Disclaimer:

The opinions, results, and conclusions reported in this article are those of the authors and are independent from the funding sources. No endorsement by ICES or the Ontario MOHLTC is intended or should be inferred. Parts of this material are based on data and information compiled and provided by the Canadian Institute for Health Information (CIHI). However, the analyses, conclusions, opinions, and statements expressed herein are those of the authors and not necessarily those of the CIHI.

Author Contributions

Drs. Gitau and Quinn had full access to all data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis

Conception and design: Gitau, Quinn, Bell

Acquisition, analysis or interpretation of the data: Gitau, Quinn, Huang

Drafting of manuscript: Gitau

Critical revision of the manuscript for important intellectual content: All authors

Statistical Analysis: Huang, Quinn, Gitau

Obtained funding: Gitau, Quinn, Bell

Administrative, technical or material support: Quinn

Supervision: Quinn, Bell, Isenberg, Stall, Ailon,

Table 1: Baseline characteristics for individuals in the patient cohort. Immigration status is reported based on inclusion of patients into the Immigration, Refugee and Citizenship Canada database. Chronic disease prevalence's captured through previously validated cohorting algorithms described above.

Characteristics		Female	Male	STANDARDIZED DIFFERENCE
Total Patients		N=354,657	N=352,065	
Age	Mean ± SD	80.54 ± 13.19	75.93 ± 13.16	0.35
	Median (IQR)	84 (73-90)	78 (67-86)	0.39
	30-39	2,012 (0.6%)	2,433 (0.7%)	0.02
	40-49	6,537 (1.8%)	8,829 (2.5%)	0.05
	50-59	19,757 (5.6%)	30,545 (8.7%)	0.12
	60-69	38,901 (11.0%)	59,327 (16.9%)	0.17
	70-79	66,065 (18.6%)	85,723 (24.3%)	0.14
	80-89	123,141 (34.7%)	116,185 (33.0%)	0.04
	90-99	90,672 (25.6%)	46,325 (13.2%)	0.32
	100-109	6,721 (1.9%)	1,488 (0.4%)	0.14
Rural Residence	missing	759 (0.2%)	855 (0.2%)	0.01
	Y	48,187 (13.6%)	52,921 (15.0%)	0.04

Neighbourhood Income Quintile	missing	1,645 (0.5%)	1,764 (0.5%)	0.01
	1	90,338 (25.5%)	84,896 (24.1%)	0.03
	2	76,310 (21.5%)	75,959 (21.6%)	0
	3	66,979 (18.9%)	67,723 (19.2%)	0.01
	4	61,560 (17.4%)	62,982 (17.9%)	0.01
	5	57,825 (16.3%)	58,741 (16.7%)	0.01
Recent Immigrance Status	Non-Immigrant	336,077 (94.8%)	333,326 (94.7%)	0
	Economic (Economic class) immigrants	3,044 (0.9%)	4,543 (1.3%)	0.04
	Other immigrants	633 (0.2%)	582 (0.2%)	0
	Resettled Refugee & Protected Person in Canada	1,887 (0.5%)	3,074 (0.9%)	0.04
	Sponsored family (Family	13,016 (3.7%)	10,540 (3.0%)	0.04

	Class) immigrants			
frailty score group	0	30,085 (8.5%)	33,860 (9.6%)	0.04
	0.1-8.9	142,989 (40.3%)	156,005 (44.3%)	0.08
	9+	144,849 (40.8%)	134,342 (38.2%)	0.05
	Missing	36,734 (10.4%)	27,858 (7.9%)	0.08
Chronic Disease Prevalence	Cancer prevalent	153,840 (43.4%)	184,760 (52.5%)	0.18
	Cirrhosis prevalant	2,003 (0.6%)	6,095 (1.7%)	0.11
	CHF prevalent	126,431 (35.6%)	123,745 (35.1%)	0.01
	COPD prevalent	85,378 (24.1%)	97,250 (27.6%)	0.08
	Coronary prevalent	61,649 (17.4%)	91,793 (26.1%)	0.21
	Non-psychotic Mood and Anxiety Disorders prevalent	94,955 (26.8%)	76,909 (21.8%)	0.12

	Dementia prevalent	110,530 (31.2%)	72,846 (20.7%)	0.24
	Diabetes prevalent	122,327 (34.5%)	142,383 (40.4%)	0.12
	Hypertension prevalent	286,100 (80.7%)	268,531 (76.3%)	0.11
	(Other) Mental Health Conditions prevalent	49,896 (14.1%)	63,706 (18.1%)	0.11
	Renal Disease prevalent	83,262 (23.5%)	100,780 (28.6%)	0.12
	Stroke prevalent	42,330 (11.9%)	39,551 (11.2%)	0.02
Received Palliative Care		192,022 (54.1%)	185,476 (52.7%)	0.03
Illness Trajectory/Cause of Death	Dementia (Frailty)	117,906 (52.3%)	107,702 (47.7%)	0.06
	Organ failure	134,490 (50.8%)	130,219 (49.2%)	0.02

