Survival disparities in Indigenous and non-Indigenous New Zealanders with colon cancer: the role of patient comorbidity, treatment and health service factors

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MeSH keywords:

colonic neoplasms, delivery of health care, ethnic groups, New Zealand, survival analysis

Word count

Summary: 248
Text: 3148

Abstract

Background. Ethnic disparities in cancer survival have been documented in many populations and cancer types. The causes of these inequalities are not well understood but may include disease and patient characteristics, treatment differences and health service factors. We compared survival in a cohort of Māori (Indigenous) and non-Māori New Zealanders with colon cancer and assessed the contribution of demographics, disease characteristics, patient comorbidity, treatment and health care factors to survival disparities.

Methods. Māori patients diagnosed with colon cancer between 1996 and 2003 were identified from the New Zealand Cancer Registry and compared with a randomly-selected sample of non-Māori patients. Clinical and outcome data were obtained from medical records, pathology reports and the national mortality database. Cancer-specific survival was examined using Kaplan-Meier survival curves and Cox hazards modelling with multivariable adjustment.

Results. We compared 301 Māori and 328 non-Māori patients with colon cancer. Māori had significantly poorer cancer survival than non-Māori (hazard ratio [HR] = 1.33, 95% CI: 1.03-1.71) that was not explained by demographic or disease characteristics. The most important factors contributing to poorer survival in Māori were patient comorbidity and markers of health care access, each of which accounted for around a third of the survival disparity. The final model accounted for almost all the survival disparity between Māori and non-Māori patients (HR = 1.07, 95% CI: 0.77-1.47).

Conclusion. Higher patient comorbidity and poorer access and quality of cancer care are both important explanations for worse survival in Māori compared with non-Māori New Zealanders with colon cancer.

Introduction

Ethnic disparities in cancer survival have been described in many populations and cancer types. Survival disparities are found between Indigenous and non-Indigenous peoples in New Zealand,[1-3] Australia,[4, 5] and the United States (US)[6-8] and between ethnic minority and majority populations in many countries, particularly the US.[6, 9, 10] Survival differences are seen across a range of cancer sites including malignancies of the breast, prostate, lung and colon. [6, 9, 10]

Cancer is an important and growing contributor to **the eight to nine year difference in life expectancy** between Māori and non-Māori New Zealanders.[11, 12] **Māori are the Indigenous peoples of New Zealand and make up 15% of the 4 million population; the non-Indigenous population is predominantly European in origin with significant Pacific (7%) and Asian (9%) groupings.**[13] As with many kinds of cancer, Māori patients have poorer survival from colon cancer compared with non-Maori.[1, 2] New Zealand has particularly high incidence and mortality from colorectal cancer.[14] **Age-adjusted incidence is lower in Māori compared with non-Maori populations (9 compared with 15 per 100,000)[2] but mortality rates are now similar, having decreased in non-Māori and increased in Māori over time**.[11, 15, 16]

The causes of ethnic disparities in cancer survival are poorly understood but are likely to include factors at the level of individual patients, health care processes and health systems overall.[9, 17, 18] The existence of ethnic survival disparities in many populations and cancer types suggests these factors are at work across a range of different contexts and ethnic groupings.

Patient-level factors that may affect survival include tumour characteristics (grade and stage at diagnosis) and comorbid conditions. Late-stage diagnosis contributes to cancer survival disparities between Māori and non-Māori New Zealanders,[1, 2] Indigenous and non-Indigenous

Australians[4] and Black and White Americans[19-21] but is unlikely to explain the majority of ethnic survival disparities. Fewer studies have assessed the impact of patient cormorbidity (which is difficult to measure accurately from administrative data), although higher comorbidity contributes to survival disparities between Indigenous and non-Indigenous Australians.[4] There is some evidence that biological factors play a role in survival disparities for breast cancer[22] but not for colon cancer.[20, 23]

Health system factors may impact both at the level of treatment decisions and processes and at more structural levels such as the location, resourcing and accessibility of health care facilities. Lower rates of cancer treatment (including surgery and chemotherapy) contribute to Indigenous/non-Indigenous survival disparities in Australia[4] and ethnic survival disparities in the US.[9, 19, 24-26] Differential health care access and institutional factors receive particular emphasis in the US context[27, 28] but do not fully explain survival inequalities since these are found even in equal-access healthcare settings.[9, 19]

