Socioeconomic Inequalities in Cancer Survival in New Zealand: The Role of Extent of Disease at Diagnosis

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Abstract

We examined socioeconomic inequalities in cancer survival in New Zealand among 132,006 people ages 15 to 99 years who had a cancer registered (1994-2003) and were followed up to 2004. Relative survival rates (RSR) were calculated using deprivation-specific life tables. A census-based measure of socioeconomic position (New Zealand deprivation based on the 1996 census) based on residence at the time of cancer registration was used. All RSRs were age-standardized, and further standardization was used to investigate the effect of extent of disease at diagnosis on survival. Weighted linear regression was used to estimate the deprivation gap (slope index of inequality) between the most and least deprived cases. Socioeconomic inequalities in cancer survival were evident for all of the major cancer sites, with the deprivation gap being particularly high for prostate (−0.15), kidney and uterus (both −0.14), bladder (−0.12), colorectum (−0.10), and brain (+0.10). Accounting for extent of disease explained some of the inequalities in survival from breast and colorectal cancer and melanoma and all of the deprivation gaps in survival of cervical cancer; however, it did not affect RSRs for cancers of the kidney, uterus, and brain. No substantial differences between the total compared with the non-Māori population were found, indicating that the findings were not due to confounding by ethnicity. In summary, socioeconomic disparities in survival were consistent for nearly all cancer sites, persisted in ethnic-specific analyses, and were only partially explained by differential extent of disease at diagnosis. Further investigation of reasons for persisting inequalities is required. (Cancer Epidemiol Biomarkers Prev 2009;18(3):915–21)

Introduction

Several decades of research have documented ongoing social disparities in cancer (1, 2), including disparities in incidence, mortality, and survival. These inequalities are evident in many countries (3-8) and are apparent for almost all cancer sites (9-12). Ascertaining the reasons for, with the hope of eventual elimination of, cancer inequalities remains high on both the research and policy agenda in many countries (13-16).

The New Zealand Cancer Registry was established in 1948, and incidence and mortality statistics are published annually, e.g., ref. 17. However, other than previous reports on mortality to incidence ratios (17, 18), the first Ministry of Health report on cancer survival was not published until 2006 (19).

There are clear disparities in mortality in New Zealand across both socioeconomic (20) and ethnic (21) groups, and the close relationship between ethnicity and socioeconomic position needs to be acknowledged in understanding these patterns (22). We have previously described inequalities in cancer survival across different ethnic groups in New Zealand (23). Having accounted for differences in underlying mortality rates by using ethnic-specific life tables for the estimation of relative survival, we showed that Māori (the indigenous people of New Zealand, ~15% of the population), as well as Pacific people (~7% of the population), have considerably poorer survival from all cancers than non-Māori, non-Pacific New Zealanders. Large disparities in relative survival persisted for all major cancers having controlled for extent of disease at diagnosis (23). These residual disparities, at least for colon cancer, are probably due to multiple factors, including differences in levels of comorbidity and differential access to health care between ethnic groups.[6]

In the study reported here, we aim to (*a*) assess the extent of socioeconomic inequalities in cancer survival in New Zealand, (*b*) quantify the proportion of these inequalities that are attributable to extent of disease at diagnosis, and (*c*) identify whether these inequalities could be explained by confounding by ethnicity.

Materials and Methods

Patients ages 15 to 99 years who had 1 of 20 chosen cancers registered on the New Zealand Cancer Registry between July 1, 1994, and June 30, 2003, were identified (N = 136,323). We excluded 4,257 patients because they

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had (*a*) a date of registration equal to date of death, *n* = 2,666, 2.0%; (*b*) *in situ* cancer (*n* = 92, <0.1%); (*c*) a home address overseas (*n* = 467, 0.3%); or (*d*) no data available on socioeconomic position (see below; *n* = 1,092, 0.8%). Mortality data completed in June 2004 were linked with the Cancer Registry using the National Health Index number, a unique personal identifier assigned to anyone who accesses the public health care system.