	Cancer (Terminal Illness)	102,261 (47.3%)	114,144 (52.7%)	0.08

Figure 1: Creation of the study cohort

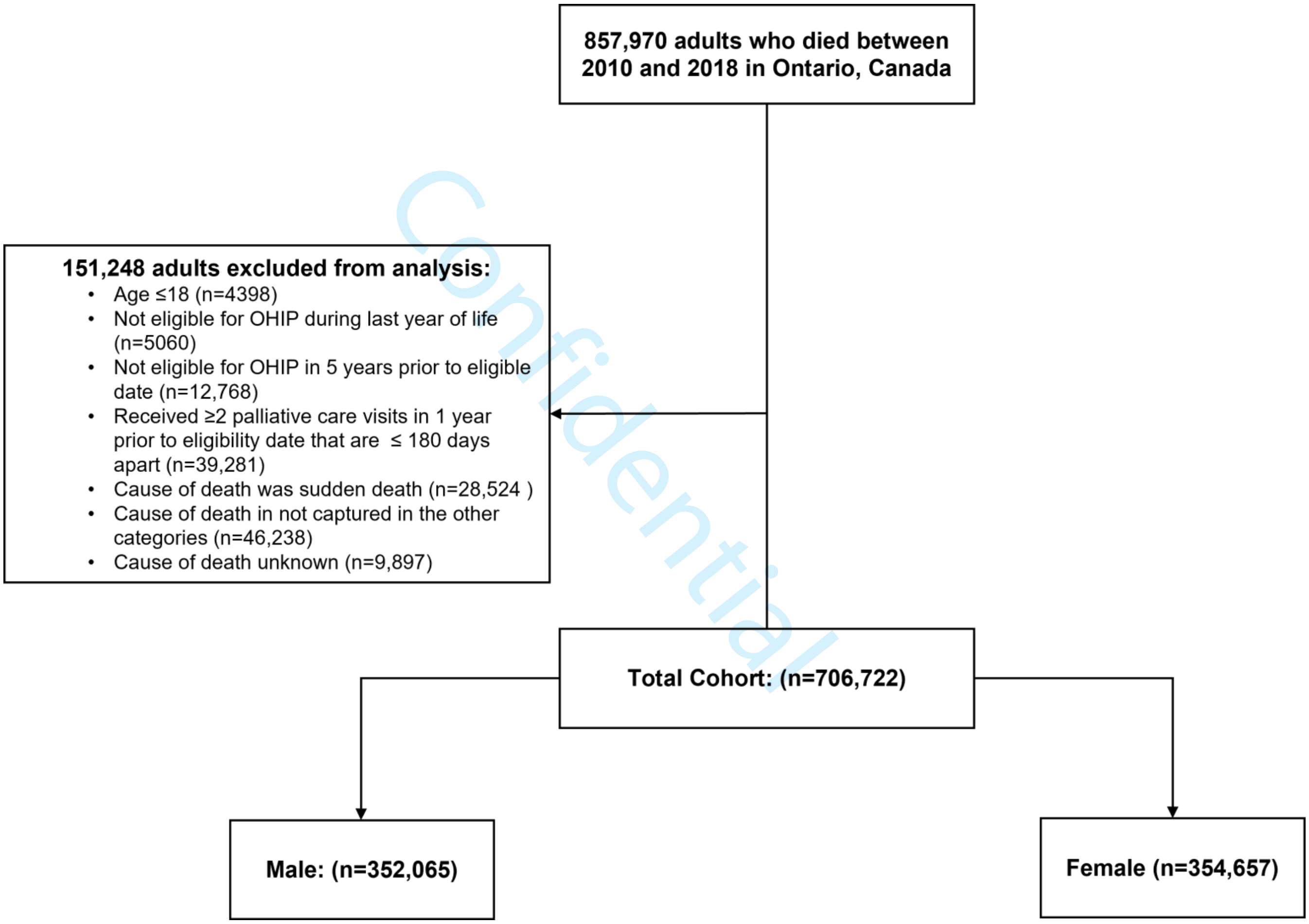


Figure 2: ***A depiction of the p*****robability of receiving physician delivered palliative care in the last year of life according to patient sex among 706,722 adults who died between 2010 and 2018 in Ontario, Canada. Models were adjusted for age and chronic conditions, and stratified by risk of death (RR>1, Female>Male)**

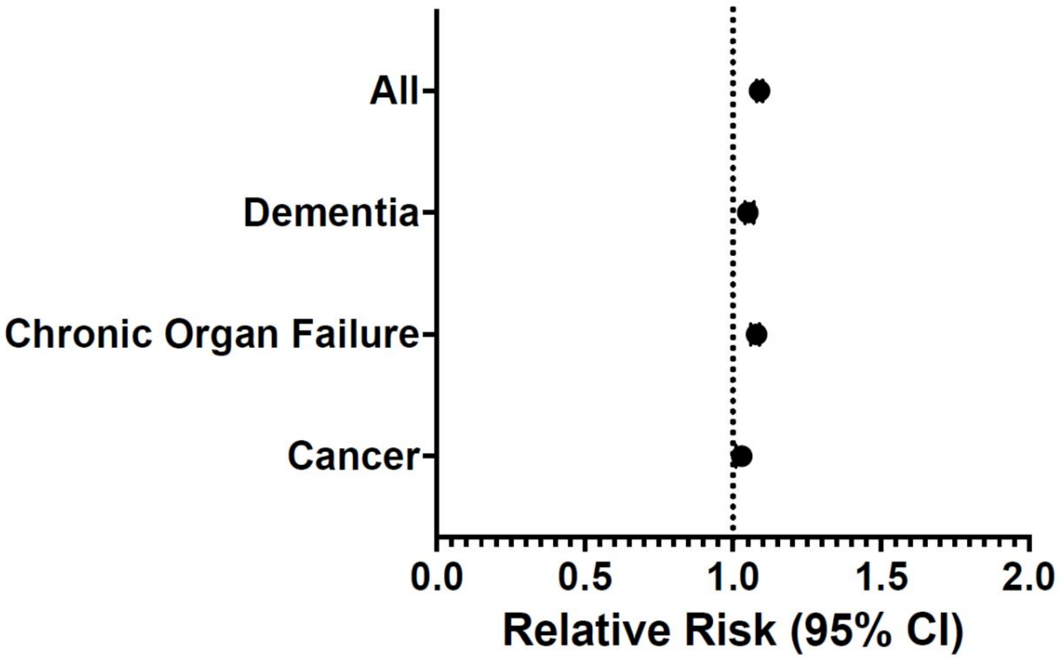


Figure 3: Depicts probability of a palliative approach to care during the first hospitalization in the last year of life, according to patient sex among 706,722 adults who died between 2010 and 2018 in Ontario, Canada. Models were adjusted for age and chronic conditions. ●: Palliative Care Intent Likely, ▲: Palliative Care Intent Unlikely, ■ : No Palliative Care (RR>1, Female>Male)

