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## **Income and Long-Term Breast Cancer Survival: Comparisons of Vulnerable Urban Places in Ontario and California**

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### **Abstract**

Effects of socioeconomic status on the long-term survival of 808 women with node-negative breast cancer in Canada and the United States were observed. Ontario and California samples diagnosed between 1988 and 1990 were followed until 2006. Socioeconomic data were taken from population censuses. Compared with their California counterparts, residents of low-income urban areas in Ontario experienced a significant 15-year survival advantage (RR = 1.66 [95% CI: 1.00, 2.76]). In these and other vulnerable, lower-middle- to working-class neighborhoods, significantly more Ontario residents gained access to adjuvant radiation therapy (RR = 1.75 [1.21, 2.53]) which seemed associated with better long-term survival (RR = 1.36 [0.99, 1.86]). This stage-adjusted, historical cohort analysis suggests much greater cancer care equity in Canada than in the United States.

### **Keywords**

adjuvant treatment; California; Canada; health insurance; long-term survival; node-negative breast cancer; Ontario; radiation therapy; socioeconomic factors; United States

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Studies of breast cancer survival in diverse Canadian and United States metropolitan areas have tested a health insurance hypothesis and consistently found advantaged survival among Canadians in vulnerable low-income neighborhoods (1–4). None of those studies accounted for stage of disease at diagnosis. This one did. Recent staged analyses observed Canadian advantages in low-income Ontario places versus similar California places on 5-year node-positive breast cancer survival (5). Such Canadian women gained greater access to adjuvant chemo- and radio-therapies (6). Long-term investigations in this field are rare (7), and no previous international comparative study followed patients for more than 5 years. This Ontario-California cohort did. Consistent with a health insurance theory, we hypothesized that significantly more low-income Canadian women with node-negative breast cancer would enjoy long-term survival.

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## METHODS

A historical cohort of 1,802 women diagnosed between 1988 and 1990 with nonmetastasized, invasive breast cancer in Ontario and California were randomly selected. No significant difference on long-term survival was observed for node-positive disease or for node-negative disease in rural places. So, this study explored its node-negative-specific hypothesis in urban places. Ontario and California cancer registries, respectively, selected 366 and 442 node-negative cases from large (Toronto and San Francisco) and small cities (Windsor and Modesto) (8–10). Census tract-based socioeconomic status measures (“low-income” in Canada and US “poverty”) have defined income deciles (11,12). They aggregated similar low-income areas in both countries. The lowest income deciles were defined in US dollars as follows: Ontario—median low-income household prevalence (34.6%, \$20,260) and California—poor (28.7%, \$19,190) (13). Socioeconomically vulnerable areas (5th, 7th, and 10th lowest deciles) that demonstrated the poorest US survival were aggregated and defined as follows: Ontario (16.0%, \$33,250) and California (10.0%, \$30,060). They were similar to previously studied decile areas in Hawaii that were more predominantly represented not only by the poor but also by the near poor (up to 200% of the federal poverty criterion) (2,12). Disease stage and treatments were reliably abstracted from patient charts (average  $\kappa$  coefficient 0.95) (14–16). Cohorts followed until 2006 were able to detect 20% survival differences ( $\alpha = 0.05$  and  $1 - \beta = \text{Power} = 0.80$ ) (17). All-cause (15-year) survival was used because, although survival is highly accurate in these registries, the underlying cause of death is not (8). Survival rate ratios (RR) were age-adjusted and confidence intervals (95% CI) were based on the Mantel–Haenszel chi-squared test (18,19). Methodological details have been reported (5).

## RESULTS

Long-term node-negative breast cancer survival was not associated with income in Ontario, but it was in California. As hypothesized for the lowest income places, significantly advantaged Canadian survival was observed (RR = 1.66), and Canadian women in vulnerable areas were similarly advantaged (RR = 1.35 [95% CI: 1.01, 1.81], not shown in Table 1). These findings did not differ by place size. Analyses among vulnerable samples found that women in such Ontario areas were more likely to have received a lumpectomy than were their counterparts in California (RR = 1.86 [1.37, 2.52]), but the lumpectomy-mastectomy difference was not itself associated with long-term survival. Potentially vulnerable women in Ontario were also more likely to have received adjuvant radiation therapy (age-adjusted rates of 0.427 versus 0.244, RR = 1.75 [1.21, 2.53]) which did seem associated with better long-term survival (RR = 1.36 [0.99, 1.86]). There were no significant between-country difference on tumor size, receipt of adjuvant chemotherapy or on wait-times for initial surgical or adjuvant treatments.

## DISCUSSION

This study found that residents of vulnerable low-income urban areas in Ontario with node-negative breast cancer were significantly advantaged on 15-year survival as compared with similar women in California. Such neighborhoods are more predominantly represented, not only by the poor, but also by the near poor or cyclically poor in middle- to working-class neighborhoods, who are more likely to be inadequately insured in the US (2,12,20). In an era of breast cancer treatment innovations, this study observed that relatively poor women in Ontario gained access to them (lumpectomy and adjuvant radiation therapy) more readily than their counterparts in California, and such access, particularly to adjuvant radiotherapy seemed to matter in terms of their long-term survival chances. These findings are consistent

with well known socioeconomic (health insurance)-breast cancer care gradients in the US and nonassociations in Canada (Ontario) (5,21–27).

