

Supplemental Online Content

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This supplemental material has been provided by the authors to give readers additional information about their work.

eTable 1. Data Sources

Database	Description
Ontario Cancer Registry (OCR)	The OCR is a passive, provincial registry all incident cancer diagnoses in Ontario. It includes 96% of cancer diagnoses in the province. Information included in the registry: cancer topography and morphology/histology, and details on diagnosis (e.g., types of contributing information to the diagnosis, dates).
Activity Level Report (ALR) of Cancer Care Ontario	Cancer Care Ontario maintains a database of cancers-specific services, including consultations, chemotherapy, and radiotherapy provided by regional cancer centers in the province. Because all radiotherapy is delivered at RCCs, it is a complete source of information. However, because not all cancer patients who receive surgery or chemotherapy visit an RCC, it cannot be used as a population data sources for those treatments.
Registered Patient Database (RPDB)	The RPDB is an ICES database derived from all administrative data sources and provides demographic data including age, patient residence, vital status, date of last contact with the healthcare system, and OHIP eligibility.
Ontario Registrar General (ORG)	The ORG contains gold standard vital status data for all Ontarians. According to the Vital Statistics Act, it is mandatory to register all deaths occurring in the province.
Ontario Marginalization Index (ONMarg)	The ON-MARG is a specialized database using Census data to profile relative area-level marginalization dependency, deprivation, ethnic concentration, and instability at various geographic levels in Ontario.
Ontario Health Insurance Plan (OHIP)	The OHIP database contains all physician billing data including information on diagnoses as well as services provided, such as receipt of surgery, chemotherapy, and radiotherapy.
Ontario Drug Benefit Database (ODB)	The ODB contains all information for prescription drug claims for individuals covered by the provincial plan (all individuals ≥ 65 years old), including type of medication, dose, date of prescription filling, and duration of treatment.
Canadian Institute of Health Information – Discharge Abstract Database and Same-Day Surgery (CIHI-DAD and SDS)	CIHI-DAD and SDS are mandatory reporting systems that provide information on hospital admissions and same-day surgeries, including diagnoses, procedures, and length of stay.

eTable 2. Cohort Identification Strategy

Cancer site	Sub-type	ICD.O-3 code
Breast		C50.0 to 50.9
Melanoma		C44.2 to C 44.9
Gastro-intestinal	Esophageal	C15.0 to C15.9
	Gastric	C16.0 to C16.9
	Hepato-pancreatico-biliary	Liver C22.0, C22.1 Biliary C23.9, C24.0, C24.1, C24.8, C24.9 Pancreas C25.0 to C25.9
	Colo-rectal and enteric	Small bowel C17.0 to C17.9 Colon C18.0 to C18.9 Rectum C19.9, C20.9
Genito-urinary (excluding penis, seminal vesicle, urethra)	Kidney and ureter	C64.9, C65.9, C66.9
	Bladder	C67.0 to C67.9
	Prostate	C61.9
	Adrenal	C74.0, C74.1, C74.9
Gynecologic (excluding vulva)		Vagina C52.9 Cervix C53.0, C53.1, C53.8, C53.9 Uterus C54.0, C54.1, C54.2, C54.3, C54.8, C54.9, C55.9 Ovaries C56.9, C57.0, C57.1, C57.2, C57.3, C57.4 Others C57.7, C57.8, C57.9
Broncho-pulmonary		C30.0 to 34.9, C38.1 to 39.9
Oro-pharyngeal		C00.0 to C14.8, C76.0