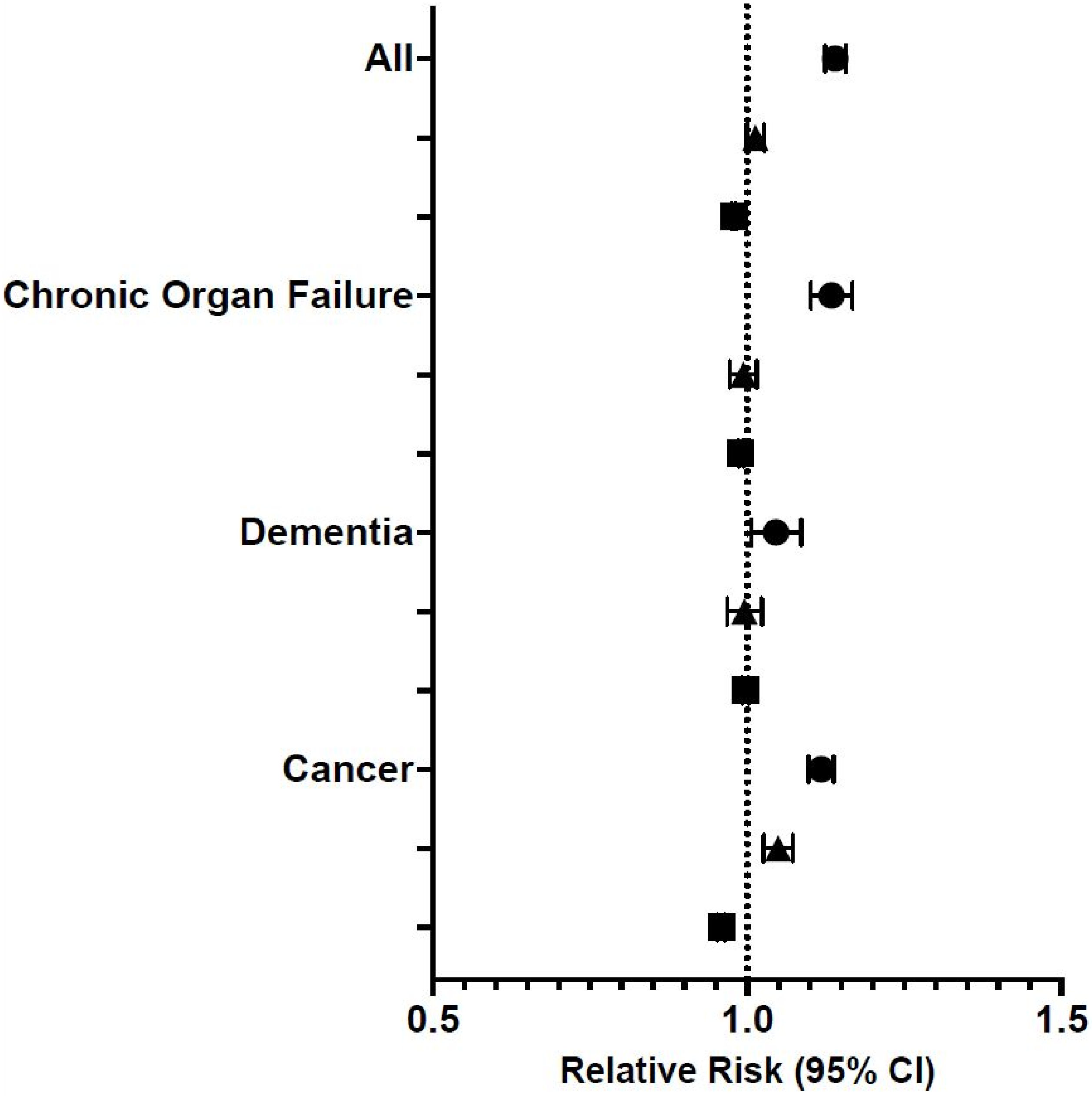
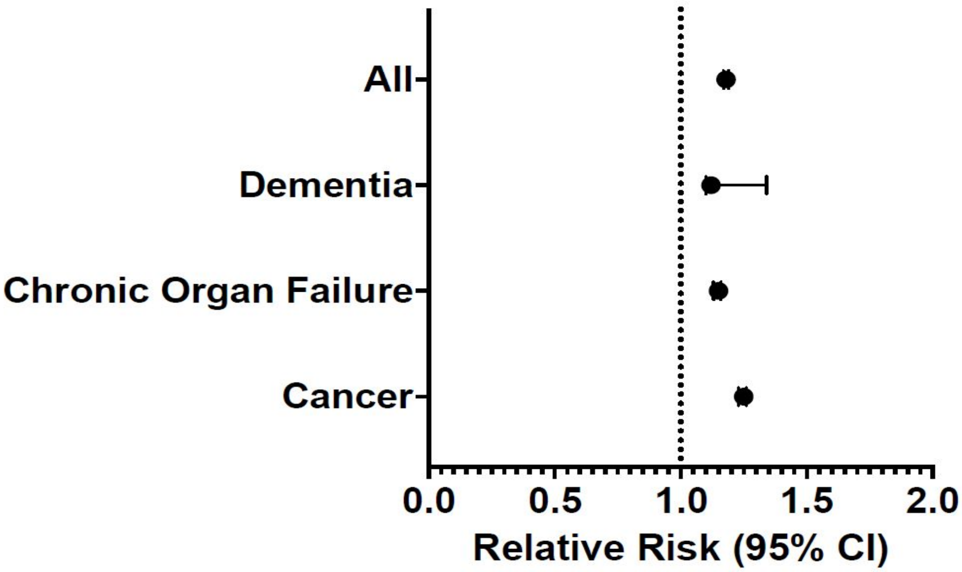


Figure 3: Depicts probability of a female patient being referred to palliative care by a female physician (patient-physician sex concordance). Models were adjusted for patient age and chronic conditions, physician sex, location of practice, and location of medical training, and was stratified by cause of death. (RR>1, Female>Male)



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The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	RECORD items	Location in manuscript where items are reported
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	(a) Included, Abstract (b) Included, Abstract 1.1: Included, Abstract (Design and Setting), Methods (Study Design) 1.2: Included, Abstract (Design and Setting) Methods (Study Design) 1.3: Included, Abstract (Design and Setting), Methods (Study Design)
Background rationale	2	Explain the scientific background and rationale for the investigation being reported		Included, Introduction
Objectives	3	State specific objectives, including any prespecified hypotheses		Included, Introduction
Study Design	4	Present key elements of study design early in the paper		Included, Methods
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection		Included, Methods
Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided.	(a) Included, Methods 6.1: Included, Methods 6.2: Included, Methods

		Case-control study - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case	RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	6.3: Included, Supplementary Online Material
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Included, Methods 7.1: Included, Methods
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		Included, Methods
Bias	9	Describe any efforts to address potential sources of bias		Included, Methods *Selection Bias:* - The use of population-based data capturing all older adults in Ontario,

				Canada minimizes the risk of selection bias, as does our broad inclusion criteria. *Information Bias:* - Use of well-validated linked health administrative databases are routinely used to conduct population-based studies - Information on medication prescribing for individuals ≥65 years of age *Confounding:* - Matched cohort design - Further discussed in Limitations
Study size	10	Explain how the study size was arrived at		Included, (Figure 1) CONSORT DIAGRAM
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why		Included, Methods
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical		(a) Included, Methods (b) Included, Methods (c) Included, Methods (d) Included, Methods (e) Included, Methods

		methods taking account of sampling strategy (e) Describe any sensitivity analyses		
Data access and cleaning methods		..	RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	12.1: Data is securely housed at the ICES. Only authorized individuals have access to data. 12.2: Data are inspected and cleaned upon importation to ICES.
Linkage		..	RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	12.3: Included, Methods
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram	RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	(a,b,c) Included, Figure 1
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders		(a) Included, Results, Table 1, eTable 2 and 3 (b) Table 1 (c) Included, Methods

