2000

An international comparison of cancer survival: metropolitan Toronto, Ontario, and Honolulu, Hawaii

Kevin M. Gorey
University of Windsor

An International Comparison of Cancer Survival: Metropolitan Toronto, Ontario, and Honolulu, Hawaii

Kevin M. Gorey, PhD, MSW, Eric J. Holowaty, MD, FRCPC, MSc, Gordon Fehringer, MSc, Ethan Laukkanen, MD, FRCPC, Nancy L. Richter, MSW, and Cynthia M. Meyer, BSW

ABSTRACT

Objectives. Comparisons of cancer survival in Canadian and US metropolitan areas have shown consistent Canadian advantages. This study tests a health insurance hypothesis by comparing cancer survival in Toronto, Ontario, and Honolulu, Hawaii.

Methods. Ontario and Hawaii registries provided a total of 9190 and 2895 cancer cases (breast and prostate, 1986–1990, followed until 1996). Socioeconomic data for each person's residence at the time of diagnosis were taken from population censuses.

Results. Socioeconomic status and cancer survival were directly associated in the US cohort, but not in the Canadian cohort. Compared with similar patients in Honolulu, residents of low-income areas in Toronto experienced 5-year survival advantages for breast and prostate cancer. In support of the health insurance hypothesis, between-country differences were smaller than those observed with other state samples and the Canadian advantage was larger among younger women.

Conclusions. Hawaii seems to provide better cancer care than many other states, but patients in Toronto still enjoy a significant survival advantage. Although Hawaii's employer-mandated health insurance coverage seems an effective step toward providing equitable health care, even better care could be expected with a universally accessible, single-payer system. (*Am J Public Health.* 2000;90:1866–1872)

A recent study of cancer survival in Toronto, Ontario, and in Detroit, Michigan, compared their ecologically defined poor and found advantaged survival among Canadians for 13 of 15 cancer sites (weighted mean 5-year survival rate ratio [SRR] = 1.55).[1,2] This consistent pattern of Canadian cancer survival advantage was then systematically replicated with 3 more economically resourceful US metropolitan areas (Seattle, Wash; San Francisco, Calif; and Hartford, Conn).[3] Again, significantly better 5-year survival rates were observed for 13 of 15 common types of cancer among the relatively poor of Toronto compared with similarly poor US subjects (SRR = 1.35). Moreover, no such between-country differentials were observed in the middle- or high-income groups. Cancer survival reported in the first Canada–US comparative study in this research field was substantively similar.[4] However, that study's essentially nonsignificant findings are not surprising, as it did not include any measure of socioeconomic status (SES). It merely compared cohorts across all aggregated SES levels and so could not observe any modification of between-country survival differences by SES.

Another recent study, which systematically replicated Canadian cancer survival advantages among those who live in relatively poor communities, probably compromised internal validity in its attempt to extend external validity.[5] Its aggregate comparison of the province of Ontario with a sample of the entire United States may have been confounded by other than socioeconomic variability related to the diverse metropolitan, exurban, and rural residences represented among its samples or, relatedly, by the size of its ecologic units of analysis, which ranged by a factor of more than 1000, from smaller areal units (e.g., census tract, 0.5 km^2) typical of metropolitan areas to much larger census subdivision or county units (e.g., 500 km^2) more typically used in other areas. The present study attempts to extend this research field's external validity without making such compromises.

The central inference has been that a key structural difference between Canada and the United States—single-payer vs multipayer health care systems—is the most cogent explanation for the observed consistent pattern of Canadian survival advantage across various cancer sites; that is, the more equitable access they offer to preventive and therapeutic health care services is responsible for the differences. In the United States, insurance status—noninsured or underinsured vs some insurance or better insured—has been found to be strongly associated with the receipt of primary care, the receipt of cancer screening services, stage of cancer at the time of diagnosis,[6–15] receipt of various cancer treatments,[16–20] and survival of cancer (weighted risk ratios consistent with disadvantage among the uninsured ranged from 1.50 to 10.00).[21–26] Cancer care in Canada has not been without its apparent inequities. For example, a socioeconomic mammography gradient, albeit much smaller than the US one, was observed in Canada in the mid-1980s along with evidence of higher screening rates among American women.[27,28] More recent samples, however, have demonstrated that federal and provincial initiatives have substantially reduced or eliminated these inequities.[29]

The fact that the more prevalent screening participation among American women was not attendant with earlier stage at diagnosis or survival advantages underscores the probable

Kevin M. Gorey, Nancy L. Richter, and Cynthia M. Meyer are with the School of Social Work, University of Windsor, Windsor, Ontario. Eric J. Holowaty is with the Division of Preventive Oncology and Gordon Fehringer is with the Ontario Cancer Registry, Cancer Care Ontario, Toronto, Ontario. Ethan Laukkanen is with the Windsor Regional Cancer Center, Windsor, Ontario.

Requests for reprints should be sent to Kevin M. Gorey, PhD, MSW, School of Social Work, University of Windsor, 401 Sunset Ave, Windsor, Ontario, N9B 3P4, Canada (e-mail: gorey@uwindsor.ca).

This article was accepted April 3, 2000.

importance of other prevention strategies such as the opportunity to develop an ongoing, continuous relationship with a primary care physician. Such more generalist life-course preventive interventions probably are more readily available in Canada, particularly among the relatively poor. Given that previous studies have provided substantial adjustments for absolute income status, race/ethnicity and culture, differential longevity, and competing causes of death and that the consistent pattern of the Canadian advantage has been observed across divergent types of cancer (e.g., some associated with lifestyle, others not), the developing health insurance theory certainly seems to hold prima facie validity.