eTable 3. Covariate Definitions

Variable	Definition	Source	Type	Analysis format
Socio-demographic characteristics				
<i>Age</i>	Age at diagnosis	Ontario Cancer Registry (OCR)	Categorical	70-74 75-79 80-84 >85
			Continuous	years
<i>Sex</i>	Sex	OCR	Dichotomous	Male/Female
<i>Material deprivation</i>	Measure of the inability for individuals or households to afford goods or activities typical in a society at a given time [1]	Canadian Census Registered person database (RPDB) Ontario Marginalization index (ONMarg)	Categorical	1 st (lowest) 2 nd 3 rd 4 th 5 th (highest)
<i>Rural residence</i>	Determined with postal code of residence as per national census definition of a community <10,000 people [2]	RPDB	Dichotomous	Urban/Rural
Clinical characteristics				
<i>Time period of diagnosis</i>	Year of cancer diagnosis date	OCR	Categorical	2007-2011 2012-2017
<i>Comorbidity burden</i>	Measured using the Johns Hopkins Adjusted Clinical Groups system score based on health services use with a 24-month look-back window prior to the date of cancer diagnosis whereby the 32 aggregated diagnosis groups (ADG) are summed to create a total score [3,4]	CIHI-Discharge abstract database (DAD) CIHI – Same day surgery (SDS) Ontario Health Insurance Plan (OHIP)	Dichotomous	<10 ≥10
<i>Frailty score</i>	Measured using the Johns Hopkins Aggregates Clinical Diagnoses frailty marker [5]	CIHI-DAD CIHI-SDS NACRS	Dichotomous	Frailty No frailty
<i>Cancer type</i>	Type of primary cancer based on ICD-O.3 codes (Supplemental Table 2)	OCR	Categorical	Breast Skin Gastrointestinal Genitourinary Gynecologic Broncho-pulmonary Oropharyngeal
Therapy characteristics				
<i>Procedure intensity</i>	Intensity of the surgical procedure in terms of baseline risk, using a consensus validated definition [6]	CIHI-DAD CIHI-SDS	Dichotomous	Low High
<i>Perioperative cancer therapy</i>	Receipt of chemotherapy and/or radiation therapy ≤180 days prior to surgery to ≤180 days after surgery [7]	OHIP ALR	Dichotomous	Yes No

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2. Du Plessis V, Beshiri R, Bollman R. Definitions of "rural". *Rural Small Town Canada Anal Bull*. 2013;3:1-43
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4. Reid RJ, MacWilliam L, Verhulst L, Roos N, Atkinson M. Performance of the ACG case-mix system in two Canadian provinces. *Med Care*. 2001 Jan;39(1):86-99.
5. Sternberg SA, Wershof Schwartz A, Karunanathan S, Bergman H, Mark Clarfield A. The identification of frailty: a systematic literature review. *J Am Geriatr Soc*. 2011;59(11):2129-2138.
6. Schwarze ML, Barnato AE, Rathouz PJ, et al. Development of a list of high-risk operations for patients 65 years and older. *JAMA Surg*. 2015;150(4):325-331.
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eTable 4. Surgical Procedure Intensity