		(b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)		
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure category, or summary measures of exposure *Cross-sectional study* - Report numbers of outcome events or summary measures		Included, Results
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		(a) Included, Results (b) Included, Results (c) N/A
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses		Included, Results
Key results	18	Summarise key results with reference to study objectives		Included, Results
Limitations	19	Discuss limitations of the study, taking into account sources of	RECORD 19.1: Discuss the implications of using data that were not	Included, Discussion

		potential bias or imprecision. Discuss both direction and magnitude of any potential bias	created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	19.1: Included, Discussion
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence		Included, Discussion
Generalisability	21	Discuss the generalisability (external validity) of the study results		Included, Discussion
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		Included, Funding
Accessibility of protocol, raw data, and programming code		..	RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	Included, Access to Data

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

Supplementary Table 1: A description of the multiple linked databases housed at ICES which were used for this study

Data regarding sex and death was captured through the Registered Persons Database (RPDB) Database which helped define the decedent cohort. Furthermore, information regarding: postal code, income quintile and rurality was captured through the Vital Statistics Database in conjunction with Statistics Canada census data. Information regarding physician delivered palliative care was captured through billing information contained in the Ontario Health Insurance Plan (OHIP) database. Information regarding approach to care during hospitalization was captured through the Canadian Institute for Health Information Discharge Abstract Database (CIHI-DAD). Data regarding physician practice/training demographics was captured using the Physician Service Databases (IPDB) whilst information on physicians rostering decedents was captured using the Client Agency Program Enrollment (CAPE). Decedents with recent immigrance to Canada were identified through a registry maintained by Immigration, Refugees and Citizenship Canada (IRCC). Decedents were categorized into three end-of-life illness trajectories: organ failure, terminal illness and frailty on the basis of their listed cause of death. Please see supplementary materials for further details on qualifying ICD codes. Data regarding decedents inclusion in chronic disease prevalent cohorts was also captured. This method of categorizing decedents into disease prevalent groups is achieved through previously described and validated cohorting algorithms developed at ICES.[26–30]

Supplementary Table 2: Information regarding linked clinical/health administrative databases located at ICES (Institute for Clinical Evaluative Sciences) that were used as part of this study

Database	**Description**
Canadian Institute for Health Information Discharge Abstract Database (CIHI-DAD)	**Contains detailed diagnostic and procedural information for all hospital admissions in Canada.** **DAD records have been demonstrated to have excellent agreement (over 99%) for demographic and administrative data. Regarding diagnoses, median agreement between original DAD records and re-abstracted records for the 50 most common most responsible diagnoses was noted to be 81% (Sensitivity 82%; Specificity 82%). The corresponding median agreement for the 50 most frequently performed surgical procedures was 92% (sensitivity 95%, positive predictive value 91%).(1)**

Continuing Care Reporting System Long-Term Care (CCRS-LTC)	**Contains demographic, administrative, clinical and resource utilization information on patients who receive continuing care services in hospitals or long-term care (LTC) homes in Canada. The long-term care dataset is generated from the Individual Assessment Instrument Minimum Data Set 2.0, a mandatory comprehensive, standardized and validated instrument for evaluating the needs, strengths, and preferences of elderly adults residing in nursing homes and receiving home care, contains detailed information on the functional status of these people.(2) Full assessments are completed on admission or referral, at quarterly intervals and following any significant health status change.**
Home Care Database (HCD)	**Contains patient-level data on government-funded home and community services.**
Ontario Health Insurance Plan (OHIP)	**Identifies physician billing claims and specialty on all services provided by fee-for-service physicians in Ontario and "shadow billings" for physicians paid under alternate payment plans.**

Registered Persons Database (RPDB)	**Registry of all Ontarians eligible to receive insured health services in the province and contains detailed demographic information as well as the Local Health Integration Networks (LHIN), which defines Ontario's 14 regional areas within which people received most of their hospital care from local hospitals.**
Client Agency Program Enrolment (CAPE)	**This dataset indicates the enrolment of an individual in a program with a specific practitioner and group. A new record is created when a Registered Person enrols in a program. The individual must be eligible for Ontario Health Insurance at the time of rostering.**
ICES Physician Database (IPDB)	**This database contains information regarding physicians demographics for physicians registered in the province of Ontario billing within the provincial health insurance for patient services**
Immigration, Refugees and Citizenship Canada (IRCC/CIC):	**This dataset includes immigration application records for people who initially applied to land in Ontario. Records date from 1985. The data contains permanent residents' demographic information such as country of citizenship, level of education, mother tongue, and landing date. This is a protected database with special permissions**

Supplementary Table 3: Identification and Coding of decedents in different trajectories of death (based on cause of death)

Conditions Leading to Death	**Criteria**
Terminal Illness (Cancer)	ICD-10 codes B24, C, D1 - D3, D40 - D48, N18, D022, D090, D010, D051, D075, D001, D015, D020, D042, D045, D059, D069, D070,
Frailty (Dementia)	ICD-10 codes A02 - A04, A08, A09, A37, A48, A49, B01, B02, B37, B95, B96, E4, E5, E60 - E64, E86, E87, E97, F00 - F03, G20 - G26^, G30 - G32, G35 - G37, G81, G82, I21, I25.0, I25.3, I25.4, I25.5, I25.6, I25.8, I25.9, I251, I69, J00 - J06, J10 - J16, J18, J20 - J22, J69, J80, K59,x L89, M00 - M03, M05 - M09, M11 - M19, M32 - M36, M41 - M43, M45, M46, M80 - M85, M91, M92, N30, R54, R63.3, R63.4
Organ Failure	ICD-10 codes A15 - A19, A50 - A53, A80, A81, A86 - A89, B15 - B19, B90 - B94, D5 - D70, D71 - D77, D80 - D84, D86, D89, E00 - E07, E10 - E16, E2, E30 - E35, E65 - E68, E70 - E75.0, E75.1, E75.2, E75.3, E75.4, E75.5, E75.6, E76 - E80, E83 - E85, E88, F1, G0, G10 - G13, G40, G41, G45 - G47, G5, G60 - G64, G70 - G73, G80, G90 - G95, H0 - H8, H91 - H95, I01, I05 - I13, I15, I20, I22 - I24, I25.2, I26 - I28, I3, I4, I50 - I52, I60 - I68, I70 - I74, I77 - I79, I8, I95, I97 - I99, J30.0, J30.1, J30.2, J30.3, J30.4, J31.0, J31.1, J31.2, J32 - J38, J40 - J45, J47, J60 - J68, J70, J81, J82, J84 - J86, J90 - J94, J96, J98, J99, K0, K10 - K14, K20 - K23, K25 - K31, K35 - K38, K40 - K46, K50 - K52, K55 - K58, K60.0, K60.1, K60.2, K60.3, K60.4, K60.5, K61.0, K61.1, K61.2, K61.3, K61.4, K62, K63, K65 - K67, K70 - K73, K74.0, K74.1, K74.2, K74.3, K74.4, K74.5, K74.6, K75 - K77, K80 - K83, K85, K86, K90 - K93, L00, L01.0, L01.1, L02 - L05, L08, L10 - L14, L20 - L27, L28.0, L28.1, L28.2, L29, L30, L40 - L45, L50 - L54, L70 - L74, L93.0, L93.1, L93.2, L94, L95.0, L97 - L99, M10, M22 - M25, M30, M31, M47 - M49, M51, M73, M79, M86 - M90, M93, M94, N00 -

