Cancer Survival in Ontario, 1986-2003

Evidence of Equitable Advances Across Most Diverse Urban and Rural Places

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ABSTRACT

Objectives: This study examined whether place and socio-economic status had differential effects on the survival of women diagnosed with breast cancer in Ontario during the 1980s and the 1990s.

Methods: The Ontario Cancer Registry provided 29,934 primary malignant breast cancer cases. Successive historical cohorts (1986-1988 and 1995-1997) were, respectively, followed until 1994 and 2003. Diverse places were compared: the greater metropolitan Toronto area, other cities, ranging in size from 50,000 to a million people, smaller towns and villages, and rural and remote areas. Socio-economic data for each woman's residence at the time of diagnosis were taken from population censuses.

Results: Very small cities (6%) with populations between 50,000 and 100,000 were the only places where breast cancer survival had advanced less compared to the province as a whole. Income gradients began to appear, however, in larger cities. Urban residents in the lowest income areas were significantly disadvantaged compared to the highest income areas during the 1990s, but not during the 1980s.

Conclusion: This historical analysis of breast cancer survival evidenced remarkably equitable advances across nearly all of Ontario's diverse places. The most likely explanation for such substantial equity seems to be Canada's universally accessible, single-payer, health care system.

Key words: Breast cancer; survival; socioeconomic factors; cancer care; universal access; Ontario; health insurance

La traduction du résumé se trouve à la fin de l'article.

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Health care cost increases have outpaced other social costs in Canada over the past generation. While conservative advocates have focused on controlling costs, liberals have tended to focus on benefits, reminding us that a basic tenet of the Canada Health Act – equitable health care access – ought to be maintained. Notwithstanding the importance of interests on both sides of this political debate, it is hoped that science would precede advocacy. Indeed, the observation of health care outcomes across times and places can provide empirical sentinels for informing policy decisions. Breast cancer survival is one such sentinel outcome. The most common type of cancer among Canadian women,[1] its prognosis is excellent with access to early diagnosis and best treatments. Consequently, breast cancer survival seems a good indicator of a health care system's performance. This study will describe breast cancer survival advances across diverse places in a Canadian province over the past generation.

Studies of survival among women with breast cancer in the1980s observed equity in the greater metropolitan Toronto (GMT) area.[2-5] Studies that extended analyses to the early 1990s observed modest income-breast cancer survival gradients, indicative of lower survival in lower-income areas across the province of Ontario.[6,7] Because such province-wide studies possibly confounded place and income, one cannot tell to which specific places their observed income-survival gradients generalize. A recent study of 1989 to 1993 incident breast cancer in GMT, however, suggested that income-survival gradients had begun to appear there.[8]

Little is known about more recent income-breast cancer survival gradients in Ontario or in any specific places outside of GMT. This study aims to advance such understandings. It will examine the effects of place, income and year of diagnosis on breast cancer survival.

METHODS

All 29,934 primary invasive breast cancers (ICD-9 174) diagnosed among women 25 or older in Ontario between 1986-1988 and 1995-1997 were selected. Their source was the Ontario Cancer Registry (OCR), estimated to ascertain 98% of such cases.[9-11]

The 1980s incidence cohort was followed until January of 1994 and the 1990s cohort until January of 2003.

Statistics Canada and Health Canada definitions were used to construct face-valid places: city of Toronto (population of nearly 2.5 million), remainder of GMT (total population of nearly 5 million), large cities (500,000 to 1 million), mid-sized cities (250,000 to 499,999), small cities (100,000 to 249,999), very small cities (50,000 to 99,999), towns and villages (10,000 to 49,999), rural (less than 10,000 and less than 400 people per km^2), remote (100 to 199 km from the nearest of 10 cancer treatment centres), very remote (200 to 299 km) and extremely remote (300 km or more).[12-14] The distance between each patient's residence and the nearest cancer treatment centre was calculated with an ArcGIS Euclidean algorithm.[15] Toronto served as the baseline for comparisons.