New Zealand has a publicly-funded national health system that provides specialist and hospital care to all residents without patient charges. There are no existing New Zealand data on the role of health systems factors in cancer survival disparities, but Māori/non-Maori inequalities are found in management of other diseases with Māori receiving fewer health services relative to expected need [29] [30, 31] and lower quality care in some contexts.[32] Maori are more likely to self-report experiences of being discriminated against by a health professionals due to their ethnicity[33] which may contribute to suboptimal treatment. Higher rates of socioeconomic disadvantage in the Maori population make it harder for many Maori patients to access services requiring co-payments such as primary health care and prescription medication.[31, 34]

Our study examined survival disparities between Māori and non-Māori patients with a first-time diagnosis of colon cancer. We assessed the relative contribution of patient, treatment and health systems factors to survival disparities, adjusting for patient-level factors first in order to assess the role of treatment and health service differences independent of clinical factors. Our study cohort was drawn from the entire country and included individual review of medical notes from both public and private health facilities, allowing comprehensive comparison of factors contributing to colon cancer survival disparities at a national level.

Methods

New Zealand residents diagnosed with colon cancer between 1996 and 2003 were eligible for study inclusion. Cases came from patients notified to the New Zealand Cancer Registry with a primary tumour in the colon (ICD-10-AM site codes C18.0 to 19.0 excluding 18.1) and morphology consistent with adenocarcinoma. (New Zealand has mandatory registration of all primary cancers except non-melanoma skin cancers and carcinoma-in-situ.) Patients were ineligible if they were less than 25 years at diagnosis, were normally resident outside New Zealand, had a previous diagnosis of colon cancer, **had no histological diagnosis,** or were diagnosed after death.

All Māori patients meeting the above criteria were included along with an approximately equal number of randomly-sampled non-Māori patients. Patients were classified as Māori if their ethnicity was recorded as such in any of the three cancer registry ethnicity fields. (These fields are based on self-identified ethnicity data from hospital admission and registration sheets.) Patients whose ethnicity was not recorded in the cancer registry were classified as non-Māori.[35]

Clinical data were abstracted from patients' medical records, including public and private health care providers. Pathology reports were obtained for all patients from their health care records, the cancer registry or directly from the reporting laboratory. Data were recorded on a standardised form by a physician (SH) and double-entered into an electronic database. Data included details of patients' presentation, investigation for diagnosis of colon cancer, comorbid conditions present at the time of diagnosis, smoking status, tumour characteristics (including location, histological features and stage at diagnosis), surgical treatment, and adjuvant treatment (including chemotherapy and radiotherapy). Small area deprivation and rurality were assigned according to each patient's domicile (census area) code at the time of diagnosis. Small area

deprivation was classified by the New Zealand deprivation index, an area-based index calculated from aggregated census data on residents' socioeconomic characteristics (such as car access, housing tenure, and benefit receipt).[36] Outcome data (vital status and cause of death) were obtained by linking study patients to the national mortality database, with follow-up to the end of 2005. Patients whose deaths were not recorded in the mortality database were assumed to be still alive at the end of follow-up, while those who died from causes other than colon cancer were censored at the date of death.

Māori and non-Māori cohorts were compared for demographics, tumour characteristics, patient comorbidity and smoking, treatment and markers of health service access. Māori/non-Māori prevalence ratios were adjusted for age, sex and year of diagnosis using log poisson regression with robust variance estimation.[37] Cancer-specific survival curves for Māori and non-Māori were estimated using the Kaplan-Meier method and compared by log-rank test. Mortality hazards were compared using Cox regression modelling.