Low intensity		High intensity	
Partial and total mastectomy, with or without reconstruction	1YM87 ^{^^} , 1YM88 ^{^^} , , 1YM89 ^{^^} , 1YM90 ^{^^} ,1YM91 ^{^^} , 1YM92 ^{^^}	Lobectomy and pneumonectomy	1GR.87 ^{^^} , 1GR89 ^{^^} , 1GR91 ^{^^} , 1GT87 ^{^^} , 1GT89 ^{^^} , 1GT91 ^{^^}
Skin resection	1YF87 ^{^^} , 1YG87 ^{^^} , 1YS87 ^{^^} , 1YR87 ^{^^} , 1YT87 ^{^^} , 1YU87 ^{^^} , 1YV87 ^{^^} , 1YW87 ^{^^} , 1YZ87 ^{^^}	Major larynx – complete laryngectomy	
Adrenalectomy	1PB87 ^{^^} , 1PB89 ^{^^} laparoscopy	Gastrectomy	1NF87 ^{^^} , 1NF89 ^{^^} , 1NF90 ^{^^} , 1NF91 ^{^^} , 1NF92 ^{^^}
Gynecology	1RB87 ^{^^} , 1RB89 ^{^^} , 1RF87 ^{^^} , 1RF89 ^{^^} , 1RM87 ^{^^} , 1RM89 ^{^^} , 1RM91 ^{^^} , 1RN87 ^{^^} , 1RN89 ^{^^} , 1RN91 ^{^^} , 1RS87 ^{^^} , 1RS89 ^{^^}	Colectomy and enterectomy	1NK87 ^{^^} , 1NM87 ^{^^} , 1NM89 ^{^^} , 1NM91 ^{^^} , 1NQ87 ^{^^} , 1NQ89 ^{^^}
		Esophagectomy	1NA87 ^{^^} , 1NA88 ^{^^} , 1NA89 ^{^^} , 1NA90 ^{^^} , 1NA91 ^{^^} , 1NA92 ^{^^}
		Hepatectomy Pancreatectomy	1OA87 ^{^^} , 1OE87 ^{^^} , 1OE89 ^{^^} , 1OJ87 ^{^^} , 1OJ89 ^{^^} , 1OK87 ^{^^} , 1OK89 ^{^^} , 1OK91 ^{^^}
		Adrenalectomy	1PB87 ^{^^} , 1PB89 ^{^^} laparotomy
		Nephroureterectomy	1PC87 ^{^^} , 1PC89 ^{^^} , 1PC91 ^{^^} , 1PE87 ^{^^} , 1PE89 ^{^^} , 1PE91 ^{^^} , 1PG87 ^{^^} , 1PG89 ^{^^}
		Radical cystectomy	1PL87 ^{^^} , 1PM87 ^{^^} , 1PM89 ^{^^} , 1PM90 ^{^^} , 1PM91 ^{^^} , 1PM92 ^{^^} ,
		Prostatectomy	1QT87 ^{^^} , 1QT91 ^{^^}
		Pelvic evisceration	Included in other categories

Schwarze ML, Barnato AE, Rathouz PJ, et al. Development of a list of high-risk operations for patients 65 years and older. *JAMA Surg.* 2015;150(4):325-331.

eTable 5. Characteristics of Study Cohort by Cancer Type

Characteristic		Breast (n=22,811)	Bronchopulmonary (n=7429)	Gastrointestinal (n=32,036)	Genitourinary (n=8483)	Gynecologic (n=6658)	Oropharyngeal (867)	Melanoma (n=3758)
Age (years), median (IQR)		76 (73-81)	75 (72-79)	78 (74-83)	74 (71-78)	75 (72-80)	77 (73-82)	78 (73-83)