Measurement of Socioeconomic Position. Socioeconomic position was assigned to each individual using an area-based measure according to place of residence at the time of diagnosis. The New Zealand deprivation (NZDep) index combines nine census variables that reflect aspects of material and social deprivation. NZDep96 (based on the 1996 census) provides a deprivation score for each ''meshblock'' in New Zealand, a census-defined geographic unit containing at least 100 people. The nine variables that comprise the index are the proportions of people (*a*) with no access to a telephone; (*b*) aged 18 to 59 years, receiving a means-tested benefit; (*c*) aged 18 to 59 years, unemployed; (*d*) living in households with equivalized income below an income threshold; (*e*) with no access to a car; (*f*) aged <60 years, living in a single-parent family; (*g*) aged 18 to 59 years, without any qualifications; (*h*) not living in their own home; and (*i*) living in households below the equivalized bedroom occupancy threshold. Further details of this index have been described previously (24). The NZDep index is commonly divided into deciles (24). For this analysis, we grouped deciles 1 to 4 (least deprived), deciles 5 to 6, deciles 7 to 8, and deciles 9 to 10 (most deprived). The domicile codes of 1,092 cases could not be mapped to a deprivation decile and these were therefore excluded from all analyses.

Estimation of Relative Survival Rates. Relative survival rates (RSR) are defined as the ratio of observed survival of the patients with cancer to the expected survival of the general population; this, in effect, ''adjusts'' the mortality patterns of cancer patients for the background population rates of mortality in the same demographic group (25). Expected survival was estimated for each of the four categories of NZDep96 deciles, based on sex- and deprivation-specific life tables from the 1996 census, by single year of age (15-99 years). These were provided by Statistics New Zealand; the data are available from the authors on request. For ethnic-specific analyses, expected survival was estimated from sex-, deprivation-, and ethnic-specific life tables. All RSRs were estimated using the SURV3 software (26). SEs were calculated using Greenwood's formula (27, 28). Survival probabilities were estimated at yearly intervals. Ideally, shorter time periods would be used, particularly in the 1st year of follow-up, to ensure that the excess hazard of death is constant within each time interval (29). However, because of the sparsity of data for some cancer sites, we chose to use yearly intervals.

We used direct standardization to adjust for potential confounding by age (in five groups: 15-44, 45-54, 55-65, 65-74, and 75-99 years). We used site-specific standards, so that for each cancer site, the age-specific weights used for the ''standard population'' was the age distribution of all the cases with that cancer.

To investigate the possibility of confounding by ethnicity, all the analyses reported here were repeated in the non-Māori population. Similar analyses were not possible in the Māori population because of the sparsity of the data.

Clinicians rarely directly provide cancer stage to the Cancer Registry. Instead, trained staff at the Registry use all information available to assign the SEER summary staging (defined as one of three categories: localized, regional spread, or distant spread) for each cancer registration (30). We henceforth refer to this as ''extent of disease.'' To estimate how much of the cancer disparities were mediated by differences in extent of disease at diagnosis across socioeconomic groups, we repeated the analysis for those sites in which there was at least 60% complete data on extent of disease. We recalculated age-standardized RSRs, excluding those with missing extent of disease data. We then further standardized by extent of disease, using age/extent weights calculated by multiplying the age-specific weights by the age-specific extent distribution for each site separately. Note that SEER summary staging can only be used for solid tumors; thus, analyses of patients with leukemia or non–Hodgkin's lymphoma were not adjusted for extent of disease.

To estimate the survival gap between the least and the most deprived, we calculated survival gradients across the four levels of deprivation. This measure is also known as the slope index of inequality (31). We used weighted linear regression of RSRs on the ridit scores for each of the NZDep categories, in which NZDep 1 to 4 has the value of 0.2, NZDep 5 to 6 = 0.5, NZDep 7 to 8 = 0.7, and NZDep 9 to 10 = 0.9. Thus, each NZDep category is assigned a score equivalent to its midpoint on a cumulative rank scale. The regression estimates therefore estimate the difference between the hypothetically most deprived (score = 1.0) and least deprived (score = 0) persons. The weights used were the inverse of the variance of the RSRs and were repeated for the age-extent standardized RSRs. The percentage difference between these two sets of regression estimates gave the contribution of extent at diagnosis to deprivation differences in survival.

The Massey University Human Ethics Committee was informed of the study. Formal approval was not sought, as was standard policy at the time of the study, because it only involved anonymous record linkage between two databases.