Breast cancer cases – 1980s and 1990s cohorts – were joined to socio-economic data collected by the 1986 and 1996 population censuses.[16,17] Linkages were based on each person's residential postal code at the time of their diagnosis (96% linkage rate).[18] Census tract (CT, typical population 4,000) median annual household income, available for three quarters of the cases (urban and immediately exurban, 77%), was the preferred income definition. The construct and predictive validities of CT-based socio-economic measures have been established in the US and the better predictive validity of CT median household income versus CT low-income prevalence in Ontario has been suggested.[8,19,20] When CTs were unavailable, census subdivisions (CSD, 23%, typical population 1,500) were used. This ecological measure was then used to construct relatively low- to high-income areas; fifths, thirds or halves, depending on sample requirements. When possible, samples were designed (minimum 350 per group) to detect small 5-year survival changes (70% [baseline] to 80% [to detect]): power = .85 and α = .05).[21]

Maximum likelihood logistic regression models were used to estimate the associations of place, income area and cohort with 5-year survival adjusted for age.[22] Hazards models were not used because neither cohort nor age met the proportionality assumption.[23] All-cause survival was the outcome of interest for a number of reasons. This study is concerned with overall cancer burden. Cancer-specific survival rates may underestimate mortality because the underlying causes of many "non-cancer" deaths can be associated with cancer treatment (or non-treatment).[24] Eight of 10 of the dead study participants died as a direct result of their cancer, and though length of survival is highly accurate in the OCR, the underlying cause of death is not.[9]

Ontario's health care challenges (waiting lists, investigative and treatment equipment or physician supply shortages) could be distributed differently across its diverse places. This historical cohort analysis aims to provide place-specific clues about such potential challenges by describing how the effect of time (survival advances) differed between places and income areas in Ontario during the mid-1980s to 2003. Previous studies suggested that the effect of income increased more in GMT than elsewhere. This interaction hypothesis (cohort effect moderated by place [GMT/elsewhere] and income) will be tested while others will be explored across other relatively homogeneous places: mid-sized to large cities, very small to small cities, towns and villages, and rural and remote places.

RESULTS

The main effects of place and income within cohorts as well as the moderation of cohort effects across place and income strata are displayed in the top half of Table I. Though statistically significant moderations of cohort effects were observed, in a practical-policy sense nearly all places and income areas enjoyed rather large breast cancer survival advances between 1986 and 2003. Only 4 of 16 places or income areas differed significantly from the overall cohort effect (OR = 1.56, 95% CI 1.48-1.65 [not shown in table]), two doing better (extremely remote, and highest-income areas) and two worse (very small cities and second-lowest income area).

Within the 1980s cohort, the odds of breast cancer survival were slightly lower in other large Ontario cities compared to Toronto – an 11% differential that approached statistical significance in the 1990s (OR = 0.89, 95% CI 0.78-1.02). Survival in towns, villages, rural and remote areas was 15% to 20% lower, a statistically and practically significant difference that was maintained across cohorts. Across the province, in the 1980s there seemed to have been no effect of income for the vast majority of women with breast cancer. Only those living in the lowest fifth of income areas differed slightly from those in the highest fifth (OR = 0.88, 95% CI 0.78-1.00), but this gradient seemed to become steeper and more pervasive over time. In the 1990s, all other income quintiles differed significantly from the highest one, and the size of the lowest-highest difference had increased (OR = 0.74, 95% CI 0.66-0.84).

The bottom half of Table I provides support for this study's hypothesized cohort effect moderation by place and income. The increased significance of income was observed in GMT as well as in other urban places, but not in rural and remote places. No income-survival gradient was observed in GMT during the 1980s, but a significant one had appeared in the 1990s so that breast cancer survival advances were significantly greater in the highest fifth of GMT's income areas (OR = 1.74, 95% CI 1.48-2.03) compared to the lowest (OR = 1.36, 95% CI 1.05-1.75). This pattern was similar in mid-sized to large cities, but not elsewhere. It should be noted, however, that even in the lowest-income fifths of GMT and other mid-sized to large cities, the odds of surviving for 5 years increased substantially (36% to 47%).