Age category (years)	70-74	8,994 (39.4%)	3,271 (44.0%)	9,837 (30.7%)	4,666 (55.0%)	2,883 (43.3%)	293 (33.8%)	1,166 (31.1%)
	75-79	6,196 (27.2%)	2,581 (34.7%)	9,215 (28.8%)	2,125 (25.1%)	1,988 (29.9%)	249 (28.7%)	1,085 (28.9%)
	80-84	4,466 (19.6%)	1,260 (17.0%)	7,599 (23.7%)	1,214 (14.3%)	1,133 (17.0%)	194 (22.4%)	842 (22.4%)
	≥85	3,155 (13.8%)	317 (4.3%)	5,385 (16.8%)	478 (5.6%)	654 (9.8%)	131 (15.1%)	660 (17.6%)
Sex	Female	22,530 (98.8%)	3,706 (49.9%)	15,273 (47.7%)	2,037 (24.0%)	6,656 (100.0%)	388 (44.8%)	1,529 (40.7%)
	Male	281 (1.2%)	3,723 (50.1%)	16,763 (52.3%)	6,446 (76.0%)	--	479 (55.2%)	2,224 (59.3%)
Residence	Rural	2,079 (9.1%)	837 (11.3%)	3,489 (10.9%)	895 (10.6%)	553 (8.3%)	≤5 (0.3%)	3,282 (87.5%)
	Urban	20,577 (90.2%)	6,530 (87.9%)	28,275 (88.3%)	7,510 (88.5%)	6,075 (91.2%)	88 (10.1%)	439 (11.7%)
	Missing	155 (0.7%)	62 (0.8%)	272 (0.8%)	78 (0.9%)	30 (0.5%)	776 (89.5%)	32 (0.9%)
Comorbidity burden	High (ADG≥10)	6,571 (28.8%)	3,035 (40.9%)	21,460 (67.0%)	2,856 (33.7%)	2,060 (30.9%)	291 (33.6%)	1,174 (31.3%)
	Low (ADG<10)	16,240 (71.2%)	4,394 (59.1%)	10,576 (33.0%)	5,627 (66.3%)	4,598 (69.1%)	576 (66.4%)	2,579 (68.7%)
Material deprivation quintile	1 st (highest)	4,227 (18.5%)	1,439 (19.4%)	6,028 (18.8%)	1,248 (14.7%)	1,153 (17.3%)	165 (19.0%)	524 (14.0%)
	2 nd	4,552 (20.0%)	1,622 (21.8%)	6,676 (20.8%)	1,557 (18.4%)	1,329 (20.0%)	173 (20.0%)	721 (19.2%)
	3 rd	4,415 (19.4%)	1,496 (20.1%)	6,457 (20.2%)	1,775 (20.9%)	1,303 (19.6%)	159 (18.3%)	704 (18.8%)
	4 th	4,616 (20.2%)	1,448 (19.5%)	6,458 (20.2%)	1,764 (20.8%)	1,393 (20.9%)	178 (20.5%)	842 (22.4%)
	5 th (lowest)	4,923 (21.6%)	1,397 (18.8%)	6,307 (19.7%)	2,068 (24.4%)	1,460 (21.9%)	192 (22.1%)	951 (25.3%)
	Missing	78 (0.3%)	27 (0.4%)	110 (0.3%)	71 (0.8%)	20 (0.3%)	0 (0.0%)	11 (0.3%)
Preoperative frailty	Yes	1,715 (7.5%)	527 (7.1%)	2,905 (9.1%)	475 (5.6%)	412 (6.2%)	80 (9.2%)	329 (8.8%)
	No	21,096 (92.5%)	6,902 (92.9%)	29,131 (90.9%)	8,008 (94.4%)	6,246 (93.8%)	787 (90.8%)	3,424 (91.2%)