Results

Following the exclusions described above, there were 132,006 patients, with 1 of the 20 chosen cancer sites included in the analysis. Age-standardized 5-year RSRs are shown in Table 1. There was good evidence of a deprivation gap in favor of the least deprived group between the hypothetically least and most deprived people for most cancers, including the six most common cancer sites, namely prostate, colorectal, breast, melanoma, lung, and bladder. Equally strong was the deprivation gap for cancer of the kidney and uterus. Brain cancer was the only site in which survival in the least deprived category was significantly lower than that in the most deprived category.

Table 1. Age-standardized 5-y RSRs and 95% confidence intervals for site-specific cancers among 132,006 patients in New Zealand, by deprivation category

Cancer site	Deprivation 1-4 (least deprived)		Deprivation 5-6		Deprivation 7-8		Deprivation 9-10 (most deprived)		Deprivation gap (95% CI)*	*P*
	n	RSR	*n*	RSR	*n*	RSR	*n*	RSR		
Prostate	9,632	0.88 (0.86-0.89)	4,802	0.85 (0.83-0.87)	4,834	0.82 (0.80-0.84)	3,736	0.76 (0.73-0.78)	−0.15 (−0.27 to −0.03)	0.033
Colorectum	8,714	0.63 (0.62-0.65)	4,732	0.60 (0.58-0.62)	4,941	0.58 (0.56-0.60)	3,646	0.56 (0.54-0.58)	−0.10 (−0.10 to −0.09)	<0.001
Breast	7,674	0.84 (0.82-0.85)	3,938	0.80 (0.78-0.82)	4,006	0.81 (0.79-0.83)	3,372	0.77 (0.75-0.79)	−0.08 (−0.19 to 0.01)	0.066
Melanoma	6,496	0.93 (0.91-0.94)	3,094	0.91 (0.89-0.93)	2,993	0.90 (0.88-0.92)	2,115	0.88 (0.86-0.91)	−0.06 (−0.08 to −0.04)	0.006
Lung	4,051	0.13 (0.11-0.14)	2,884	0.10 (0.09-0.11)	3,283	0.08 (0.07-0.09)	3,425	0.08 (0.07-0.09)	−0.07 (−0.14 to 0.00)	0.048
Bladder	2,005	0.74 (0.70-0.77)	1,053	0.71 (0.66-0.75)	1,058	0.68 (0.63-0.73)	842	0.65 (0.60-0.70)	−0.12 (−0.16 to −0.08)	0.005
Non-Hodgkin's lymphoma	2,022	0.53 (0.50-0.56)	1,012	0.54 (0.50-0.58)	1,064	0.49 (0.46-0.53)	844	0.48 (0.44-0.52)	−0.07 (−0.22 to 0.07)	0.17
Leukemia	1,790	0.48 (0.45-0.51)	927	0.47 (0.43-0.52)	1,017	0.50 (0.46-0.54)	843	0.40 (0.33-0.48)	−0.03 (−0.33 to 0.27)	0.70
Stomach	1,181	0.19 (0.17-0.22)	667	0.18 (0.15-0.22)	747	0.17 (0.14-0.20)	805	0.20 (0.17-0.23)	0.00 (−0.12 to 0.12)	0.96
Kidney	1,169	0.60 (0.56-0.63)	640	0.56 (0.51-0.60)	674	0.52 (0.48-0.57)	586	0.50 (0.45-0.55)	−0.14 (−0.19 to −0.1)	0.005
Head and neck	896	0.55 (0.51-0.59)	576	0.55 (0.50-0.60)	651	0.60 (0.55-0.65)	596	0.53 (0.48-0.58)	0.00 (−0.27 to 0.28)	0.97
Pancreas	967	0.07 (0.05-0.08)	599	0.04 (0.03-0.05)	574	0.04 (0.03-0.05)	544	0.04 (0.03-0.05)	−0.03 (−0.12 to 0.04)	0.20
Ovary	983	0.46 (0.43-0.50)	519	0.40 (0.35-0.44)	542	0.45 (0.41-0.49)	513	0.45 (0.40-0.49)	−0.01 (−0.26 to 0.24)	0.86
Uterus	877	0.79 (0.75-0.83)	495	0.75 (0.69-0.80)	589	0.72 (0.68-0.77)	564	0.69 (0.64-0.74)	−0.14 (−0.15 to −0.12)	<0.001
Brain	746	0.14 (0.12-0.16)	421	0.17 (0.14-0.20)	408	0.20 (0.17-0.24)	364	0.17 (0.05-0.28)	0.10 (0.01 to 0.20)	0.040
Esophagus	625	0.11 (0.09-0.13)	398	0.13 (0.10-0.16)	434	0.11 (0.08-0.13)	358	0.10 (0.08-0.13)	−0.01 (−0.11 to 0.08)	0.59
Cervix	589	0.77 (0.73-0.81)	334	0.67 (0.61-0.73)	407	0.71 (0.66-0.76)	477	0.67 (0.63-0.72)	−0.12 (−0.37 to 0.11)	0.15
Thyroid	475	0.94 (0.90-0.98)	248	0.86 (0.79-0.92)	261	0.89 (0.67-1.00)	292	0.94 (0.89-1.00)	−0.01 (−0.34 to 0.32)	0.90
Liver	350	0.15 (0.12-0.19)	218	0.12 (0.09-0.15)	262	0.06 (0.04-0.08)	345	0.10 (0.08-0.13)	−0.09 (−0.41 to 0.23)	0.36
Pleura	71	0.34 (0.24-0.43)	40	0.19 (0.12-0.27)	52	0.24 (0.16-0.32)	32	0.15 (0.08-0.22)	−0.22 (−0.66 to 0.20)	0.15