One might wonder if it could be race/ethnicity, rather than SES that accounts for the observed survival differences. We could not statistically adjust for this factor as the OCR does not code race/ethnicity. We were able, however, to replicate key findings with the following conservative comparison: non-Hispanic white women in California versus the entire diverse sample of women in Ontario. After excluding all racial or ethnic minority group members from the California sample (18 African-American, 33 Hispanic, 19 Asian American and 2 women of other racial/ethnic backgrounds) key socioeconomic gradients were maintained. For example, the 15-year survival gradient seemed as steep or possibly even steeper within California (lowest versus highest income areas RR = 0.48 95% CI: 0.27, 0.84). Furthermore, the Canadian survival advantage seemed also to have been maintained in the lowest income areas (Ontario versus California lowest income areas RR = 1.84 [90% CI: 1.10, 3.09]). Therefore, we think that race, per se, or race the biologic, rather than the social construction, is probably not a potent alternative explanation for this study's pattern of findings. This study might also be limited by its focus on all-cause, rather than cancer-specific or disease-free survival. For the following reasons we think not. The underlying cause of "noncancer" deaths can often be directly associated with nontreatment or even with cancer treatment complications (28). And although length of survival is highly accurate in these cancer registries, the underlying cause of death is not (8). Probably of most importance, exploratory analyses, limited to women under the age of 50 (nearly all deaths due to cancer), replicated key findings. Although this study was able to account for a number of important factors (age, income, place, and disease stage at diagnosis), it could not account for notable others such as comorbid conditions and body mass index. Previous studies, however, have suggested that their socioeconomic distributions are probably quite similar in the two, culturally similar, developed nations under study, Canada and the United States (2,4,29–31). Therefore, we think that such factors probably did not potentially confound this study's findings.

## CONCLUSION

More inclusive health insurance coverage in Canada versus the United States seems the most plausible explanation for the observed Canadian advantages on treatment access and survival.

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Associations of Country and Socioeconomic Status with 15-Year Node-Negative Breast Cancer Survival

Table 1

Income group	Ontario				California				Ontario versus California			
	n	Rate <sup>1</sup>	RR <sup>2</sup>	95% CI <sup>3</sup>	n	Rate <sup>1</sup>	RR <sup>2</sup>	95% CI <sup>3</sup>	RR	95% CI <sup>3</sup>	RR	95% CI <sup>3</sup>
Highest	43	0.522	1.00	—	44	0.570	1.00	—	0.92	0.67, 1.26	0.92	0.67, 1.26
	31	0.461	0.88	0.54, 1.42	50	0.569	1.00	0.96, 1.04	0.81	0.56, 1.16	0.81	0.56, 1.16
	42	0.527	1.01	0.88, 1.16	47	0.482	0.85	0.56, 1.30	1.09	0.67, 1.78	1.09	0.67, 1.78
Middle	35	0.576	1.10	0.78, 1.55	42	0.576	1.01	0.65, 1.56	1.00	0.84, 1.20	1.00	0.84, 1.20
	34	0.474	0.91	0.54, 1.52	41	0.319	<b>0.56</b>	<b>0.34, 0.92</b>	1.49	0.88, 2.53	1.49	0.88, 2.53
	36	0.550	1.05	0.78, 1.42	47	0.521	0.91	0.65, 1.28	1.06	0.80, 1.41	1.06	0.80, 1.41
Lowest	35	0.493	0.94	0.55, 1.62	44	0.394	<b>0.69</b>	<b>0.45, 1.06<sup>4</sup></b>	1.25	0.78, 2.01	1.25	0.78, 2.01
	46	0.530	1.02	0.65, 1.61	41	0.477	0.84	0.53, 1.33	1.11	0.77, 1.60	1.11	0.77, 1.60
	28	0.571	1.09	0.77, 1.54	45	0.479	0.84	0.54, 1.31	1.19	0.80, 1.76	1.19	0.80, 1.76
	36	0.502	0.96	0.60, 1.54	41	0.302	<b>0.60</b>	<b>0.37, 0.97</b>	<b>1.66</b>	<b>1.00, 2.76</b>	<b>1.66</b>	<b>1.00, 2.76</b>

n, number of incident breast cancer cases; Rate, directly age-adjusted 15-year survival rate; RR, standardized survival rate ratio; CI, confidence interval.

Bolded RRs and CIs are statistically significant.

<sup>1</sup> All rates were directly age-adjusted using this study's combined Ontario-California population of cases as the standard (age strata: 25–44, 45–54, 55–64, 65–74 and 75 years or older), so all of the rates are directly comparable.

<sup>2</sup> A survival rate ratio of 1.00 is the within-country baseline.

<sup>3</sup> Confidence intervals are based on the Mantel-Haenszel chi-squared test.

<sup>4</sup> 90% confidence interval does not include the null (0.48, 0.99).