The present analysis tests the health insurance hypothesis by means of a systematic replication of previous Canada (Toronto)–US cancer survival comparisons with a US metropolitan sample from Hawaii, a state that is atypical in its history of offering health insurance coverage to its residents. Hawaii has mandated employer-based health insurance coverage since 1974, and through related legislation it has also endeavored to insure people employed part-time as well as those unemployed. Estimates of Hawaii's prevalent health insurance coverage have ranged from 89% to 98% (median estimate=96%).[30–34] Such a legislative mandate has not guaranteed everyone health insurance, and Hawaii has not been able to completely eliminate all health status inequities (traditional "at-risk" groups [e.g., Native Hawaiians] and geographic service variabilities still exist). Nevertheless, Hawaii seems to stand alone among US states in minimizing the risk of being uninsured. During the mid-1980s to the mid-1990s, the period during which the international research on cancer survival was performed, the prevalence of Hawaii's uninsured typically has been half to one quarter that of most other states. We therefore hypothesized that relatively poor Hawaiians would enjoy a cancer survival experience more similar to that of their relatively poor Canadian counterparts, although we still hypothesized advantaged survival among Canadians.

Methods

Cancer cases arose from the populations of greater metropolitan Toronto, Ontario (Toronto, York, and Peel regions; population 3.5 million in 1991), and Honolulu, Hawaii (Honolulu County; population 825 000 in 1991).[35,36] Metropolitan samples were selected to provide some control for natural health care service endowment. Physician and hospital-based preventive, investigative, and therapeutic oncology services, although they may not be equitably accessible, are well known as the most available in such areas of Canada and the United States. The data sources were the Ontario Cancer Registry (Toronto data) and the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) program (Honolulu data). Definitions of the study cohorts were constrained by the following: 1986 was the first year in which the Ontario Cancer Registry coded the postal code of residence for most cases, and cohort termination or the date of last follow-up for both cohorts was December 31, 1995.[37,38] A 5-year survival analysis was based on cumulative incident cases diagnosed from 1986 to 1990. Power calculations based on the between-country comparisons reported in the original Toronto–Detroit study as well as 3 statistical criteria (2-tailed test; power, defined as $[1-\beta]=.80$; and $\alpha=.05$ [95% confidence intervals])[1,39] determined that there would be sufficient power to detect meaningful between-country differences for breast and prostate cancer, the 2 most common types of cancer for which preventive and therapeutic interventions are expected to make a difference. All primary malignant cancers of the breast among women and of the prostate among men that occurred in adults (25 years or older) were included in the analysis (5807 breast and 3383 prostate cancer cases in Toronto and 1783 breast and 1112 prostate cancer cases in Honolulu).

The present analysis, like the original, used a census-based SES measure (census tract proportion meeting a "low-income" criterion in Canada and "poverty" threshold in the United States) to define relative income quantiles.[35,36] Its critical comparisons were therefore between corresponding income tertiles and deciles in Toronto and Honolulu. Descriptive profiles of the resultant income areas that are displayed in Table 1 demonstrate 2 methodologically important principles: (1) the construct validity of this study's ecologic measures of relative SES is supported by the clear median income hierarchies—relatively low to high income areas—observed in both Toronto and Honolulu, and (2) even though Statistics Canada's low-income criterion is much more liberal than the US Census Bureau's poverty threshold, the corresponding Toronto–Honolulu relative income areas are strikingly similar in terms of their typical incomes (and population sizes and areas; see Table 1 footnotes a and b), providing substantial ecologic control for absolute economic status. This study's Honolulu cohort was nearly identical to the original Toronto and other US cohorts on data quality indicators: 97.5% of their residences (census tracts) at the time of diagnosis were coded, 95.9% of the cancers were microscopically confirmed, and 0.8% were enumerated on the basis of death certificates only.[37,38]

Analytically, the present study's 5-year survival analysis was a near-exact replicate of the original. Survival rates were directly age adjusted on the basis of this study's combined Toronto–Honolulu population of cases by each specific cancer site across the following age strata: 25–44, 45–54, 55–64, 65–74, and 75 years or older. Among all the breast and prostate cancer cases in which the patient was dead at follow-up, 79% and 63%, respectively, of the patients died as a direct result of cancer. Among the sample of cases diagnosed before 65 years of age, however, nearly all subsequent deaths were attributable to cancer (90% and 81%, respectively). Cancer survival comparisons across specific income area strata were then performed, so that SRRs were greater than 1.00 if Toronto residents were advantaged and less than 1.00 if Honolulu residents were advantaged. Ninety-five-percent confidence intervals around survival rate ratios were based on the Mantel-Haenszel χ^2 test.[40,41] Throughout the text, when referring to SRR point estimates that "approached statistical significance," we specifically mean that although their associated 95% confidence intervals intersected the null (not significant at $\alpha=.05$), their corresponding 90% confidence intervals did not (significant at $\alpha=.10$).

Results

This study systematically replicated the findings of previous Canadian–US cancer survival analyses across socioeconomic tertiles—low-, middle-, and high-income areas—in the following 3 ways (top of Table 2).

1. The Toronto samples of breast and prostate cancer cases that extended previous analyses by 2 years continued to demonstrate no association between SES and cancer survival, whereas the Honolulu samples did; 5-year survival rates were significantly lower in Honolulu's relatively low-income areas (breast and prostate cancer low-income vs high-income SRRs were 0.94 and 0.85, respectively).