NOTE: Data are standardized to the age distribution of patients with each site-specific cancer.
Abbreviation: 95% CI, 95% confidence interval.
*Deprivation gap is negative if survival is lower in the most deprived compared with least deprived groups. See text for a description of the calculation.

To investigate the role that extent of disease played in explaining inequalities in survival, we focused further analyses on those people for whom extent of disease had been recorded. Overall, 34% of patient with solid tumors did not have extent of disease recorded on the registry, and this varied by deprivation category, ranging from 33.6% in the least deprived group to 36.1% in the most deprived group ($P < 0.001$). The degree of missing data also varied by site. Extent of disease data were <60% complete for cancers of prostate, lung, bladder, head and neck, pancreas, esophagus, liver, and pleura. These cancers were excluded for the remainder of the analyses because of the concern of selection bias in analyzing variables with such incomplete data.

Based only on the subset of people with recorded extent of disease, age-standardized RSRs were computed for the remaining cancers. As seen by comparing the RSRs and deprivation gaps in Tables 1 and 2, the exclusion of people with missing data attenuated the strength of the survival gradient between the most and least deprived groups, and none of the regression-based deprivation gap estimates based on this subset of patients was significant at the 5% level. However, there was still weak evidence for lower survival in more deprived groups for colorectal, breast, and uterine cancer, as well as for melanoma.

Age- and extent-standardized RSRs are shown in Table 3. Standardizing for extent of disease at diagnosis barely altered the RSR for cancers of the kidney, uterus, and brain; the contribution to the deprivation gap was 2.7%, 5.1%, and 0.5%, respectively. A small proportion (12.2%) of the inequalities in colorectal cancer were explained by extent of disease. For breast cancer (33.8%) and melanoma (50%), the extent of disease explained about half of the deprivation gap in survival, and it explained the entire deprivation gap in cervical cancer. In the case of stomach and thyroid cancer, extent standardization marginally strengthened the association between deprivation and survival. However, all of these percentage changes after adjusting for extent must be interpreted with caution because the initial disparities were small and the absolute effect of standardization was minimal.

To investigate the possible effect of confounding by ethnicity, we repeated these analyses in the non-Māori population. There were no substantial differences in the results found, although overall, the inequalities were marginally smaller in the non-Māori population than in the total population.

Discussion

In this report, we have shown the presence of socioeconomic inequalities in cancer survival in New Zealand. These inequalities, albeit some of them are relatively small in magnitude, were evident for all of the major cancer sites. Following standardization to account for differences in extent of disease at the time of diagnosis between deprivation groups, many of the socioeconomic inequalities were attenuated. The results that we have presented were not due to confounding by ethnicity, as shown by the similar results found when the analyses were conducted in non-Māori only.