DISCUSSION

Very small cities were the only places where breast cancer survival had advanced less compared to the province as a whole. There was also a persistent effect of living in smaller places such as towns and villages, and rural and remote areas that were less than 100 km from urban centres. Their breast cancer survival rates were slightly less than Toronto's during the 1980s and 1990s. Also, income-survival gradients had begun to appear in larger cities with populations of 250,000 or more. Residents in the lowest fifth of income areas of such cities were significantly disadvantaged relative to residents of

TABLE I

Effects of Place, Income Area and Cohort on Breast Cancer 5-Year Survival in Ontario: Women Diagnosed Between 1986 and 1988, and 1995 and 1997 Were Respectively Followed Until January 1, 1994 and 2003

	1980s 5-Year Survival Cohort			1990s 5-Year Survival Cohort			1980s to 1990s Survival Advancement	
	n	OR*	95% CI	n	OR*	95% CI	OR	95% CI
Places	Main Effect of Place Within Respective Cohorts						Cohort Effect Moderated by Place‡	
City of Toronto	3269	1.00		3987	1.00		1.54	1.38, 1.72
Other GMT	1827	0.91	0.80, 1.03	3103	0.96	0.85, 1.08	1.67	1.46, 1.92
Large cities	1549	0.87	0.76, 0.99	2111	0.89	0.78, 1.02†	1.60	1.37, 1.87
Mid-sized cities	1485	0.84	0.74, 0.97	2277	0.92	0.81, 1.05	1.68	1.44, 1.95
Small cities	903	0.95	0.81, 1.13	1364	0.93	0.80, 1.09	1.51	1.24, 1.84
Very small cities	717	1.12	0.93, 1.35	998	0.94	0.79, 1.12	1.29	1.03, 1.62§
Towns and villages	808	0.79	0.66, 0.93	1846	0.86	0.75, 0.99	1.67	1.39, 2.01
Rural	931	0.86	0.73, 1.01†	954	0.80	0.68, 0.96	1.44	1.17, 1.78
Remote	422	0.88	0.70, 1.10	910	0.84	0.70, 1.00	1.47	1.13, 1.91
Very remote	111	1.19	0.76, 1.86	152	0.99	0.66, 1.49	1.37	0.75, 2.49
Extremely remote	83	0.70	0.44, 1.11	127	1.48	0.89, 2.45	3.28	1.66, 6.47§
Income Areas	Main Effect of Income Within Respective Cohorts						Cohort Effect Moderated by Income‡	
Highest	2403	1.00		3560	1.00		1.76	1.55, 2.02§
	2439	0.97	0.85, 1.10	3569	0.89	0.78, 1.00	1.60	1.42, 1.81
Middle	2417	0.94	0.83, 1.07	3563	0.85	0.75, 0.96	1.56	1.38, 1.76
	2418	0.97	0.85, 1.10	3539	0.75	0.67, 0.85	1.38	1.23, 1.56§
Lowest	2428	0.88	0.78, 1.00	3598	0.74	0.66, 0.84	1.46	1.30, 1.64
Income Areas Within Similar Aggregated Places	Main Effect of Income Within Places and Respective Cohorts						Cohort Effect Moderated by Place and Income‡	
Greater Metropolitan Toronto								
Highest	1684	1.00		2289	1.00		1.74	1.48, 2.03‖
	1226	0.98	0.83, 1.15	1612	1.00	0.85, 1.18	1.68	1.40, 2.02‖
Middle	918	1.08	0.90, 1.30	1202	0.87	0.73, 1.04	1.43	1.17, 1.76
	884	0.93	0.78, 1.12	1051	0.84	0.70, 1.01†	1.46	1.20, 1.78
Lowest	384	0.96	0.75, 1.23	936	0.79	0.65, 0.95	1.36	1.05, 1.75¶
Mid-sized to Large Cities								
Highest	576	1.00		954	1.00		1.75	1.32, 2.32‖
	483	0.97	0.74, 1.27	924	0.78	0.62, 0.99	1.57	1.23, 2.00
Middle	661	0.80	0.63, 1.03†	760	0.72	0.56, 0.92	1.65	1.30, 2.10
	577	0.97	0.74, 1.25	811	0.77	0.61, 0.98	1.55	1.21, 1.97
Lowest	737	0.82	0.64, 1.04†	939	0.65	0.51, 0.81	1.47	1.18, 1.83¶
Very Small to Small Cities								
High	375	1.00		649	1.00		2.02	1.41, 2.90
	563	1.05	0.78, 1.42	858	0.85	0.65, 1.11	1.38	1.08, 1.76
Low	682	1.09	0.82, 1.47	855	0.71	0.54, 0.93	1.18	0.93, 1.49
Towns and Villages								
High-Middle	362	1.00		938	1.00		1.87	1.41, 2.48
Low	446	1.03	0.77, 1.39	908	0.79	0.63, 0.98	1.47	1.15, 1.89
Rural and Remote Places								
High-Middle	563	1.00		949	1.00		1.55	1.22, 1.97
Low	790	1.20	0.94, 1.52	915	1.10	0.89, 1.37	1.43	1.15, 1.77
Very to Extremely Remote Places								
High-Middle	102	1.00		218	1.00		1.73	0.92, 3.27†
Low	92	0.87	0.46, 1.66	61	1.05	0.50, 2.21	2.01	0.81, 4.98