2. The 2 countries' samples did not differ significantly on cancer survival in the middle- or high-income groups.

3. As hypothesized for low-income groups, significantly advantageous survival in Toronto was observed for both breast cancer (SRR=1.06) and prostate cancer (SRR=1.10). Also as hypothesized, the Toronto advantage was much smaller than had been observed with its previous comparison with Detroit; the corresponding Toronto–Detroit breast and prostate SRRs were 1.30 and 1.21.[1]

Consistent with a health insurance explanation for the observed SES–cancer survival associations in the United States, along with the observed survival advantages among Canadians who live in relatively low-income areas

TABLE 1—Descriptive Profiles of Census Tract–Based Income Areas in Toronto, Ontario (1991), and Honolulu, Hawaii (1990)

	Toronto, Ontario[a]			Honolulu, Hawaii[b]		
	Low-Income Prevalence			Poverty Prevalence		
Income Group	Range	Median	Income ($)[c]	Range	Median	Income ($)[c]
			Income tertiles			
Highest						
1	1.30–9.40	5.63	56 639	0.00–3.29	1.97	57 965
2	9.41–17.14	11.69	43 315	3.30–7.89	5.38	42 780
3	17.15–66.75	22.65	30 377	7.90–68.65	16.70	30 012
Lowest						
			Income deciles			
Highest						
1	1.30–5.09	3.75	58 741	0.00–1.59	0.81	61 384
2	5.10–6.99	5.95	57 161	1.60–2.29	1.90	59 130
3	7.00–8.99	7.60	54 389	2.30–2.99	2.69	54 798
4	9.00–10.89	9.55	49 886	3.00–3.89	3.28	52 380
5	10.90–12.49	11.50	47 117	3.90–5.29	4.80	43 502
6	12.50–15.09	13.51	42 276	5.30–6.79	6.02	39 280
7	15.10–18.39	16.32	39 628	6.80–8.59	7.44	38 144
8	18.40–22.69	20.19	34 337	8.60–10.79	9.53	32 690
9	22.70–27.69	25.00	32 010	10.80–17.49	13.90	30 979
10	27.70–66.75	32.10	25 090	17.50–68.65	24.42	21 420
Lowest						

[a]Population of 3 498 768 in 1991: 728 census tracts with a mean population of 4806 (SD = 1825) and a median population of 4742. Excluding the small number of outlying tracts (2.6% of 50 km^2 or larger), census tracts typically had areas of 1 km^2 or less (40%) and a median area of 1.15 km^2 (mean = 2.53, SD = 4.84).
[b]Population of 824 600 in 1990: 190 census tracts with a mean population of 4340 (SD = 2074) and a median population of 4200. Excluding the small number of outlying tracts (5.3% of 50 km^2 or larger), census tracts typically had areas of 1 km^2 or less (45%) and a median area of 1.25 km^2 (mean = 3.61, SD = 5.70).
[c]Census tract median annual household income in US dollars.

compared with their US counterparts, most such associations were larger when the analysis was restricted to patients diagnosed before the age of 65 years who were not yet eligible for Medicare coverage in the United States (bottom of Table 2). Among these younger breast cancer cohorts, which made up 61% of this study's sample of women with breast cancer, the low-income vs high-income SRR in Honolulu was 0.88 (the middle-income vs high-income SRR approached statistical significance [0.93]). Among low-income groups, even better survival was observed in Toronto vs Honolulu (SRR = 1.12) than had been observed among the breast cancer cases involving patients of all ages. None of the within-country or between-country breast cancer survival comparisons were significant among the sample of women 65 years or older (not shown in Table 2). As for the younger prostate cancer cohorts, which made up only 18% of the sample of men with prostate cancer, a remarkably similar pattern of within- and between-country disadvantage among Honolulu's relatively poor was observed, although it was generally characterized by point estimates that approached statistical significance and nonsignificant trends. Unlike older women with breast cancer, older prostate cancer patients in relatively low-income areas remained disadvantaged regarding 5-year cancer survival compared with their counterparts in relatively high-income areas (SRR = 0.87; 95% confidence interval [95% CI] = 0.77, 0.99).

We then expanded these analyses across income decile groups to characterize cancer survival differences across more diverse socioeconomic areas, from the categorically most affluent to the most impoverished underclass neighborhoods (Table 3). The following 3 patterns, of interest with regard to health care policy, emerged from this systematic replication.

1. Even with greatly expanded socioeconomic variability across 10 income areas, no association was observed between SES and cancer survival in the Canadian sample; the stark similarity of breast and prostate cancer survival in Toronto was maintained, even when the lowest-income decile was compared with the highest.

2. The poorest US income areas were extremely disadvantaged compared with the most affluent ones; 5-year survival rates were significantly lower in Honolulu's lowest-income areas (breast and prostate cancer lowest-income vs highest-income decile SRRs were 0.78 and 0.69, respectively). Among the Honolulu sample of women younger than 65 years with breast cancer, the socioeconomic survival gradient was even larger (lowest-income vs highest-income decile SRR = 0.69; 95% CI = 0.52, 0.91; not shown in Table 3).

3. Consistent with previous tertile-based analyses, significantly advantageous survival among the lowest-income groups in Toronto was observed for both breast cancer (SRR = 1.20) and prostate cancer (SRR = 1.24). Among women younger than 65 years with breast cancer, the estimate of advantaged Canadian survival was even greater (SRR = 1.28; 95% CI = 1.07, 1.53; not shown in Table 3).

It is also important to note that a pattern of diminished survival typically approaching statistical significance was observed among Honolulu's breast and prostate cancer patients who lived in Honolulu's fifth through eighth income deciles, which may be categorically defined as representing middle-class to lower-middle- or working-class neighborhoods (SRRs ranged from 0.80 to 0.90). Relatedly, in the sixth decile, fewer such middle-income women with breast cancer survived for 5 years than did their Canadian counterparts (SRR = 1.10). Finally, the Toronto–Honolulu breast cancer (SRR = 0.91) and prostate cancer (SRR = 0.89) SRR estimates that approached statistical significance and were nonsignificant, respectively, suggested that among the most economically resourceful cancer patients who live in the wealthiest 10% of North American neighborhoods, Americans may enjoy a survival advantage.