The strength of these results lies in the high quality of the data collection systems in New Zealand, with almost

Table 2. Age-standardized 5-y RSRs and 95% confidence intervals for people with extent of disease data recorded on the New Zealand Cancer Registry, by deprivation category

Cancer site (% with extent data)	Deprivation 1-4 (least deprived)		Deprivation 5-6		Deprivation 7-8		Deprivation 9-10 (most deprived)		Deprivation gap*	*P*
	n	RSR	*n*	RSR	*n*	RSR	*n*	RSR		
Colorectum (89%)	7,770	0.63 (0.62-0.65)	4,226	0.60 (0.58-0.63)	4,452	0.59 (0.56-0.61)	3,227	0.60 (0.57-0.62)	−0.07 (−0.16 to 0.02)	0.079
Melanoma (97%)	6,286	0.92 (0.90-0.93)	2,969	0.90 (0.88-0.92)	2,873	0.90 (0.88-0.92)	2,028	0.89 (0.87-0.92)	−0.03 (−0.06 to 0.01)	0.074
Breast (81%)	6,283	0.84 (0.82-0.85)	3,244	0.81 (0.79-0.83)	3,211	0.82 (0.80-0.84)	2,715	0.80 (0.78-0.82)	−0.05 (−0.12 to 0.02)	0.083
Kidney (82%)	968	0.62 (0.57-0.66)	518	0.58 (0.52-0.63)	548	0.54 (0.49-0.60)	479	0.56 (0.50-0.63)	−0.10 (−0.25 to 0.05)	0.11
Stomach (64%)	761	0.22 (0.18-0.26)	464	0.22 (0.17-0.27)	485	0.17 (0.13-0.22)	516	0.23 (0.18-0.28)	−0.02 (−0.28 to 0.25)	0.82
Uterus (83%)	724	0.81 (0.76-0.85)	433	0.77 (0.71-0.82)	499	0.75 (0.70-0.80)	474	0.75 (0.69-0.81)	−0.09 (−0.18 to 0.01)	0.061
Brain (86%)	650	0.13 (0.11-0.16)	364	0.17 (0.14-0.20)	362	0.21 (0.16-0.25)	307	0.17 (0.13-0.21)	0.07 (−0.10 to 0.24)	0.22
Thyroid (89%)	431	0.94 (0.90-0.98)	219	0.85 (0.79-0.92)	220	0.91 (0.85-0.97)	253	0.97 (0.92-1.02)	0.02 (−0.36 to 0.40)	0.84
Cervix (65%)	402	0.83 (0.78-0.88)	210	0.80 (0.72-0.89)	264	0.74 (0.69-0.79)	288	0.80 (0.73-0.87)	−0.10 (−0.41 to 0.21)	0.29

NOTE: Data are standardized to the same age distribution of patients with each site-specific cancer; thus, data are fully comparable with Table 1. This table is restricted to those cancer sites for which >60% of cases had extent of disease data recorded.

*Deprivation gap is negative if survival is lower in the most deprived compared with least deprived groups. See text for a description of the calculation.

Table 3. Age- and extent-standardized 5-y RSRs and 95% confidence intervals, by deprivation category

Cancer site	Deprivation 1-4 (least deprived)	Deprivation 5-6	Deprivation 7-8	Deprivation 9-10 (most deprived)	Deprivation gap*	*P*
	RSR	RSR	RSR	RSR		
Colorectum	0.63 (0.61-0.64)	0.60 (0.58-0.62)	0.59 (0.57-0.61)	0.60 (0.57-0.62)	−0.06 (−0.14 to 0.02)	0.088
Melanoma	0.91 (0.90-0.92)	0.89 (0.87-0.91)	0.91 (0.89-0.93)	0.89 (0.87-0.92)	−0.01 (−0.09 to 0.06)	0.50
Breast	0.83 (0.82-0.85)	0.82 (0.80-0.84)	0.82 (0.80-0.84)	0.80 (0.78-0.82)	−0.03 (−0.09 to 0.02)	0.11
Kidney	0.62 (0.58-0.65)	0.57 (0.52-0.61)	0.58 (0.53-0.63)	0.55 (0.49-0.60)	−0.09 (−0.22 to 0.03)	0.089
Stomach	0.23 (0.19-0.26)	0.21 (0.16-0.25)	0.19 (0.14-0.23)	0.22 (0.18-0.27)	−0.02 (−0.19 to 0.15)	0.60
Uterus	0.79 (0.75-0.83)	0.76 (0.71-0.82)	0.73 (0.68-0.77)	0.74 (0.69-0.80)	−0.09 (−0.21 to 0.03)	0.085
Brain	0.13 (0.11-0.16)	0.17 (0.13-0.20)	0.20 (0.16-0.25)	0.17 (0.13-0.21)	0.07 (−0.10 to 0.24)	0.21
Thyroid	0.92 (0.89-0.96)	0.84 (0.78-0.90)	0.91 (0.87-0.95)	0.97 (0.94-1.00)	0.06 (−0.30 to 0.42)	0.55
Cervix	0.80 (0.76-0.83)	0.76 (0.72-0.80)	0.75 (0.71-0.79)	0.82 (0.78-0.85)	0.00 (−0.30 to 0.31)	0.97