Intensity of surgical procedure	High	66 (0.3%)	7,266 (97.8%)	185 (0.6%)	8,298 (97.8%)	508 (7.6%)	734 (84.7%)	89 (2.4%)
	Low	22,745 (99.7%)	163 (2.2%)	31,851 (99.4%)	185 (2.2%)	6,150 (92.4%)	133 (15.3%)	3,664 (97.6%)
Diagnosis year	2007-2011	9,504 (41.7%)	3,098 (41.7%)	15,193 (47.4%)	3,851 (45.4%)	2,789 (41.9%)	366 (42.2%)	1,543 (41.1%)
	2012-2017	13,307 (58.3%)	4,331 (58.3%)	16,843 (52.6%)	4,632 (54.6%)	3,869 (58.1%)	501 (57.8%)	2,210 (58.9%)
Perioperative therapy	Yes	12,965 (56.8%)	1,837 (24.7%)	25,128 (78.4%)	7,558 (89.1%)	3,392 (50.9%)	553 (63.8%)	331 (8.8%)
	No	9,846 (43.2%)	5,592 (75.3%)	6,908 (21.6%)	925 (10.9%)	3,266 (49.1%)	314 (36.2%)	3,422 (91.2%)

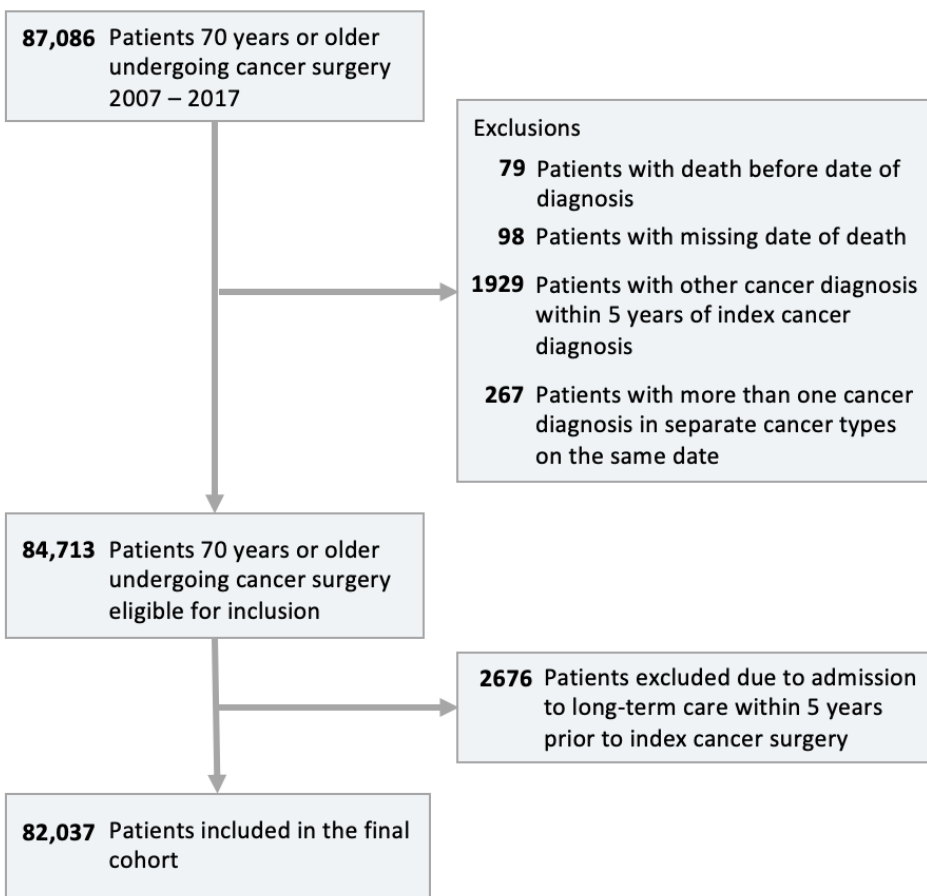
Abbreviations: ADG, aggregated diagnosis groups | IQR, interquartile range | n, number
 Values are n (%) representing column percentages, unless otherwise indicated.