Discussion

We studied the effect of SES on survival from breast and prostate cancer among the adult populations of Toronto, Ontario, and Honolulu, Hawaii. In within-country comparisons, breast and prostate cancer survival in Honolulu was significantly poorer (on the basis of 95% confidence interval) among people from lower socioeconomic areas. These SES–survival associations were larger for steeper socioeconomic gradients (income deciles vs tertiles) and among younger breast cancer patients (younger than 65 years) not yet eligible for Medicare participation. No such associations were found among Toronto's population. In the between-country analysis that compared cases arising from Toronto and Honolulu's low-income areas (lowest third and lowest tenth), we found a consistently significant survival advantage in Toronto that was, again, even larger among younger breast cancer patients. Furthermore, we found more tentative evidence of a smaller survival advantage in Toronto among some categorical middle-class patients and a concomitant advantage in the United States among some upper-class patients.

This pattern of findings points toward the different health care systems in Canada and the United States (single-payer vs multipayer) as its most cogent explanation. Because of Hawaii's more prevalent health insurance coverage, we predicted (correctly) that it would have a cancer survival experience more similar to a that of a Canadian sample than US samples in previous Canadian–US comparative studies had. This study's general pattern of results, along with its somewhat attenuated observed associations, substantiates the health insurance hypothesis as an explanation for Canadian–US differences on cancer survival, particularly among the relatively poor but also among middle-class and more affluent cancer patients.

Among the poor, this study's findings are consistent with the well-known strong associations of health insurance status—no insurance or underinsured vs some or adequate coverage—with SES in the United States.[42] Notwithstanding questions about the relative effectiveness of Medicaid, America's health care program for the poor, this study's relatively poor areas contained almost 2 "near-poor" people (up to 200% of the federally established poverty criterion) for each of their poor residents. Many such marginally impoverished people, while generally not meeting Medicaid's means test, probably have difficulty purchasing private health insurance. As for this study's middle-class or working-class neighborhoods, these also include significant enclaves of the near poor (2-fold to 3-fold more prevalent than the poor in this study's US sample), including the working poor as well as better-off working people who, for a number of social structural and economic reasons, remain uninsured or underinsured.[42] The tentative evidence that American cancer survival advantage is enjoyed by only a very select few—that is, the most affluent 10% of the population—only serves to further indict the American health care system. It seems to suggest that only the most fortunate, generally well-insured people with ample disposable incomes can expect the best that the US health care system has to offer.

Hawaii's pattern of cancer survival, which is more similar to that of Canada, and its smaller SES–cancer survival gradients are different from what has been observed in other states (California, Connecticut, Michigan, and Washington).[1–3] These findings are certainly consistent with Hawaii's much greater prevalence of health insurance coverage; they are also consistent with secular trends within Hawaii. Whereas others have recently found no association between SES and breast cancer survival in Hawaii, the gradient most typical of other states (lower survival rates among the poor) was observed there in earlier cohorts from the 1960s through 1970s.[43,44] The previously observed pattern of advantaged Hawaiian cancer survival within the United States is

TABLE 2—Association of Income Tertiles With Breast and Prostate Cancer 5-Year Survival: Toronto, Ontario, and Honolulu, Hawaii

Cancer Site (*ICD-9* Code) and Income Group	Toronto, Ontario				Honolulu, Hawaii				Toronto/Honolulu Cases	
	n	SR	SRR[a]	(95% CI)[b]	n	SR	SRR[a]	(95% CI)[b]	SRR[a]	(95% CI)[b]
All adult cancer cases										
Breast (174)										
High	2350	.710	1.00	. . .	595	.728	1.00	. . .	0.98	(0.94, 1.03)
Middle	1582	.716	1.01	(0.97, 1.06)	613	.699	0.96	(0.89, 1.03)	1.02	(0.97, 1.07)
Low	1875	.724	1.02	(0.98, 1.06)	575	.684	0.94	(0.88, 1.00)	1.06	(1.00, 1.12)
Prostate (185)										
High	1413	.579	1.00	. . .	327	.605	1.00	. . .	0.96	(0.88, 1.05)
Middle	927	.555	0.95	(0.87, 1.03)	373	.557	0.92	(0.81, 1.05)	1.00	(0.93, 1.07)
Low	1043	.569	0.98	(0.91, 1.06)	412	.517	0.85	(0.74, 0.97)	1.10	(1.00, 1.22)
Adult cancer case patients younger than 65 y										
Breast (174)										
High	1432	.760	1.00	. . .	418	.785	1.00	. . .	0.97	(0.92, 1.03)
Middle	940	.749	0.99	(0.96, 1.02)	378	.731	0.93	(0.86, 1.01)[c]	1.02	(0.96, 1.08)
Low	1110	.771	1.01	(0.98, 1.04)	360	.689	0.88	(0.81, 0.96)	1.12	(1.04, 1.20)
Prostate (185)										
High	263	.736	1.00	. . .	60	.749	1.00	. . .	0.98	(0.80, 1.20)
Middle	173	.730	0.99	(0.91, 1.08)	63	.684	0.91	(0.73, 1.13)	1.07	(0.88, 1.30)
Low	207	.698	0.95	(0.86, 1.05)	43	.614	0.82	(0.64, 1.05)[c]	1.14	(0.92, 1.41)

Note. ICD-9 = International Classification of Diseases, Ninth Revision; n = number of cumulative incident cancer cases; SR = cumulative survival rate; SRR = survival rate ratio; CI = confidence interval. Within- and between-country comparisons among adult cancer case patients 65 years or older are excluded from the table because all except 1 of them (reported in the text) were not minimally statistically significant. Because statistical power is clearly insufficient to detect meaningful between-country differences among relatively young men with prostate cancer, this exploratory subanalysis ought to be interpreted with extreme caution until it is either confirmed or refuted with larger samples.