NOTE: The numbers of people in each cancer site/deprivation category are the same as in Table 2.
*Deprivation gap is negative if survival is lower in the most deprived compared with least deprived groups. See text for a description of the calculation.

complete coverage of cancer registration and death ascertainment. However, the degree of missing data in the extent of disease field was substantial for some cancers. It differed across deprivation groups and age-standardized deprivation gaps were smaller when restricting to those with data on extent, indicative of possible selection bias. Our extent-standardized results for stomach and cervical cancer need to be interpreted cautiously in the light of 35% of the data being missing. In particular for cervical cancer, it is likely that the large degree of missing data, which was more common in women from more deprived groups, could have underestimated the deprivation gap. There are several possible reasons on why extent data might be missing, including insufficient information for the determination of extent, e.g., unknown primary site, incomplete evaluation of the extent of disease due to poor prognosis or high level of clinical complexity, patients choosing not to have the needed further testing to determine the extent of disease, or leaving New Zealand before the completion of such tests. Furthermore, more affluent or educated people may be better placed to navigate their way through the health system. Maximizing completeness of data is an urgent priority for future monitoring of cancer survival in New Zealand. It has been suggested that staging of disease may be not only more complete but also more accurate in higher social classes (32), thus biasing the estimated effect of disease stage on survival inequalities. In the current study, we had no information available to enable us to investigate this hypothesis. A further possible bias in the study is that there have been anecdotal suggestions that Pacific people may return to Pacific Islands following a diagnosis of cancer. Following emigration, death data would not be recorded in New Zealand, and we may have overestimated the survival of this group. As the majority of Pacific people in New Zealand live in areas of high deprivation (33), this would have led to an underestimation of the survival inequalities described here. Nevertheless, our results clearly show a pattern of a modest contribution only of extent of disease to deprivation gaps in survival.

As is common in most record linkage studies, the only measure of socioeconomic position that we had available was an area-based measure based on census characteristics. The resulting misclassification of exposure will have attenuated the detected differences in survival between socioeconomic groups that we report. A comparison of individual and area-based measures from the same census (2006) found only weak correlation ($r = 0.34$) between the two (24). However, one should note that correlations between different individual-level socioeconomic factors (e.g., income and education) are also far from 1.0. Area-based measures of socioeconomic position also capture the contextual effects of a neighborhood's socioeconomic profile on health, and extricating the individual from the area-level effects is difficult (34). Work in the United Kingdom has shown that for breast cancer survival, the larger the population size of the small area used in area-based measures of deprivation, the greater the underestimation of the socioeconomic disparities, with an underestimation in the deprivation gap of up to 25% (35). This effect is a result of higher socioeconomic heterogeneity in larger areas and as such is likely to be applicable to other cancers and probably in the New Zealand context also. Ideally, individual-based measures of socioeconomic position would be used; for example, car access and housing tenure have been identified in the United Kingdom as more sensitive measures of deprivation than area-based measures (36).

A strong predictor of prognosis is the stage of the cancer at diagnosis. Socioeconomic disparities in stage may arise as a result of inequalities in access to screening and primary care, particularly in settings such as New Zealand where there is a fee payable for general practitioner visits, including those in which cervical smears are taken. A review of studies from the 1970s and 1980s concluded that although stage of disease at diagnosis is one explanation for social inequalities in cancer survival, it is not the full explanation of such disparities (32). Furthermore, the prognostic effect of stage on inequalities in cancer survival varies by cancer site as well as by country (32). A more recent review highlighted persisting inequalities in cancer survival and noted that explanations for these inequalities need to focus on patient and tumor characteristics, as well as quality of treatment and stage of disease at diagnosis (2). In our study, we were limited by the extent of disease data available on the New Zealand Cancer Registry. The SEER categories used are broad, and there will be significant clinical heterogeneity within each category. Thus, our standardized results are likely to be affected by residual confounding. Detailed site-specific analyses incorporating clinical and further sociodemographic details are required to investigate this in more detail.