eTable 6. Cumulative Incidence at 1-year, 3-year, and 5-year Timepoints

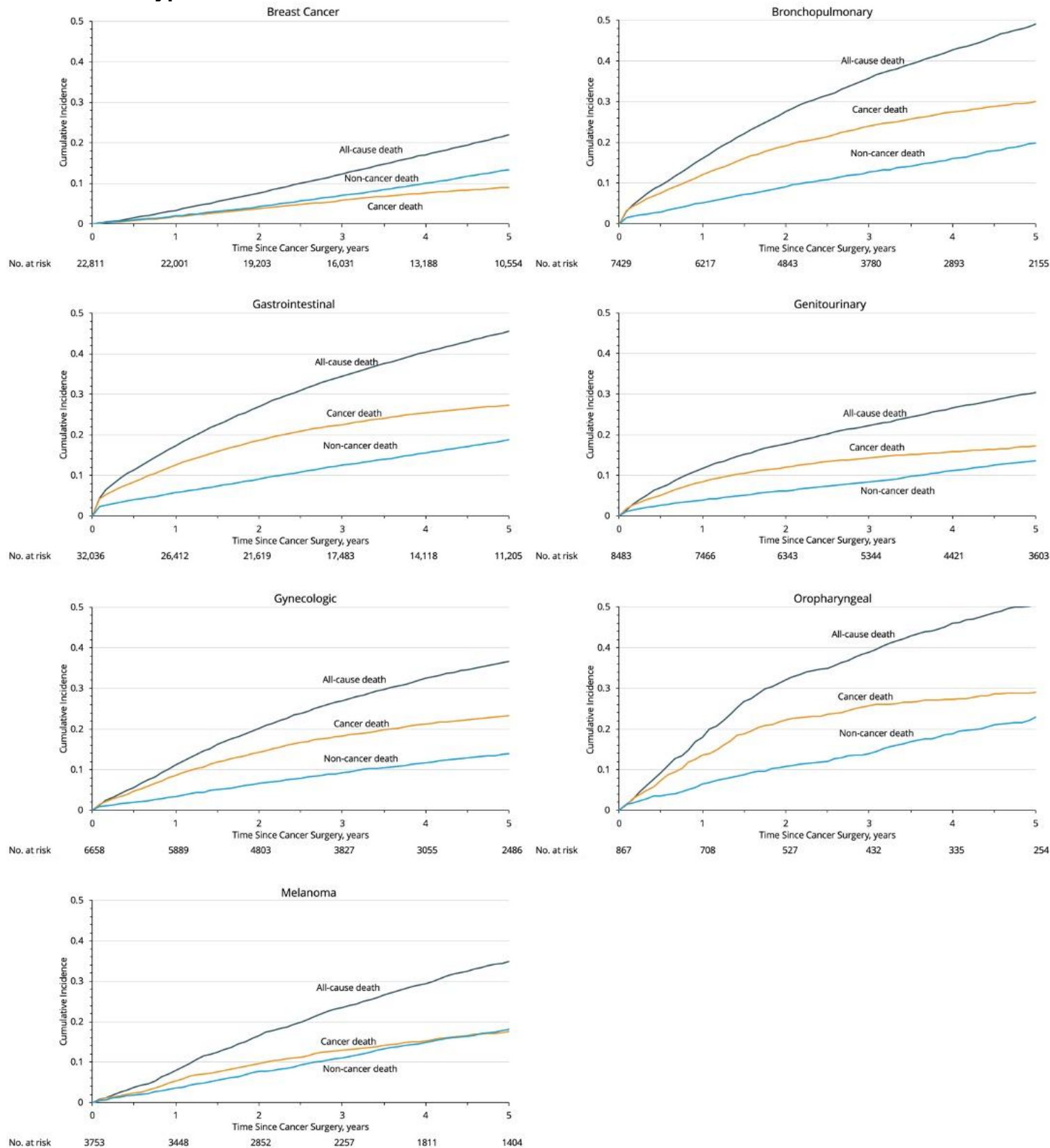
Group	Cancer Death			Non-cancer Death			All-cause Death		
	Cumulative incidence (95% CI)			Cumulative incidence (95% CI)			Cumulative incidence (95% CI)		
	1-year	3-year	5-year	1-year	3-year	5-year	1-year	3-year	5-year
All patients (n=82,037)	8.4% (8.2-8.6%)	16.4% (16.2-16.7%)	20.7% (20.4-21.0%)	5.3% (5.1-5.5%)	11.9% (11.6-12.2%)	18.1% (17.8-18.5%)	11.8% (11.6-12.0%)	26.1% (25.8-26.4%)	36.6% (36.3-37.0%)
Cancer Type									
Breast (n=22,811)	1.8% (1.6-1.9%)	5.8% (5.5-6.1%)	9.1% (8.6-9.5%)	1.9% (1.8-2.1%)	7.0% (6.7-7.4%)	13.4% (12.9-13.9%)	3.3% (3.1-3.6%)	12.3% (11.9-12.8%)	22.0% (21.4-22.6%)
Broncho-pulmonary (n=7429)	12.0% (11.3-12.7%)	24.0% (23.0-25.0%)	30.0% (28.9-31.1%)	5.1% (4.6-5.6%)	12.7% (12.0-13.5%)	19.9% (18.9-20.9%)	16.1% (15.3-16.9%)	35.8% (34.7-36.9%)	49.1% (47.8-50.3%)
Gastro-intestinal (n=32,036)	12.5% (12.2-12.9%)	22.6% (22.1-23.0%)	27.3% (26.8-27.9%)	5.7% (5.5-6.0%)	12.5% (12.1-12.9%)	18.8% (18.3-19.2%)	17.3% (16.9-17.7%)	34.5% (34.0-35.0%)	45.6% (45.0-46.2%)
Genito-urinary (n=8483)	8.5% (7.9-9.1%)	14.3% (13.5-15.0%)	17.2% (16.4-18.1%)	3.9% (3.5-4.4%)	8.4% (7.8-9.0%)	13.7% (12.9-14.5%)	11.7% (11.0-12.4%)	22.3% (21.4-23.2%)	30.4% (29.4-31.5%)