[a]A survival rate ratio of 1.00 is the baseline.

[b]Confidence intervals are based on the Mantel-Haenszel χ^2 test.

[c]Approached statistical significance: 90% confidence interval does not intersect the null value of 1.00.

TABLE 3—Association of Income Deciles With Breast and Prostate Cancer 5-Year Survival: Toronto, Ontario, and Honolulu, Hawaii

Income Group	Toronto, Ontario n	Toronto, Ontario SR	Toronto, Ontario SRR[a]	Toronto, Ontario (95% CI)[b]	Honolulu, Hawaii n	Honolulu, Hawaii SR	Honolulu, Hawaii SRR[a]	Honolulu, Hawaii (95% CI)[b]	Toronto/Honolulu Cases SRR[a]	Toronto/Honolulu Cases (95% CI)[b]
Breast cancer										
Highest										
1	685	.705	1.00	. . .	120	.774	1.00	. . .	0.91	(0.81, 1.02)[c]
2	777	.711	1.01	(0.93, 1.10)	272	.730	0.94	(0.82, 1.07)	0.97	(0.89, 1.06)
3	737	.713	1.01	(0.95, 1.08)	157	.717	0.93	(0.81, 1.06)	0.99	(0.89, 1.10)
4	472	.726	1.03	(0.96, 1.11)	147	.751	0.97	(0.86, 1.09)	0.97	(0.87, 1.08)
5	488	.734	1.04	(0.97, 1.12)	192	.723	0.93	(0.81, 1.07)	1.02	(0.87, 1.19)
6	453	.682	0.97	(0.90, 1.04)	186	.620	0.80	(0.69, 0.93)	1.10	(0.98, 1.23)[c]
7	422	.708	1.00	(0.81, 1.24)	177	.697	0.90	(0.79, 1.02)[c]	1.02	(0.91, 1.15)
8	597	.724	1.03	(0.95, 1.11)	223	.750	0.97	(0.87, 1.09)	0.97	(0.89, 1.05)
9	457	.743	1.05	(0.98, 1.13)	157	.704	0.91	(0.80, 1.04)	1.06	(0.95, 1.18)
10	719	.718	1.02	(0.95, 1.10)	152	.600	0.78	(0.67, 0.91)	1.20	(1.06, 1.36)
Lowest										
Prostate cancer										
Highest										
1	432	.568	1.00	. . .	80	.638	1.00	. . .	0.89	(0.73, 1.08)
2	423	.595	1.05	(0.94, 1.18)	125	.644	1.01	(0.67, 1.51)	0.92	(0.79, 1.07)
3	457	.580	1.02	(0.92, 1.13)	103	.569	0.89	(0.69, 1.14)	1.02	(0.76, 1.36)
4	293	.576	1.01	(0.94, 1.09)	90	.579	0.91	(0.72, 1.15)	0.99	(0.75, 1.31)
5	278	.525	0.92	(0.79, 1.07)	130	.508	0.80	(0.63, 1.02)[c]	1.03	(0.86, 1.23)
6	282	.556	0.98	(0.85, 1.13)	94	.585	0.92	(0.73, 1.16)	0.95	(0.77, 1.17)
7	243	.569	1.00	(0.80, 1.26)	117	.527	0.83	(0.65, 1.06)	1.08	(0.90, 1.29)
8	325	.570	1.00	(0.91, 1.10)	160	.523	0.82	(0.66, 1.03)[c]	1.09	(0.93, 1.28)
9	252	.560	0.99	(0.93, 1.05)	110	.580	0.91	(0.72, 1.15)	0.97	(0.83. 1.13)
10	398	.547	0.96	(0.83, 1.11)	103	.440	0.69	(0.53, 0.90)	1.24	(1.01, 1.53)
Lowest										

Note. ICD-9= International Classification of Diseases, Ninth Revision; n = number of cumulative incident cancer cases; SR = cumulative survival rate; SRR = survival rate ratio; CI = confidence interval.

[a]A survival rate ratio of 1.00 is the baseline.

[b]Confidence intervals are based on the Mantel-Haenszel χ^2 test.

[c]Approached statistical significance: 90% confidence interval does not intersect the null value of 1.00.

also consistent with this study's findings.[45] It is possible—but, we think, improbable—that other factors may account for this study's findings. In addition to its unique health insurance system, Hawaii also has a relatively unique ethnic distribution and at least the suggestion of a significantly different lifestyle than elsewhere.

As elsewhere, race/ethnicity and lifestyle factors such as diet and smoking have been observed to be associated with the occurrence and prognosis of some cancers,[46–55] although the effects, particularly for survival, may generally be categorized as very small. The majority of cancer case patients we studied in Honolulu were Asian Americans or Pacific Islanders (63%); most of the others were White (32%).[37,38] It was not possible to mathematically adjust for this factor, as the Ontario Cancer Registry does not routinely code race/ethnicity. However, we did replicate the between-country comparisons with the non-White and White Honolulu cohorts. Although there were some power problems, these analyses did not result in any practical alteration of our findings. We think that the ethnicity/lifestyle hypotheses are not particularly potent alternative explanations, for a number of other reasons.

1. The findings within Hawaii were as divergent from those of other states, as were the between-country ones.

2. Asian Americans and Pacific Islanders are by no means a homogeneous group of people. In fact, evidence suggests that regarding breast cancer survival among Hawaiian residents, for example, Native Hawaiian, Filipino, and Chinese people may be disadvantaged relative to Whites, while Japanese people are advantaged.[49]

3. Toronto may also be generally characterized as a multicultural population, although not to the same degree as Honolulu. Approximately a third of Toronto's residents are people of color, and nearly one quarter of them emigrated during the past 10 years.[35]

4. The so-called Hawaiian lifestyle seems to be based more in mythology than empiricism. The prevalence of actual relevant risky behaviors (lack of exercise, overweight, smoking, and excessive alcohol consumption) among Hawaiians has been observed to be strikingly similar to that of most other states.[56] Therefore, whatever influences ethnicity and lifestyle impart in such survival analyses, they are not likely to be systematic, and so they are not likely to confound this study's findings.