Hazard ratios were sequentially adjusted for five domains of covariates to assess the relative contribution of each domain to Māori/non-Maori survival disparities. These domains were: patient demographics (age, sex and year of diagnosis), disease characteristics (stage, grade and site of tumour, and emergency presentation), patient comorbidity (specific comorbid conditions and smoking), treatment (definitive surgery, surgeon type, delay to surgery, adjuvant chemotherapy), and markers of health care access (treatment facility type, small area deprivation and rurality). We used the Hausman test to assess the significance of a change in hazard ratio with adjustment for each domain.[38, 39]

Specific comorbid conditions were included as covariates in survival analyses if they were found to be independently associated with colon cancer survival in the study

cohort.[40] These **conditions** were: previous myocardial infarction, previous or current heart failure, current respiratory disease, diabetes mellitus, cerebrovascular disease, renal disease and neurological disorders. **For the purpose of survival analyses, small area deprivation was conceptualised as a marker of health care access (rather than an individual sociodemographic variable). This reflects the influence of deprivation on cancer survival independent of individual characteristics such as stage at diagnosis, comorbidity or smoking (which were adjusted for prior to including deprivation in the model).**[41, 42]

Approval for this study was granted by the New Zealand Multi-Region Ethics Committee (MEC/05/06/069). All analyses were carried out in SAS (version 9.1, SAS Institute Inc., Cary, NC).

Results

A total of 376 Māori patients met the study criteria based on cancer registry records, and a further 400 non-Māori patients were randomly selected from the registry as a comparison cohort. Ninety one (12%) of those sampled were later excluded because further information showed they were ineligible for study inclusion (65 had miscoded data (primarily cancer site) in the cancer registry and a further 26 had no histological diagnosis), giving 329 Māori and 356 non-Māori patients. Full data were obtained for 301 Māori and 328 non-Māori patients (92% of the eligible sample). **Based on cancer registry records 93% of the non-Maori cohort were of European ethnicity**.

The Māori cohort was significantly younger than the non-Māori cohort (Table 1) in keeping with the younger age structure of the total Māori population in New Zealand.[12] Māori patients had a higher prevalence of comorbid conditions, with around two and a half times the rates of diabetes, heart failure, respiratory disease and renal disease seen in non-Māori. Māori patients were about 50% more likely to be smokers.

Compared with non-Māori patients Māori were more likely to be diagnosed with advanced (metastatic) cancer and less likely to be diagnosed with localised disease, although differences were non-significant after adjustment for age and sex. **The stage distribution of the study cohort was not significantly different to that of all registered colon cancers from the corresponding period, except that the study cohort had a lower prevalence of unstaged cancer (4.5% overall compared with 7.4% in the Cancer Registry, p=0.003).** Māori patients were more likely to have left-sided tumours while non-Māori had more right-sided tumours. Cancers in Māori patients tended to be less aggressive with a higher proportion of well-differentiated tumours. Māori patients were significantly more likely to present to hospital

services as an emergency case (with bowel obstruction, for example) rather than being electively referred by a primary care physician.

Table 1 Demographics, tumour characteristics, comorbid conditions and smoking status in Māori and non-Māori cohorts

	Māori (n=301)	non-Māori (n=356)	PR (95%CI)*		p value
Age at diagnosis (mean)	61.3 years	70.6 years			<0.0001
Female	43.9%	52.4%			0.03
Tumour stage					
Stage I and II	40.9%	44.8%	1.01	(0.83 - 1.23)	0.9
Stage III (+ve nodes)	28.9%	34.2%	0.84	(0.65 - 1.08)	0.2
Stage IV (metastases)	28.9%	20.1%	1.20	(0.89 - 1.62)	0.2
Unstaged	1.3%	0.9%	2.33	(0.91 - 5.97)	0.08
Tumour site					
Right colon	35.9%	46.7%	0.81	(0.66 - 0.99)	0.04
Left colon	44.9%	29.6%	1.37	(1.09 - 1.72)	0.007
Rectosigmoid	16.0%	16.2%	1.09	(0.74 - 1.61)	0.7
Synchronous	3.3%	7.6%	0.46	(0.20 - 1.05)	0.06
Tumour grade					
Well-differentiated	12.0%	7.6%	1.97	(1.17 - 3.33)	0.01
Mod differentiated	71.1%	73.5%	0.93	(0.84 - 1.04)	0.2
Poorly differentiated	16.9%	18.9%	0.91	(0.63 - 1.32)	0.6
Emergency presentation	38.2%	26.5%	1.44	(1.13 - 1.84)	0.004
Comorbid conditions					
Previous heart attack	8.0%	8.2%	1.22	(0.68 - 2.19)	0.5
Heart failure	11.6%	9.2%	2.65	(1.63 - 4.32)	<0.0001
Diabetes	20.9%	10.7%	2.46	(1.66 - 3.65)	<0.0001
Respiratory disease	7.0%	3.7%	2.42	(1.18 - 5.00)	0. 02
Cerebrovascular disease	6.6%	9.2%	1.25	(0.69 - 2.26)	0.5
Renal disease	6.6%	4.0%	2.60	(1.27 - 5.32)	0.01
Neurological disorder†	5.3%	7.6%	0.71	(0.36 - 1.40)	0.3
Smoking status					
Current smoker	27.9%	12.2%	1.54	(1.07 - 2.23)	0.02
Ex-smoker	38.5%	36.0%	1.20	(0.97 - 1.49)	0.09
Non-smoker	29.6%	45.4%	0.72	(0.57 - 0.90)	0.005
missing	4.0%	6.4%	0.64	(0.31 - 1.33)	0.2