	N08, N10 - N13, N14.0, N14.1, N14.2, N14.3, N14.4, N15 - N17, N19 - N22, N25 - N29, N31 - N33, N34.0, N34.1, N34.2, N34.3, N35 - N37, N39 - N45, N47 - N51, N60 - N64, N70 - N77, N8, N90 - N96, Q00 - Q07, Q10 - Q18, Q20 - Q28, Q3, Q40 - Q45, Q50 - Q56, Q6 - Q9, J670, L732, J672, J64, J65, J678,
Sudden Death/Other	**Sudden death:** R95, R96, W03, W2 – W9, W11 - W17, X, V, Y0 - Y2, Y30 Y36 **Other:** ICD-10 codes A00, A01, A05 - A07, A20 - A28, A30 - A36, A38 - A44, A46, A54 - A60, A63 - A71, A74 - A79, A82, A85, A91 - A99, B00, B03 - B09, B25 - B27, B30, B33 - B36, B38, B39, B4 - B7, B80 - B83, B85 - B89, B97, B99, F04 - F07, F09, F20 - F25, F28 - F34, F38 - F45, F48, F50 - F55, F59, F6 - F9, G43, G83, G96 - G99, I00, I02, J17, J39, J95, K91, L55 - L68, L80 - L88, L90 - L92, M20, M21, M40, M50, M53, M54, M60 - M63, M65 - M68, M70 - M72, M75 - M77, M95, M96, M99, N46, N97 - N99, O00 - O08, O10 - O16, O21 - O26, O28 - O36, O40 - O48, O6, O70 - O75, O8, O90 - O92, O95 - O99, P00 - P08, P10 - P15, P2, P35 - P39, P5, P60, P61, P70 - P78, P80 - P83, P90 - P96, R0, R1, R20 - R23, R25 - R29, R3, R4, R50 - R53, R55 - R69, R7, R8, R90 - R94, R98, R99, W00 - W02, W04 - W10, W18, W19, Y4 - Y9

Supplementary Table 4: Physician claims fee codes used to identify delivery of palliative care including location

Outpatient	A945 (without and with B codes): Special palliative care consultation in clinic, office, home; minimum 50 min

	· K015 (if no other fee code combination below was met): Counselling of relatives -on behalf of catastrophically or terminally ill patient · K023 (if no other fee code combination below was met): Palliative care support in half-hour increments; may be used to add time for longer consultations following a code for A945, or for any PC support visit. Exclude if patient is in hospital, long-term care (LTC), complex continuing care (CCC), or rehabilitation
Home-based	· A900 with (B966, B998, B997): Complex house call assessment · A901 with (B966, B998, B997): House call assessment · A945 with any B code: Special palliative care consultation · K023 with A900 A901 or any B code: Palliative care support · K015 with A900 A901 or any B code: Counselling of relatives -on behalf of catastrophically or terminally ill patient · B966: Palliative care home visit; travel premium – weekdays daytime · B998: Palliative care home visit; special visit premium – weekdays daytime, first-person seen · B997: Palliative care home visit; special visit premium – nights, first-person seen · A900 A901 B960 B961 B962 B963 B964 B986 B987 B988 B990 B992 B993 B994

	B996 within the last 3 months prior to death
Hospital inpatient	· C945: Special palliative care consultation · C882: Palliative care; Non-emergency subsequent visits by the MRP following transfer from an Intensive Care Area · C982: Palliative care; Emergency subsequent visits by the MRP following transfer from an Intensive Care Area · K015 with (C945 C882 C982): Counselling of relatives -on behalf of catastrophically or terminally ill patient · K023 with (C945 C882 C982): Palliative care support in half-hour increments; may be used to add time for longer consultations following code for A945, or for any PC support visit.
Subacute care	· W882: Palliative care; Long-term care subsequent visit · W982: Palliative care; Long-term care subsequent visit (for community medicine practitioners) · K015 with (W882 W982): Counselling of relatives -on behalf of catastrophically or terminally ill patient · K023 with (W882 W982): Palliative care support in half-hour increments; may be used to add time for longer consultations

	following a code for A945, or for any PC support visit.
Third-party encounters	· G511: Telephone services to a patient receiving PC at home (max. 2/week) · G512: Weekly care case management from palliative primary care management (Monday–Sunday) · K700: Palliative care outpatient case conference

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Supplementary Table 5: Definition of Approach to In-Patient Palliative Care

Level of involvement	Definition	Example(s) of patient typology
Palliative Intent Likely (High Involvement)	Hospitalizations in which palliative care was the **most responsible diagnosis** *and* the **most responsible service provider**.	Patients admitted to inpatient palliative care units.
Palliative Intent Likely (Medium Involvement)	Hospitalizations in which palliative care was the **most responsible diagnosis** *or* the **most responsible service provider** *or* hospitalizations with involvement from a **palliative care specialist**.	Patients admitted primarily for palliative care purposes, but under the care of non-palliative care service providers, such as oncologists or general internists. Patients who received care from a palliative care specialist (e.g., palliative care team was consulted), regardless of their admission diagnoses or most responsible service provider.