In fact, we believe that if there is any bias in this study's Canada–US comparative analyses of low-income groups, it is probably that its SRR point estimates are underestimates of the truth, for the following reasons.

1. Whereas both female life expectancy and male life expectancy at birth are more than 2 years greater in Canada than in the United States, these figures are more than 3 years greater for Honolulu than for Toronto.[57–60]

2. Any information bias due to ecologic measurement of SES is likely to be similarly nondifferential among this study's Canadian and US samples[1–3,5,61–70]; relatedly, owing to this study's focus on 10 socioeconomic areas (in Honolulu, median household incomes in these areas in 1990 ranged from $21 420 to $61 384), actual socioeconomic variability, and therefore the ability to detect meaningful effects, was substantially diminished (Honolulu median incomes across its 190 census tracts ranged from $5000 to $149 850).

3. In focusing on all-cause rather than cancer-specific censored survival, this study used a more conservative analytic approach, in that cancer-specific death rates may underestimate the mortality associated with a diagnosis of cancer.[71] Recall also that cancer was the underlying cause of the vast majority of deaths, particularly among the younger cohort not eligible for Medicare. Moreover, the underlying cause of the majority of "noncancer" deaths—respiratory and circulatory problems—can often be directly associated with the treatment of cancer or, for that matter, with its nontreatment. We therefore believe that this study's findings are best characterized as conservative estimates of Canadian–US cancer outcome differences.

Conclusions

This study's central finding of advantaged Canadian vs American cancer survival, particularly among relatively low-income groups, implicates health care systemic factors as its most cogent explanation. Although Hawaii's prevalent health insurance coverage does seem attendant with better management of cancer care than that of other states, people with cancer in Toronto still enjoy a significant survival advantage. Employer-mandated health insurance coverage certainly seems to be a large step toward providing more equitable health care. However, this study provides evidence to suggest that even better care could be expected among more Americans through movement to a more universally accessible, single-payer system such as Canada's. □

Contributors

K. M. Gorey formulated the original research question, planned the study design, supervised data analysis, and wrote the paper. E. J. Holowaty and G. Fehringer assisted with study design and data interpretation. E. Laukkanen and N. L. Richter assisted with data interpretation and C. M. Meyer assisted with data analysis. All coauthors contributed to the writing of the paper.

Acknowledgments

This study was supported by an internal grant from the University of Windsor funded by the Social Science and Humanities Research Council of Canada.

The authors gratefully acknowledge the helpful technical assistance provided by Richard A. Dumala, MA, senior research associate, and Robyn J. Nease, MA, statistical consultant, Computing Services, University of Windsor; and David J. Webster, BA, geography information systems technician, Algonquin Forestry Authority, Ministry of Natural Resources, Huntsville, Ontario. The first author is also extremely grateful to his father-in-law, Arthur R. Richter, whose insightful reading and discussion of health care issues inspired this study's germinal idea.