Gynecologic (n=6658)	8.6% (7.9-9.3%)	18.3% (17.3-19.2%)	23.3% (22.2-24.4%)	3.5% (3.0-3.9%)	9.3% (8.6-10.0%)	13.9% (13.0-14.9%)	11.2% (10.5-12.0%)	26.9% (25.8-28.0%)	36.7% (35.4-38.0%)
Oro-pharyngeal (867)	13.5% (11.3-15.9%)	25.7% (22.8-28.7%)	29.1% (25.9-32.3%)	6.5% (5.0-8.2%)	13.9% (11.7-16.4%)	22.9% (19.9-26.0%)	18.0% (15.6-20.7%)	39.0% (35.7-42.4%)	50.8% (47.2-54.4%)
Melanoma (n=3758)	5.2% (4.5-6.0%)	12.9% (11.9-14.1%)	17.5% (16.2-18.8%)	3.5% (2.9-4.1%)	11.1% (10.1-12.1%)	18.1% (16.8-19.5%)	8.0% (7.1-8.9%)	23.5% (22.1-24.9%)	34.9% (33.2-36.7%)
Age Group									
Age 70-74 (n=31,110)	5.8% (5.5-6.1%)	12.4% (12.0-12.8%)	16.4% (15.9-16.8%)	2.6% (2.4-2.8%)	6.6% (6.3-6.9%)	10.4% (10.0-10.8%)	7.9% (7.6-8.2%)	18.5% (18.0-18.9%)	26.4% (25.8-26.9%)
Age 75-79 (n=23,439)	8.4% (8.0-8.7%)	17.0% (16.5-17.5%)	21.4% (20.8-22.0%)	3.7% (3.5-4.0%)	9.3% (8.9-9.7%)	14.7% (14.2-15.2%)	11.3% (10.9-11.8%)	25.8% (25.2-26.4%)	35.6% (35.0-36.3%)
Age 80-85 (n=16,708)	10.4% (10.0-10.9%)	19.5% (18.9-20.1%)	24.1% (23.4-24.8%)	5.1% (4.8-5.5%)	12.6% (12.1-13.1%)	20.4% (19.8-21.1%)	14.6% (14.1-15.2%)	31.4% (30.7-32.1%)	43.8% (43.0-44.7%)