Palliative Intent Unlikely	Hospitalizations in which **palliative care was a component of care** provided during the hospitalization, but not the primary reason for the admission (palliative care was secondary diagnosis), or hospitalizations with involvement from a **palliative care generalist**.	Patients admitted primarily for non-palliative care purposes, but for whom palliative care was a component of care. Patients who received care from a palliative care generalist (e.g., internist), regardless of their admission diagnoses or most responsible service provider.
No palliative care	Hospitalizations in which **no palliative care** indicator was identified in the administrative databases.	Patients with no indication of palliative care involvement during the admission (i.e. no palliative care diagnosis, no palliative care service provider, no palliative care physician billing claim).

Supplementary Table 6: Probability of receiving physician delivered palliative care in the last year of life according to patient sex among 706,722 adults who died between 2010 and 2018 in Ontario, Canada. Models were adjusted for age and chronic conditions.

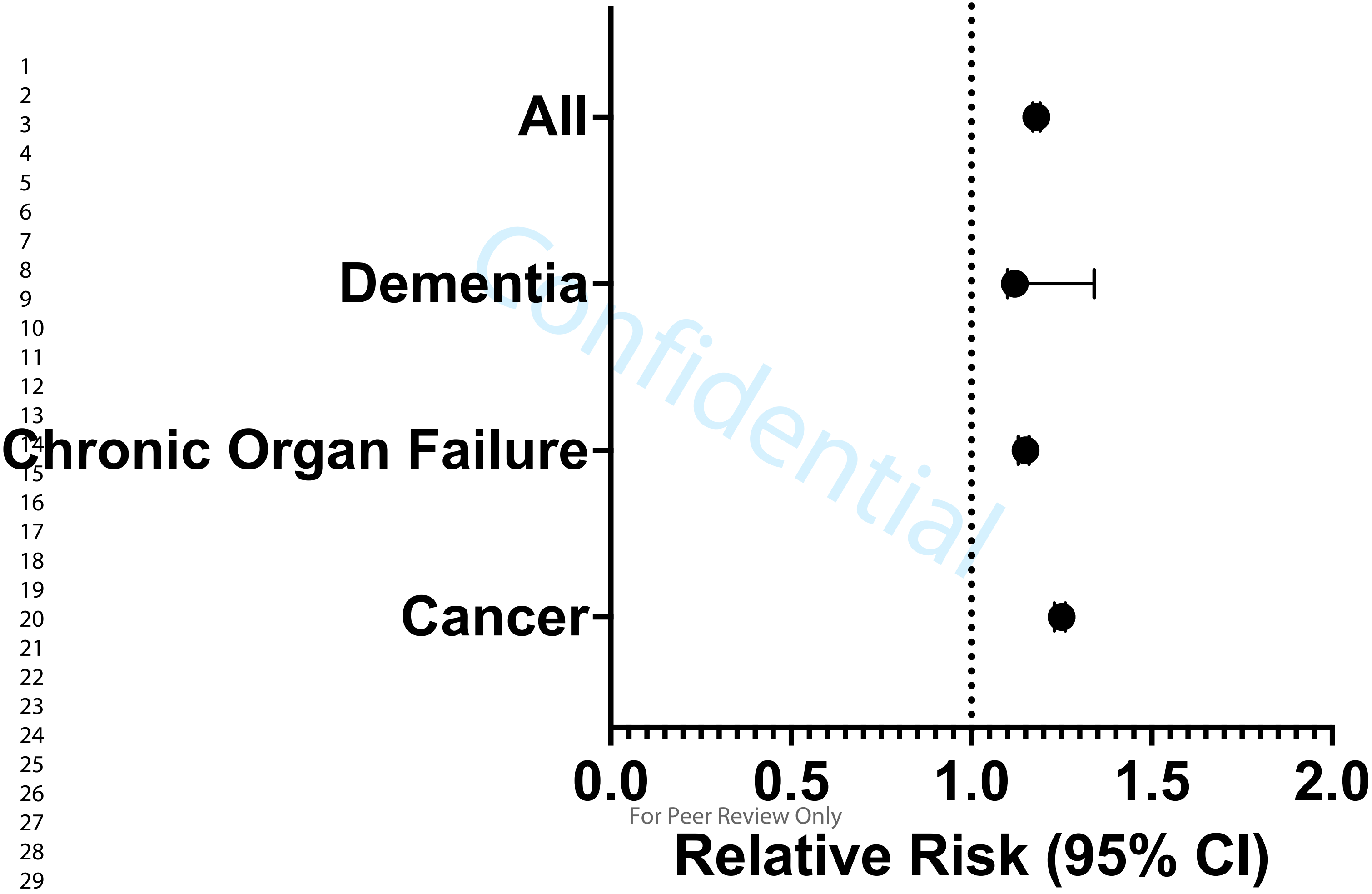
	Receipt of Palliative Care Rate Ratio (95% CI) (Female versus Male)	p-value
All	1.09 (1.08 to 1.10)	<.0001
Dementia	1.05 (1.04 to 1.07)	<.0001
Chronic Organ Failure	1.08 (1.06 to 1.09)	<.0001
Cancer	1.03 (1.01 to 1.03)	<.0001