Notes. n = number of incident cancer cases, OR = odds ratio, CI = confidence interval, GMT = greater metropolitan Toronto. Main and interaction effects of place, income and cohort were estimated from logistic regression models (ORs and 95% CIs estimated from regression statistics). All effects were age-adjusted in logistic regression models that treated non-linear age (lower survival among the youngest and oldest) as a categorical variable: 25-44 (reference category), 45-54, 55-64, 65-74, 75 years of age and older.

* An odds ratio of 1.00 is the baseline.

† 90% confidence interval does not include the null ($p<0.10$).

‡ Statistically significant 2-way (cohort effect moderated by place or income) and 3-way interactions (cohort effect moderated by place and income); $p<0.05$.

§ Cohort effect significantly different from the rest of the province ($p<0.05$).

‖¶ Within-place cohort effects with different superscripts were significantly different from each other ($p<0.05$).

the highest fifth during the 1990s, but not during the 1980s. However, this developing income-survival gradient seems modest in comparison to that in the US.[25,26] Even in the lowest fifth of income areas of metropolitan areas in Ontario, breast cancer survival had advanced significantly. In fact, such advancement was similar to that of white women in the highest fifth of income areas in metropolitan Detroit, Michigan (Gorey and colleagues, unpublished data). This study's breast cancer survival outcomes in Ontario were consistent with systematically reviewed Canada-US studies that accounted for socio-economic factors, all of which favoured Canada.[27,28] Thus, there seems to be a compelling caution against the call to borrow health care policies from America.

Favourable outcomes in two places – GMT during the 1980s and extremely remote places in the 1990s – provide hope that health care challenges in Canada can be met. They record the histories of high-quality cancer care in distinctly different places in Ontario. The complete absence of a social gradient in such a diverse megalopolis as Toronto is almost certainly matchless in worldwide public health annals. And the finding of outcome equity in extremely remote areas stands in stark contrast to the large disadvantages of such places in the US.[29] During the 1990s, the

Ontario Breast Cancer Screening program and regional cancer centres instituted outreach in numerous remote sites.[30] Such apparently effective programs, in areas where there are not large profits to be made, demonstrate that a largely publicly funded health care system is capable of expeditious action to effectively meet identified challenges – probably more so than would be more privately funded systems of care.