*PR=prevalence ratio. Prevalence ratios are adjusted for age, sex and year of diagnosis using log poisson regression with robust convergence estimation.

†Significant neurological and psychiatric disorders other than cerebrovascular disease – that is, bipolar disorder, blindness, dementia, epilepsy, idiopathic peripheral neuropathy, intellectual impairment, multiple sclerosis, Parkinson's disease, polio, previous head injury, schizophrenia and spinal stenosis. Prevalence ratios are adjusted for age, sex and year of diagnosis using log poisson regression.

Table 2 Treatment and markers of health service access in Māori and non-Māori cohorts

	Māori (n=301)	non-Māori (n=356)	PR (95%CI)*		p value
Definitive surgery†	87.7	93.6	0.93	(0.88 - 0.98)	0.01
Surgeon type					
Colorectal surgeon	14.3	15.6	0.70	(0.47 - 1.05)	0.09
General surgeon	72.1	72.9	1.02	(0.92 - 1.13)	0.7
Surgical trainee	8.6	6.7	1.37	(0.76 - 2.49)	0.3
Delay to surgery (>28 d)	14.3	11.9	1.40	(0.90 - 2.20)	0.1
Adjuvant chemotherapy	18.9	19.8	0.61	(0.42 - 0.86)	0.006
Treatment facility					
Public secondary	61.1	46.3	1.40	(1.20 - 1.65)	<0.0001
Public tertiary	29.2	33.2	0.89	(0.69 - 1.14)	0.4
Private	5.0	17.7	0.19	(0.11 - 0.32)	<0.0001
Small area deprivation					
1 (least deprived)	6.3	14.3	0.37	(0.22 - 0.62)	0.0002
2	7.3	19.2	0.34	(0.21 - 0.56)	<0.0001
3	16.0	22.0	0.81	(0.57 - 1.16)	0.2
4	27.2	26.5	1.06	(0.80 - 1.41)	0.7
5 (most deprived)	43.2	18.0	2.41	(1.82 - 3.19)	<0.0001
Rurality					
Urban	77.4	90.0	0.86	(0.79 - 0.93)	0.0001
Urban-rural	6.6	4.9	1.20	(0.59 - 2.41)	0.6
Rural	16.0	4.3	3.82	(2.00 - 7.29)	<0.0001

*PR=prevalence ratio. Prevalence ratios are adjusted for age, sex and year of diagnosis using log poisson regression with robust convergence estimation.

†Definitive surgery: surgical removal of tumour (including complete excision during colonoscopy).

Non-Māori patients were significantly more likely than Māori to undergo definitive surgery (that is, complete removal of the primary tumour either at colonoscopy or at operation) (Table 2). No significant differences were found in the type of surgeon performing the operation, but Māori patients were (non-significantly) more likely to experience a delay of a month or more between diagnosis and treatment. Māori patients were significantly less likely to receive adjuvant chemotherapy.

The cohorts differed significantly in indicators of health service access. Māori patients were more likely to be treated in secondary (smaller) public health care facilities and less likely to be treated in private facilities. They were also more likely to live in high deprivation areas, and were almost four times as likely to live in rural areas compared with non-Māori patients.

<Figure 1 about here>

Figure 1 Cancer-specific survival for Māori and non-Māori cohorts (unadjusted)

Māori had lower cancer-specific survival compared with non-Māori patients (Figure 1). Crude five-year cancer-specific survival was 61.1% in non-Māori and 52.5% in Māori patients. The crude mortality hazard ratio for Māori compared with non-Māori patients was 1.33 (95% confidence interval 1.03-1.71) (Table 3). This disparity persisted with adjustment for demographic factors (hazard ratio = 1.30 after adjustment for age, sex and year of diagnosis) and disease factors (hazard ratio = 1.33 after further adjustment for stage, grade and site of tumour, and emergency presentation).