References

1. Gorey KM, Holowaty EJ, Fehringer G, et al. An international comparison of cancer survival: Toronto, Ontario and Detroit, Michigan metropolitan areas. *Am J Public Health.* 1997;87:1156–1163.
2. Gorey KM, Holowaty EJ, Laukkanen E, Fehringer G, Richter NL. An international comparison of cancer survival: advantage of Canada's poor over the near poor of the United States. *Can J Public Health.* 1998;89:102–104.
3. Gorey KM, Holowaty EJ, Fehringer G, Laukkanen E, Richter NL, Meyer CM. An international comparison of cancer survival: Toronto, Ontario and three relatively resourceful United States metropolitan areas. *J Public Health Med.* 2000;22:343–348.
4. Keller DM, Peterson EA, Silberman G. Survival rates for four forms of cancer in the United States and Ontario. *Am J Public Health.* 1997;87:1164–1167.
5. Boyd C, Zhang-Salomons JY, Groome PA, Mackillop WJ. Associations between community income and cancer survival in Ontario, Canada, and the United States. *J Clin Oncol.* 1999;17:2244–2255.
6. Conlisk EA, Lengerich EJ, Demark-Wahnefried W, Schildkraut JM, Aldrich TE. Prostate cancer: demographic and behavioral correlates of stage at diagnosis among blacks and whites in North Carolina. *Urology.* 1999;53:1194–1199.
7. Eisen SA, Waterman B, Skinner CS, et al. Sociodemographic and health status characteristics with prostate cancer screening in a national cohort of middle-aged male veterans. *Urology.* 1999;53:516–522.
8. Lewis JD, Asch DA. Barriers to office-based screening sigmoidoscopy: does reimbursement cover costs? *Ann Intern Med.* 1999;130:525–530.
9. Catalano RA, Satariano WA. Unemployment and the likelihood of detecting early-stage breast cancer. *Am J Public Health.* 1998;88:586–589.
10. Lannin DR, Mathews HF, Mitchell J, Swanson MS, Swanson FH, Edwards MS. Influence of socioeconomic and cultural factors on racial differences in late-stage presentation of breast cancer. *JAMA.* 1998;279:1801–1807.
11. Parker J, Gebretsadik T, Sabogal F, Newman J, Lawson HW. Mammography screening among California Medicare beneficiaries: 1993–1994. *Am J Prev Med.* 1998;15:198–205.
12. Potosky AL, Breen N, Graubarb BI, Parsons PE. The association between health care coverage and the use of cancer screening tests. Results from the 1992 National Health Interview Survey. *Med Care.* 1998;36:257–270.
13. Grumback K, Vranizan K, Bindman AB. Physician supply and access to care in urban communities. *Health Aff (Millwood).* 1997;16:71–86.
14. Trevino RP, Trevino FM, Medina R, Ramirez G, Ramirez RP. Health care access among Mexican Americans with different health insurance coverage. *J Health Care Poor Underserved.* 1996;7:112–121.
15. Freeman HE, Corey CR. *Health Insurance and Access to Medical Services: A Secondary Analysis of Three Years of NCHS Health Interview Surveys*. Santa Monica, Calif: Rand; 1993.
16. Bennett CL, Stinson TJ, Yang T, Lurain JR. The effect of reimbursement policies on the management of Medicare patients with refractory ovarian cancer. *Semin Oncol.* 1999;26(suppl 1):40–45.
17. McKinlay JB, Burns RB, Durante R, et al. Patient, physician and presentational influences on clinical decision making for breast cancer: results from a factorial experiment. *J Eval Clin Pract.* 1997;3:23–57.
18. Mitchell JM, Meehan KR, Kong J, Schulman KA. Access to bone marrow transplantation for leukemia and lymphoma: the role of sociodemographic factors. *J Clin Oncol.* 1997;15:2644–2651.
19. Hadley J, Steinberg EP, Feder J. Comparison of uninsured and privately insured hospital patients: condition on admission, resource use, and outcome. *JAMA.* 1991;265:374–379.
20. Greenberg ER, Chute CG, Stukel T, et al. Social and economic factors in the choice of lung cancer treatment: a population-based study in two rural states. *N Engl J Med.* 1988;318:612–617.
21. Preston DM, Bauer JJ, Connelly RR, et al. Prostate-specific antigen to predict outcome of external beam radiation for prostate cancer: Walter Reed Army Medical Center experience, 1988–1995. *Urology.* 1999;53:131–138.
22. Merrill RM, Henson DE, Ries LA. Conditional survival estimates in 34,963 patients with invasive carcinoma of the colon. *Dis Colon Rectum.* 1998;41:1097–1106.
23. Franzini L, Williams AF, Franklin J, Singletary SE, Theriault RL. Effects of race and socioeconomic status of 1,332 Black, Hispanic, and White women with breast cancer. *Ann Surg Oncol.* 1997;4:111–118.
24. Kallakury BV, Sheehan CE, Ambros RA, Fisher HA, Kaufman RP, Ross JS. The prognostic significance of p34cdc2 and cyclin D1 protein expression in prostate adenocarcinoma. *Cancer.* 1997;80:753–763.
25. Lyman GH, Kuderer NM, Lyman SL, Cox CE, Reintgen D, Backey P. Importance of race in breast cancer survival. *Ann Surg Oncol.* 1997;4:80–87.
26. Ayanian JZ, Kohler BA, Abe T, Epstein AM. The relation between health insurance coverage and clinical outcomes among women with breast cancer. *N Engl J Med.* 1993;329:326–331.
27. Katz SJ, Hofer TP. Socioeconomic disparities in preventive care persists despite universal coverage: breast and cervical cancer screening in Ontario and the United States. *JAMA.* 1994;272:530–534.
28. Katz SJ, Larson EB, Logerfo JP. Trends in the utilization of mammography in Washington State and British Columbia: relation to stage of diagnosis and mortality. *Med Care.* 1992;30:320–328.
29. Roos LL, Traverse D, Turner D. The role of public programs in delivering care to high-risk populations. *Med Care.* 1999;37(6 suppl):JS264–JS278.
30. Centers for Disease Control and Prevention. State-specific prevalence estimates of uninsured and underinsured persons—behavioral risk factor surveillance system, 1995. *MMWR Morb Mortal Wkly Rep.* 1998;47:51–55.
31. *Health Trends in Hawaii.* 2nd ed. Honolulu: Hawaii Medical Service Association Foundation; 1995.
32. Hellander I, Moloo J, Himmelstein DU, Woolhandler S, Wolfe SM. The growing epidemic of uninsurance: new data on the health insurance coverage of Americans. *Int J Health Serv.* 1995;25:377–392.
33. Baumgartner ET, Grossman B, Fuddy L. Hawaii's