Age 85 or more (n=10,780)	13.0% (12.4-13.7%)	22.0% (21.2-22.8%)	26.4% (25.5-27.3%)	8.1% (7.6-8.6%)	19.5% (18.7-20.3%)	31.5% (30.5-32.5%)	19.8% (19.1-20.6%)	40.6% (39.7-41.6%)	57.0% (56.0-58.1%)
Frailty Status									
Frailty (n=6,443)	13.3% (12.5-14.1%)	21.6% (20.5-22.6%)	25.6% (24.5-26.8%)	9.3% (8.6-10.0%)	20.8% (19.7-21.8%)	31.7% (30.4-32.9%)	21.4% (20.4-22.4%)	41.5% (40.3-42.8%)	56.6% (55.2-58.0%)
No Frailty (n=75,594)	8.0% (7.8-8.2%)	16.0% (15.7-16.3%)	20.3% (20.0-20.6%)	3.7% (3.6-3.9%)	9.4% (9.2-9.6%)	15.2% (14.9-15.5%)	11.0% (10.8-11.2%)	24.8% (24.5-25.1%)	34.9% (34.6-35.3%)

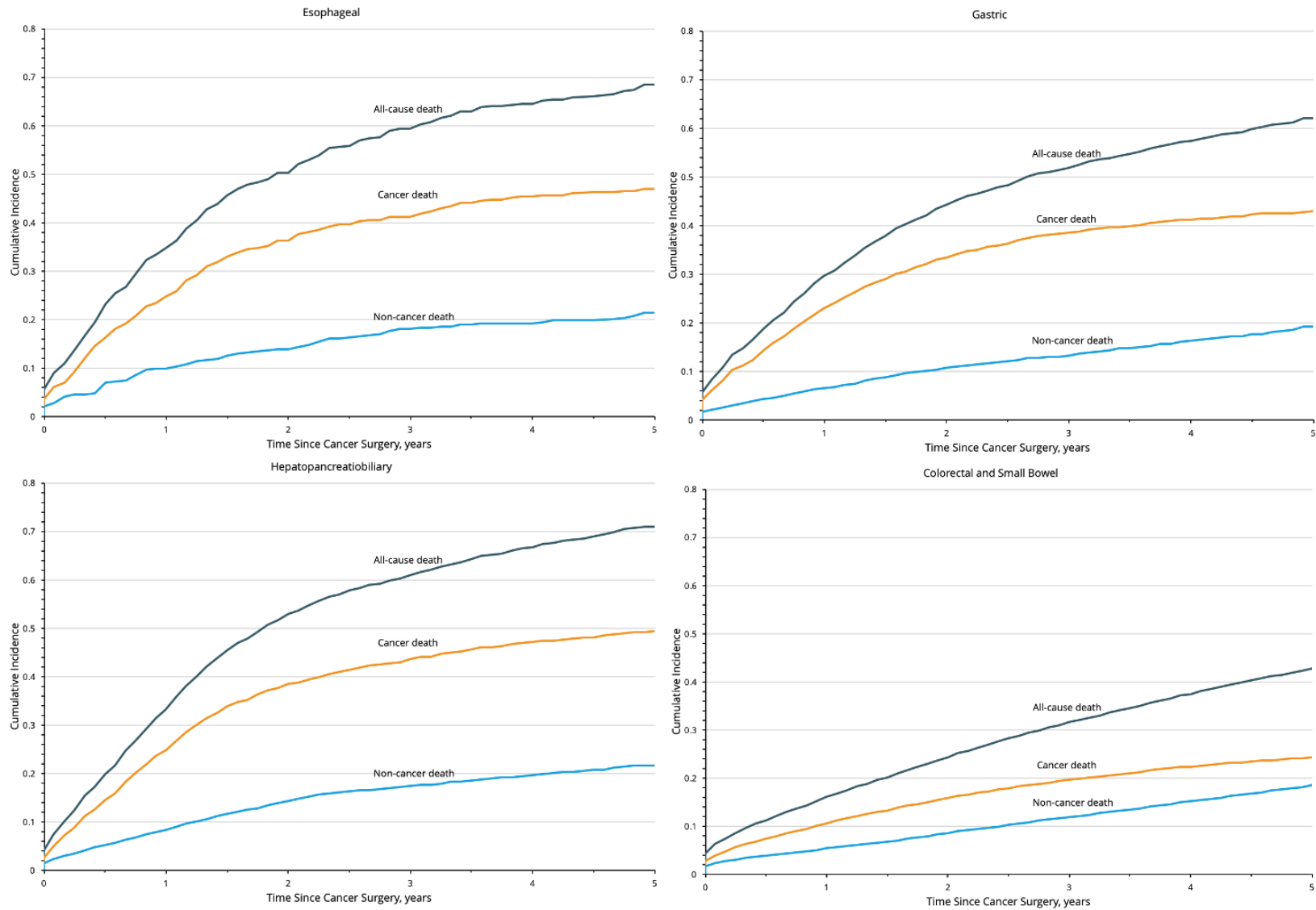
Abbreviations: CI, confidence interval

eFigure 1. Cohort Selection Flowchart

eFigure 2. Cumulative Incidence of Cancer, Non-Cancer, and All-Cause Death by Cancer Type



eFigure 3. Cumulative Incidence of Cancer, Non-Cancer, and All-Cause Death Stratified by Gastrointestinal Cancer Subtypes



eFigure 4. Cumulative Incidence of Cancer, Non-Cancer, and All-Cause Death Stratified by Genitourinary Cancer Subtypes