Table 3 Hazard ratios for cancer-specific mortality risk in Māori and non-Māori cohorts with stepwise adjustment for demographics, disease factors, patient factors, health care processes and health care access.

Adjusted for:	Additional variables in model:	HR	(95% CI)
0. Unadjusted	-	**1.33**	(1.03 - 1.71)
1. Demographics	Age, sex, year of diagnosis	**1.30**	(0.99 - 1.71)
2. Disease factors	+ Stage	1.29	(0.97 - 1.71)
	+ Grade	1.31	(0.99 - 1.74)
	+ Site	1.36	(1.01 - 1.82)
	+ Emergency presentation	**1.33**	(0.99 - 1.79)
3. Patient factors	+ Comorbidities*	1.24	(0.92 - 1.68)
	+ Smoking	**1.20†**	(0.89 - 1.63)
4. Health care processes	+ Definitive surgery	1.21	(0.89 - 1.64)
	+ Surgeon type	1.21	(0.90 - 1.65)
	+ Delay to surgery	1.20	(0.88 - 1.63)
	+ Adjuvant chemotherapy	**1.17**	(0.86 - 1.60)
5. Health care access	+ Treatment facility type	1.12	(0.82 - 1.53)
	+ Small area deprivation	1.10	(0.80 - 1.52)
	+ Rurality	**1.07†**	(0.77 - 1.47)

HR=hazard ratio. HRs calculated using Cox proportional hazards regression with imputed data for 33 individuals with missing smoking status (almost identical results obtained with missing variable indicator).

*Comorbidities – that is, previous MI, heart failure, respiratory disease, diabetes, cerebrovascular disease, renal disease and neurological disorders (as outlined in Table 1).

†Significant decrease in hazard ratio compared with previous domain - ie p-value <0.05 by Hausman test

Patient comorbidity accounted for around a third of the Māori/non-Māori disparity in cancer survival, with adjustment for specific comorbid conditions and patient smoking reducing the hazard ratio from 1.33 to 1.20 (Table 3). Differences in treatment for Māori and non-Māori patients may have contributed to the survival disparity, with a (non-significant) reduction in the hazard ratio from 1.20 to 1.17 following further adjustment for definitive surgery, surgeon type, delay to surgery and receipt of adjuvant chemotherapy. Differences in indicators of health care access contributed significantly to the survival disparity, with the hazard ratio falling from 1.17 to 1.07 with further adjustment for treatment facility type, small area deprivation and rurality of patient's residence.

Factors included in this final model (Table 4) together accounted for almost all the Māori/non-Māori disparity in cancer survival, with Māori patients only 7% more likely to die from their colon cancer after adjustment for demographics, tumour characteristics, patient comorbidity, treatment and markers of health service access.

Table 4 Hazard ratios for selected variables from final model (cancer-specific mortality risk)

	(n)	%	HR	(95% CI)
Indigenous status				
Non-Māori	(328)	52.2	1.00	
Maori	(301)	47.9	1.07	(0.77 - 1.47)
Stage at diagnosis				
Stage I	(79)	12.6	0.51	(0.22 - 1.20)
Stage II	(191)	30.4	1.00	
Stage III	(199)	31.6	3.81	(2.36 - 6.16)
Stage IV	(153)	24.3	19.64	(12.36 - 31.20)
Unstaged	(7)	1.1	4.26	(1.12 - 16.21)
Grade (cell differentiation)				
Well differentiated	(61)	9.7	0.77	(0.44 - 1.35)
Moderately differentiated	(455)	72.3	1.00	
Poorly differentiated	(113)	18.0	1.45	(1.04 - 2.03)
Tumour site				
Right colon	(261)	41.5	1.11	(0.80 - 1.55)
Left colon	(232)	36.9	1.00	
Rectosigmoid junction	(101)	16.1	0.67	(0.44 - 1.00)
> 1 site (multiple tumours)	(35)	5.6	1.02	(0.57 - 1.82)
Emergency presentation				
No	(427)	67.9	1.00	
Yes	(202)	32.1	1.26	(0.94 - 1.69)
Comorbid conditions				
Previous MI (heart attack)	(51)	8.1	1.27	(0.76 - 2.11)
Heart failure	(65)	10.3	1.53	(0.89 - 2.62)
Diabetes	(98)	15.6	0.95	(0.64 - 1.42)
Respiratory disease	(33)	5.3	0.68	(0.34 - 1.38)
Cerebrovascular disease	(50)	8.0	1.31	(0.81 - 2.12)
Renal disease	(33)	5.3	1.00	(0.49 - 2.05)
Neurological disorder†	(41)	6.5	2.01	(1.16 - 3.48)
Smoking status				
Non-smoker	(124)	19.7	1.00	
Current smoker	(234)	37.2	1.16	(0.78 - 1.72)
Ex-smoker	(238)	37.8	1.50	(1.08 - 2.10)
Definitive surgery				