There are a number of individual patient and tumor factors that affect survival and may vary across social groups. Risk behaviors, such as smoking, could explain some of the differences in cancer survival between socioeconomic groups. In New Zealand, the prevalence of smoking is approximately three times higher in the most deprived compared with the least deprived quintile of the NZDep distribution (37). Some studies have found that smoking before diagnosis adversely affects cancer survival (38, 39), although the evidence to support this is not consistent (40, 41). Further work on this issue, considering the close relationship between socioeconomic position and smoking, is required. Work is under way to construct smoking-specific life tables.

Similarly, comorbidity, which itself affects cancer survival (42), is likely to vary across socioeconomic groups. In New Zealand, people living in more deprived areas are more likely to be diagnosed with ischemic heart disease, diabetes, and chronic respiratory disease than those living in less deprived areas (37). The use of relative survival methods with deprivation-specific life tables eliminates the possibility that comorbidities directly account for lower survival in more deprived people. However, the presence of comorbidities may limit the treatment choices available to cancer patients, thus having an indirect effect on survival. For example, in a cohort of women with breast cancer, those with a higher comorbidity level (3+ versus 0 on the Charlson scale) were less likely to receive any surgery (93% versus 97%) and less likely to receive modified radical mastectomy with adjuvant therapy (17% versus 34%; ref. 43).

It is also possible that tumor prognostic characteristics vary with socioeconomic position if differences in risk factors result in different subtypes of a site-specific cancer with different case fatalities. We have investigated this possibility for breast cancer in New Zealand and found no difference in estrogen, progesterone, or HER-2 receptor status across deprivation groups (44).

Access into and through the health care system in a timely fashion is key to optimal cancer treatment and, hence, survival. Barriers to prompt treatment include first contact with primary care (or screening services), attendance at secondary care, and delays through the health system. It has been suggested, for example, that the lower survival from brain tumors in more affluent people could be accounted for by higher use of computed tomography or magnetic resonance image scanning in more affluent patients, resulting in higher rates of detection of cancers with the worst prognosis, which might otherwise have been certified on death as strokes (45). In New Zealand, despite publicly funded secondary care, users are required to pay for primary care consultations, making it difficult for those in lower socioeconomic groups to access health care. Physical access may also be a problem, and lack of car ownership may be a barrier to accessing hospital care. A study in France found that distance to the nearest hospital is related to colorectal cancer survival (46), despite free transport being offered through the health system. An international systematic review of factors that increase the delay in getting a referral to a specialist for people with suspected colorectal cancer found that lower educational level was associated with a longer delay in 7 of 15 studies (47). In a large survey in England, social class was significantly related to delay in the secondary care system for colorectal, ovarian, prostate, and breast cancer (32, 48), although similar patterns were not evident for prehospital or referral delay.

Equitable, high-quality treatment of cancer is a prerequisite for equitable outcomes. Scant research in this area has been published, but the accumulating evidence shows that physician decisions may be contributing to inequalities in cancer survival. For example, a prospective study of women with breast cancer found that women with lower levels of education were administered intentionally lower doses of first-cycle chemotherapy (49). Other studies have found evidence of lower rates of breast-conserving therapy, radiation therapy, and adjuvant chemotherapy among women of lower socioeconomic status (50, 51). An in-depth prospective study of the reasons for inequalities in breast cancer survival in New Zealand is due to begin in 2009.

The findings presented in this report have implications for the imminent colorectal cancer screening program in New Zealand. A retrospective analysis of breast cancer survival in the Netherlands found that following the introduction of mass mammography, a deprivation gap in breast cancer survival has appeared, which was not previously apparent (52). We have shown that the extent of disease at diagnosis accounts for a small proportion of the deprivation gap in colorectal cancer survival in New Zealand. It is a challenge to the colorectal cancer screening program to ensure that the disparities are reduced rather than perpetuated or accentuated.

In conclusion, we have shown socioeconomic inequalities in cancer survival, which differ by cancer site. These socioeconomic inequalities are independent of, but weaker than, the ethnic inequalities that we have previously documented (23). Extent of disease may account for some but not all of these disparities. Further detailed analyses, including data on sociodemographic, personal, and clinical factors, are required to inform action strategies to achieve equality in cancer survival.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

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