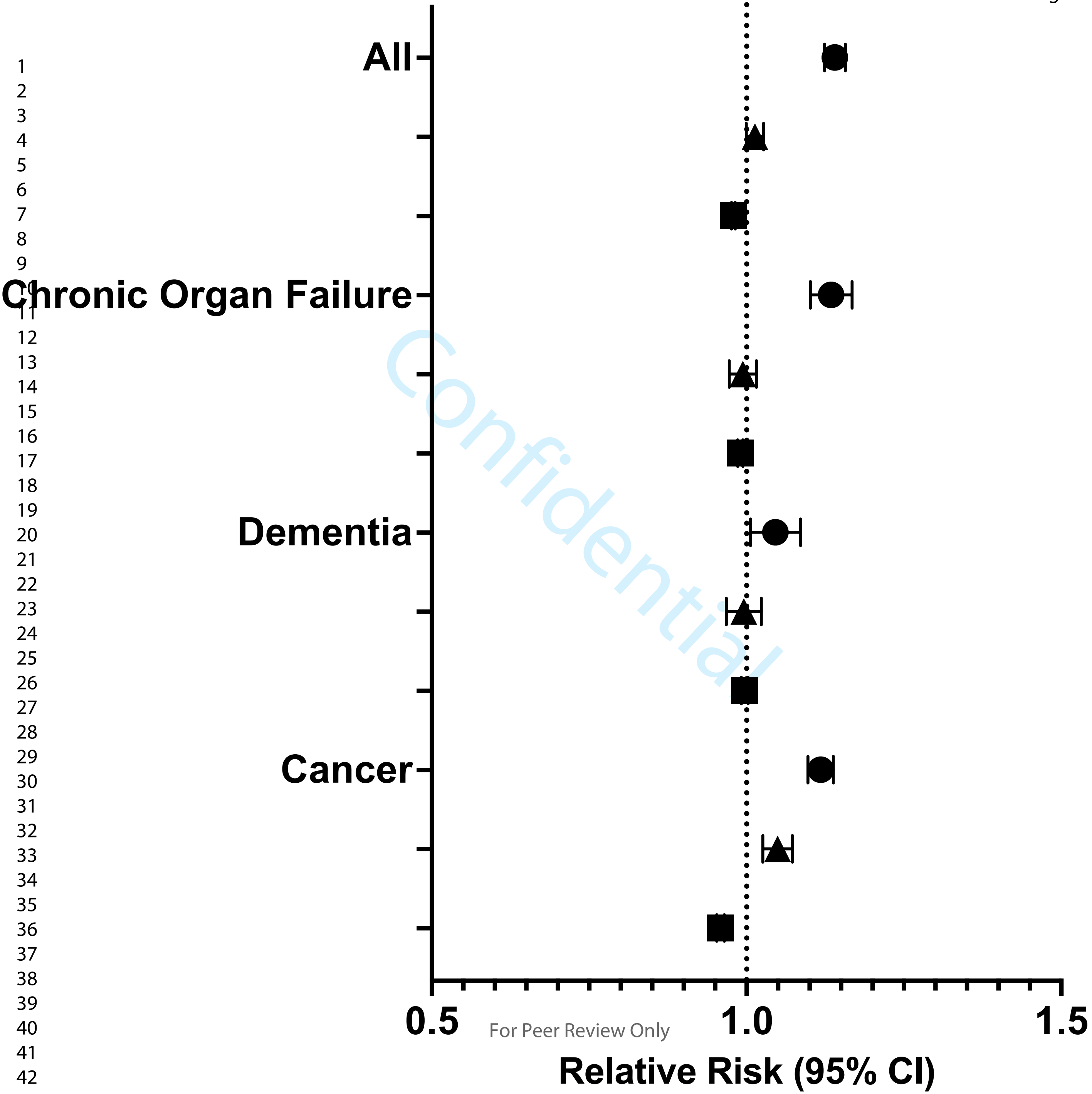
Supplementary Table 7: Probability of a palliative approach to care during the first hospitalization in the last year of life, according to patient sex among 706,722 adults who died between 2010 and 2018 in Ontario, Canada. Models were adjusted for age and chronic conditions.

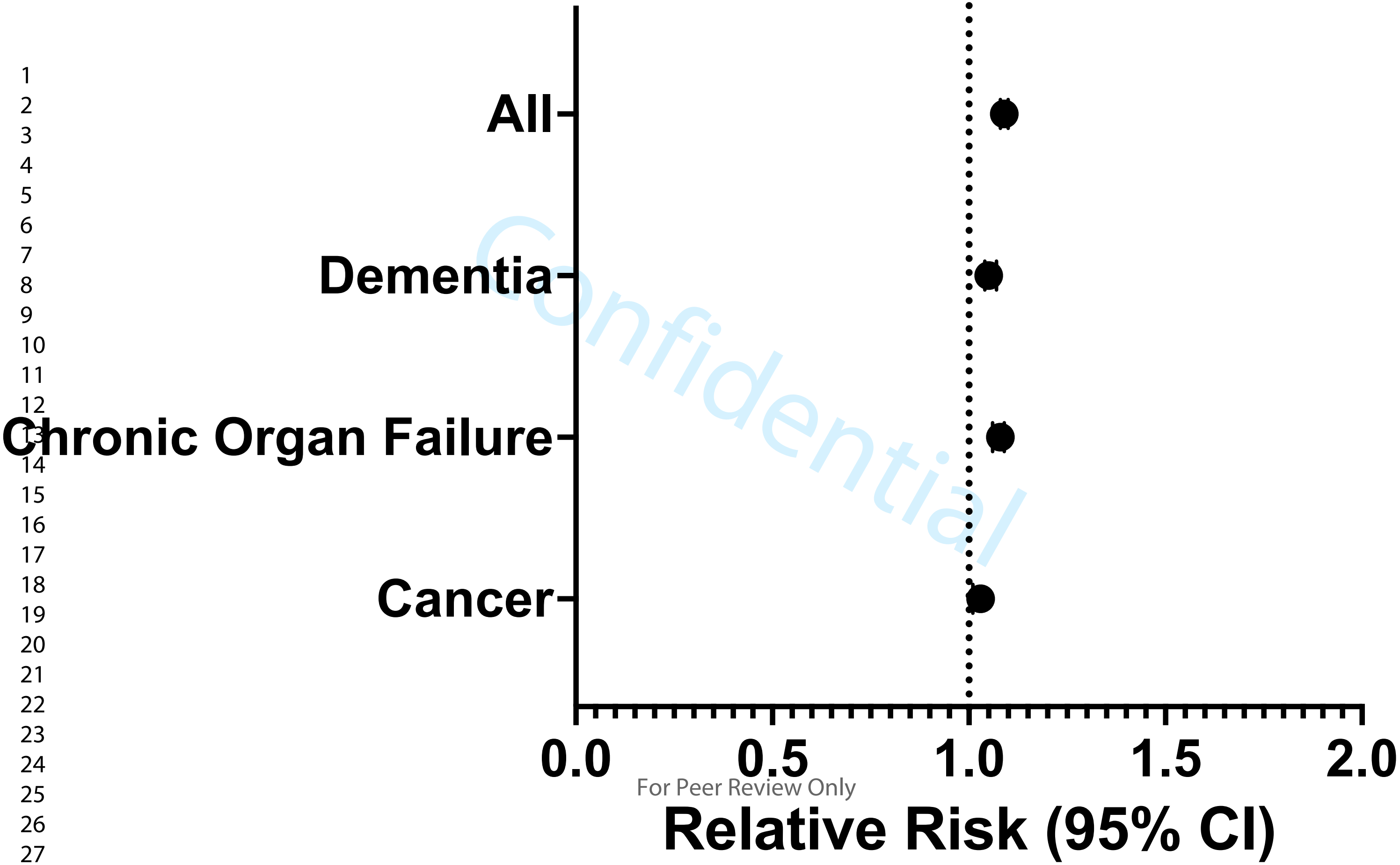
	Approach to palliative care (Female vs. Male)	RR Estimate	95% CI Lower	95% CI Upper	P value
All	Palliative care intent likely	1.1403	1.1236	1.157	<.0001
	Palliative care intent unlikely	1.0135	0.9997	1.0272	0.0548
	No palliative care intent	0.9791	0.9762	0.982	<.0001
Dementia (Frailty)	Palliative care intent likely	1.0460	1.0064	1.0856	0.0227
	Palliative care intent unlikely	0.9956	0.9677	1.0236	0.7591
	No palliative care intent	0.9970	0.9918	1.0022	0.2654
Organ Failure	Palliative care intent likely	1.1345	1.1014	1.1676	<.0001
	Palliative care intent unlikely	0.9943	0.9727	1.0158	0.6034
	No palliative care intent	0.9901	0.9859	0.9943	<.0001
Cancer (Terminal Illness)	Palliative care intent likely	1.1178	1.0977	1.1378	<.0001
	Palliative care intent unlikely	1.0493	1.0257	1.0728	<.0001
	No palliative care intent	0.9587	0.9527	0.9648	<.0001