No	(66)	10.5	1.00	
Yes	(563)	89.5	0.24	(0.15 - 0.39)
Type of surgeon				
General surgeon	(456)	72.5	1.00	
Specialist colorectal surgeon	(94)	14.9	1.22	(0.80 - 1.85)
Trainee surgeon	(48)	7.6	1.13	(0.66 - 1.92)
Delay to treatment				
No	(547)	87.0	1.00	
Yes	(82)	13.0	1.10	(0.72 - 1.70)
Adjuvant chemotherapy				
No	(507)	80.6	1.00	
Yes	(122)	19.4	0.55	(0.35 - 0.88)
Treatment facility type				
Secondary public hospital	(336)	53.4	1.34	(0.97 - 1.84)
Tertiary (teaching) public hospital	(197)	31.3	1.00	
Private hospital	(73)	11.6	0.92	(0.53 - 1.58)
Small area deprivation (per 10% increase in deprivation score)			1.02	(0.96 - 1.08)
Rurality				
Urban	(531)	84.4	1.00	
Urban-rural	(36)	5.7	1.24	(0.72 - 2.15)
Rural	(62)	9.9	1.21	(0.79 - 1.84)

HR=hazard ratio. HRs calculated using Cox proportional hazards regression with imputed data for 33 individuals with missing smoking status (almost identical results obtained with missing variable indicator).

†Significant neurological and psychiatric disorders other than cerebrovascular disease – that is, bipolar disorder, blindness, dementia, epilepsy, idiopathic peripheral neuropathy, intellectual impairment, multiple sclerosis, Parkinson's disease, polio, previous head injury, schizophrenia and spinal stenosis.

Discussion

In a population-based cohort of New Zealanders with colon cancer Māori patients had poorer survival than non-Māori, with around 30% higher risk of dying from their cancer. This survival disparity was not due to disease characteristics: Māori patients generally had lower grade tumours and were not significantly more likely to present with advanced disease. Higher rates of pre-existing medical conditions and more limited health service access each appeared to account for around a third of the excess mortality risk in Māori patients, while lower rates of cancer treatment may also have made a modest contribution. Together these factors accounted for almost all the survival disparity between Māori and non-Maori patients.

We did not find significant Māori/non-Māori differences in stage at diagnosis, **although non-significant differences were consistent with previous evidence of more advanced cancer in Māori patients.[2] New Zealand does not currently have a national screening programme for colon cancer, but Māori/non-Maori disparities are evident in access to breast and cervical cancer screening[43, 44] and specialist cancer services.[45] Inadequate** access to primary and diagnostic health services may also contribute to higher rates of emergency presentation in Māori patients **with colon cancer.**

Māori patients in our cohort tended to have more favourable tumour characteristics with a higher prevalence of well-differentiated cancers. Black patients in the US are likewise more likely than White patients to have well-differentiated tumours of the colon,[20, 23] arguing against the suggestion that survival disparities reflect less favourable biology in ethnic minority groups. Current evidence does not support a role for genetic factors in ethnic disparities in cancer survival.