near-universal health insurance—lessons learned. *J Health Care Poor Underserved.* 1993;4: 194–202.
34. Lewin JC, Sybinsky PA. Hawaii's employer mandate and its contribution to universal access. *JAMA.* 1993;269:2538–2543.
35. *Profiles of Census Tracts, 1991 (Toronto)* [on diskette]. Ottawa, Ontario: Statistics Canada; 1992.
36. *Census of Population and Housing, 1990 (Hawaii)* [summary tape file on CD-ROM]. Washington, DC: US Bureau of the Census, Data User Services Division; 1992.
37. *Surveillance, Epidemiology, and End Results (SEER) Program (1973–93)* [public use CD-ROM]. Bethesda, Md: National Cancer Institute, Cancer Statistics Branch; 1996.
38. *Surveillance, Epidemiology, and End Results (SEER) Program (1973–95)* [public use CD-ROM]. Bethesda, Md: National Cancer Institute, Cancer Statistics Branch; 1998.
39. Fleiss JL. *Statistical Methods for Rates and Proportions.* New York, NY: John Wiley & Sons; 1981.
40. Miettinen OS. Estimability and estimation in case-referent studies. *Am J Epidemiol.* 1976;103: 226–235.
41. Mantel N, Haenszel W. Statistical aspects of the analysis of data from retrospective studies of disease. *J Natl Cancer Inst.* 1959;22:719–748.
42. Gorey KM. What is wrong with the United States health care system? It does not effectively exist for one of every five Americans. *Milbank Q.* 1999;77:401–407.
43. Meng L, Maskarinec G, Wilkens L. Ethnic differences and factors related to breast cancer survival in Hawaii. *Int J Epidemiol.* 1997;26: 1151–1158.
44. Le Marchand L, Kolonel LN, Nomura AM. Relationship of ethnicity and other prognostic factors to breast cancer survival patterns in Hawaii. *J Natl Cancer Inst.* 1984;73:1259–1265.
45. Farrow DC, Samet JM, Hunt WC. Regional variation in survival following the diagnosis of cancer. *J Clin Epidemiol.* 1996;49:843–847.
46. Le Marchand L, Hankin JH, Wilkens LR, Kolonel LN, Englyst HN, Lyu LC. Dietary fiber and colorectal cancer risk. *Epidemiology.* 1997; 8:658–665.
47. Le Marchand L, Wilkens LR, Hankin JH, Kolonel LN, Lyu LC. A case-control study of diet and colorectal cancer in a multiethnic population in Hawaii (United States): lipids and foods of animal origin. *Cancer Causes Control.* 1997;8: 637–648.
48. Wu AH, Ziegler RG, Pike MC, et al. Menstrual and reproductive factors and risk of breast cancer in Asian Americans. *Br J Cancer.* 1996;73: 680–686.
49. Meng L, Maskarinec G, Lee J. Ethnicity and conditional breast cancer survival in Hawaii. *J Clin Epidemiol.* 1997;50:1289–1296.
50. Nomura AM, Le Marchand L, Kolonel LN, Hankin JH. The effect of dietary fat on breast cancer survival among Caucasian and Japanese women in Hawaii. *Breast Cancer Res Treat.* 1991; 18(suppl 1):S135–S141.
51. Holmes MD, Stampfer MJ, Colditz GA, Rosner B, Hunter DJ, Willett WC. Dietary factors and the survival of women with breast carcinoma. *Cancer.* 1999;86:826–835.
52. Meyer F, Bairati I, Shadmani R, Fradet Y, Moore L. Dietary fat and prostate cancer survival. *Cancer Causes Control.* 1999;10: 245–251.
53. Sabin SL, Rosenfeld RM, Sundaram K, Har-el G, Lucente FE. The impact of comorbidity and age on survival with laryngeal cancer. *Ear Nose Throat J.* 1999;78:581–584.
54. Freng A, Daae LN, Engeland A, et al. Malignant epithelia tumours in the upper digestive tract: a dietary and socio-medical case-control and survival study. *Eur J Clin Nutr.* 1998;52:271–278.
55. Boffetta P, Merletti F, Faggiano F, et al. Prognostic factors and survival of laryngeal cancer patients from Turin, Italy: a population-based study. *Am J Epidemiol.* 1997;145:1100–1105.
56. Siegel PZ, Brackbill RM, Frazier EL, Mariolis P, Sanderson LM, Waller MN. Behavioral risk factor surveillance, 1986–1990. *Morb Mortal Wkly Rep CDC Surveill Summ.* 1991;55:1–23.
57. Harvard Center for Population and Development Studies. *US Patterns of Mortality by County and Race, 1965–1994.* Cambridge, Mass: Burden of Disease Unit, Harvard Center for Population and Development Studies; 1999.
58. Manuel D. *Health-Adjusted Life Expectancy at the Local Level in Ontario* [master's thesis]. Toronto, Ontario: University of Toronto; 1997.
59. Office of Health Status Monitoring. *Life Expectancy in the State of Hawaii, 1980 and 1990 (Report No. 63).* Honolulu, Hawaii: State Department of Health; 1996.
60. Statistics Canada. 2000. Available at: http://www.statcan.ca/english/Pgdb/People/Health/health26.htm. Accessed October 12, 2000.
61. Mustard CA, Derksen S, Berthelot JM, Wolfson M. Assessing ecological proxies for household income: a comparison of household and neighborhood level measures in the study of population health status. *Health Place.* 1999;5: 157–171.
62. Geronimus AT, Bound J. Use of census-based aggregate variables to proxy for socioeconomic group: evidence from national samples. *Am J Epidemiol.* 1998;148:475–486.
63. Diez-Roux AV, Nieto FJ, Muntaner C, et al. Neighborhood environments and coronary heart disease: a multilevel analysis. *Am J Epidemiol.* 1997;146:48–63.
64. Fehringer G, Gorey KM, Holowaty EJ. Ecological measures of socioeconomic status: validation among samples of cancer cases and controls in metropolitan Toronto. Paper presented at: Annual Cancer Care Ontario Clinical Cancer Research Conference; November 1997; Orillia, Ontario.
65. Greenwald HP, Polissar NL, Borgatta EF, McCorkle R. Detecting survival effects of socioeconomic status: problems in the use of aggregate measures. *J Clin Epidemiol.* 1994;8: 903–909.
66. Brenner H, Savitz DA, Jockel KH, Greenland S. Effects of nondifferential exposure misclassification in ecological studies. *Am J Epidemiol.* 1992;135:85–95.
67. Cherkin DC, Grothaus L, Wagner EH. Is magnitude of co-payment effect related to income? Using census data for health services research. *Soc Sci Med.* 1992;34:33–41.
68. Krieger N. Overcoming the absence of socioeconomic data in medical records: validation and application of a census-based methodology. *Am J Public Health.* 1992;82:703–710.
69. Krieger N. Women and social class: a methodological study comparing individuals, households, and census measures as predictors of black/white differences in reproductive history. *J Epidemiol Community Health.* 1991;45: 35–42.
70. Flegal KM, Brownie C, Haas JD. The effect of exposure misclassification on estimation of relative risk. *Am J Epidemiol.* 1986;123:736–751.
71. Brown BW, Brauner C, Minnotte MC. Noncancer deaths in White adult cancer patients. *J Natl Cancer Inst.* 1993;85:979–987.