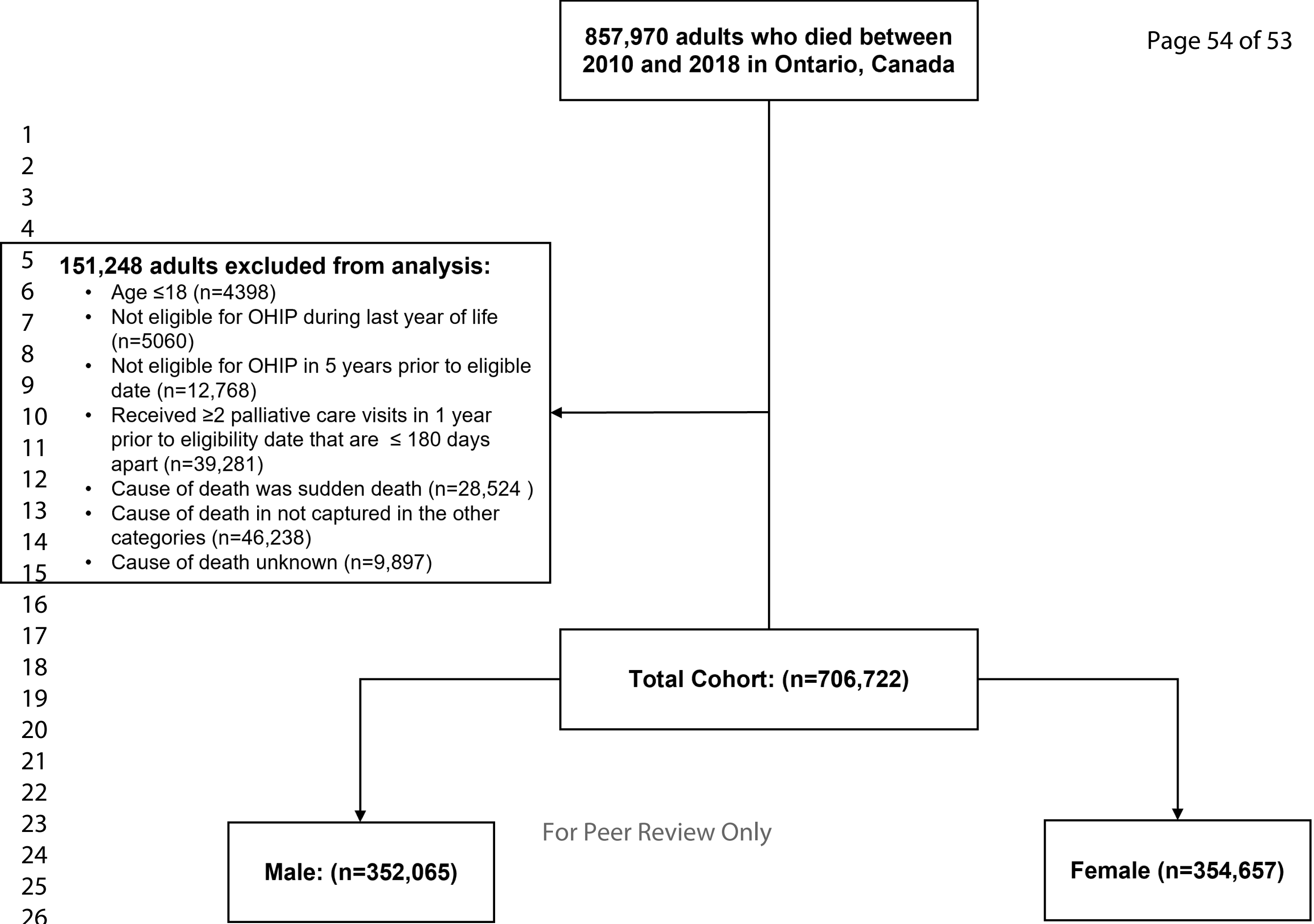
Supplementary Table 8: Probability of a female patient being referred to palliative care by a female physician (patient-physician sex concordance). Models were adjusted for patient age and chronic conditions, physician sex, location of practice, and location of medical training.

	Referral to Palliative Care RR (95% CI)	P value
Total Cohort	1.18 (1.17-1.19)	<.0001
Dementia	1.12 (1.10-1.34)	<.0001
Chronic Organ Failure	1.15 (1.13-1.16)	<.0001
Cancer	1.25 (1.23-1.26)	<.0001


All
Dementia
Chronic Organ Failure
Cancer
0.0
0.5
1.0
1.5
2.0
Relative Risk (95% CI)


All
Chronic Organ Failure
Dementia
Cancer
0.5
1.0
1.5
Relative Risk (95% CI)


All
Dementia
Chronic Organ Failure
Cancer
0.0
0.5
1.0
1.5
2.0
Relative Risk (95% CI)


857,970 adults who died between 2010 and 2018 in Ontario, Canada
151,248 adults excluded from analysis:
• Age ≤18 (n=4398)
• Not eligible for OHIP during last year of life (n=5060)
• Not eligible for OHIP in 5 years prior to eligible date (n=12,768)
• Received ≥2 palliative care visits in 1 year prior to eligibility date that are ≤ 180 days apart (n=39,281)
• Cause of death was sudden death (n=28,524)
• Cause of death in not captured in the other categories (n=46,238)
• Cause of death unknown (n=9,897)
Total Cohort: (n=706,722)
Male: (n=352,065)
Female (n=354,657)