This study's finding of substantially equitable breast cancer survival advances in Ontario is consistent with research that found little evidence of socio-economic gradients on cancer screening, stage or treatments in Ontario.[31-37] Even delays to cancer care seem not to be significantly associated with socio-economic factors.[38-42] This study was also consistent with an Ontario study of breast cancer screening that observed a socio-economic gradient in urban, but not rural places.[32] Perhaps a cancer prevention knowledge divide has begun to develop in Canada's increasingly diverse large cities. The challenges may be very different in smaller cities and still further different in rural areas. Such are questions for future research.

Research is also needed to advance understandings of ecological measures of SES in Canada. One issue that needs to be addressed is the possible effect of their size.[43-45] Focusing on CSDs and CTs, this study constructed fairly homogeneous SES measures in terms of their populations (typically ranged from 1,500 to 4,000). However, in terms of their areas, such measures ranged widely across the province, from less than 1 km^2 to more than 1,000 km^2. And they differed between urban and rural areas where typical measures were, respectively, 1.5 km^2 and 30 km^2. Though their original conceptual definitions were based on income status, their ultimate construct definitions could be very different.[46] Perhaps the smaller measures in urban areas are better compositional proxies of personal SES, whereas larger measures in rural areas are better contextual proxies of health care service endowments. Finally, this study was limited by its inability to accomplish stage-specific analyses (OCR did not include breast cancer stage during this study's time frame). Though previous studies have suggested the probable impotence of lead-time bias,[47,48] staged analyses would not only allow it to be confidently ruled out, but would also advance understanding about the relative weight of pre- (primary care, screening) and post-diagnostic treatment factors in Canadian cancer care.

CONCLUSIONS

The vast majority of women with breast cancer in Ontario during the 1980 and 1990s enjoyed equitable access to the significant advances in breast cancer care that were a hallmark of that era. The most likely explanation for such substantial outcome equity seems to be Canada's single-payer health care system. This study also serves as a sentinel, warning that equitable access to health care in Canada may have recently begun to erode.

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RÉSUMÉ

Objectifs : Déterminer si le lieu et le statut socioéconomique ont eu des effets différents sur la survie des femmes ayant reçu un diagnostic de cancer du sein en Ontario pendant les années 1980 et 1990.

Méthode : Le Registre d'inscription des cas de cancer de l'Ontario a fourni 29 934 cas de cancers malins primaires du sein. Des cohortes historiques successives (1986-1988 et 1995-1997) ont été suivies, respectivement, jusqu'en 1994 et jusqu'en 2003. Divers lieux ont été comparés : la grande agglomération de Toronto, d'autres villes comptant de 50 000 à 1 million d'habitants, de petites villes et de villages, et des régions rurales et éloignées. Les données socioéconomiques sur le lieu de résidence de chaque femme au moment de son diagnostic ont été extraites des recensements.

Résultats : Les toutes petites villes comptant entre 50 000 et 100 000 habitants (6 % de l'échantillon) étaient les seuls lieux où les taux de survie au cancer du sein avaient moins progressé que dans l'ensemble de la province. Des gradients selon le revenu commençaient cependant à se dessiner dans les villes plus grandes. En milieu urbain, les résidentes des zones aux revenus les plus faibles étaient significativement défavorisées par rapport à celles des zones aux revenus les plus élevés au cours des années 1990, mais ce n'était pas le cas pendant les années 1980.

Conclusion : Cette analyse historique des taux de survie au cancer du sein a mis au jour une progression remarquablement équitable dans presque tous les lieux de l'Ontario. Cette équité s'explique probablement par la présence au Canada d'un régime de santé universel à payeur unique.

Mots clés : cancer du sein; survie; facteurs socioéconomiques; soins du cancer; accès universel; Ontario; assurance-maladie