Patient comorbidity and smoking were significant mediators of Māori/non-Māori survival disparities. Higher rates of diabetes, cardiovascular and respiratory disease in Māori patients reflect high prevalences in the general Māori population.[12] Valery et al found similarly high comorbidity in Indigenous Australians with cancer although the contribution to survival disparities is difficult to assess (the authors controlled for comorbidity only after adjusting for treatment differences).[4] Reasons for higher comorbidity and smoking rates in Indigenous peoples are complex and include greater socioeconomic deprivation, poorer access to favourable determinants of health and (ultimately) historical disadvantage through the processes of colonisation.[12, 46]

Differences in health care access and quality are important mediators of survival disparities between Māori and non-Māori cancer patients. Similar disparities exist in cardiac care, with Māori patients more commonly admitted to hospitals lacking cardiac intervention services[47] contributing to lower rates of revascularisation compared with non-Māori.[29, 30] Our study found several markers of poorer health care access in Māori cancer patients, who were more likely to live in rural and economically deprived areas and less likely to receive treatment in specialist cancer centres or private hospitals. These markers almost certainly overlap with health care quality which was not directly assessed. Differential health care access has been shown to contribute to health disparities in other countries.[27, 28, 48] US hospitals serving predominantly African American communities have more limited capacity and struggle to meet treatment standards – a de facto segregation of health services that contributes to poorer health outcomes in the Black population.[49] Even if individual facilities in New Zealand provide equitable care the structure of the health system as a whole may result in unequal care for Māori and non-Māori patients, a form of institutional racism and an important cause of survival disparities.

New Zealand has a public health system that aims to provide equal-access care to all residents, although individuals may purchase private health insurance or pay directly to access some services (including specialist assessment and surgery) through private health providers. Health insurance coverage is much lower in the Māori population (Stillman S and Cumming J, personal communication) as reflected here by low rates of private hospital treatment amongst Māori patients. Patients with access to private health care may gain a survival benefit from shorter waiting times and easier access to diagnostic and treatment services.

In the New Zealand context socioeconomic position is strongly correlated with ethnicity and is an important mediator in the relationship between ethnicity and health.[11, 12] Our only socioeconomic measure was residential area deprivation at the time of diagnosis. In this study we view area deprivation as a marker of health service access more than individual patient demographics. Many studies show socioeconomic deprivation is a predictor of poorer cancer survival primarily through its effect on stage at diagnosis and cancer treatment.[21, 41, 42] Our multivariable models examined the effects of individual-level factors (such as stage at diagnosis and comorbidity) before contextual factors (such as health care access). Having already adjusted for stage and treatment differences the remaining effect of area deprivation is likely to occur primarily through its influence on health care access (including both contextual effects and patients' ability to reach and navigate cancer services).

Potential limitations of our study include **modest** sample size, **misclassified deaths and possible selection effects.** The relatively low occurrence of colon cancer in the Māori population during an eight-year window limits our power to demonstrate **small Māori/non-Māori** differences and changes in the hazard ratio with covariate adjustment. **Misclassification of the fact of death is likely to be very small since all study members were New Zealand residents and deaths occurring in New Zealand are recorded in the national mortality**

database. A more likely source of bias is misclassification of non-cancer deaths as due to colon cancer; this would tend to bias Māori/non-Māori hazard ratios towards the null, since a greater proportion of non-Māori deaths are due to causes other than colon cancer. Our sample may represent a slightly selected group **of patients** since inclusion required histological evidence of adenocarcinoma, excluding just under 7% of all registered cases**. This restriction increased the internal validity of our study, however, and allowed** us to assess the role of tumour biology in survival disparities.

Strengths of our study include its population-based sample frame, near-complete data ascertainment (92% of eligible cases) and comprehensive data collection including detailed comorbidity and pathology assessment from review of individual medical records. Since cohort members and data were drawn from throughout New Zealand these findings inform our understanding of Indigenous/non-Indigenous disparities at a national level, including the role played by health service access and quality. This is highly relevant given the substantial Māori/non-Māori differences that exist in geographical and socioeconomic distribution, private health insurance and access to tertiary hospitals.

Attention to health services is a key step in improving cancer care and decreasing disparities in cancer outcomes. Potential strategies to improve access for Māori patients include development and support of Māori health providers, improving the cultural accessibility and competence of mainstream providers and ensuring adequate resources for health services serving area with large Māori populations.[44, 45] Finally, ongoing monitoring of treatment and outcomes by ethnicity provides important feedback to improve services and help ensure Indigenous and non-Indigenous New Zealanders receive an equal standard of care.

WHAT THIS PAPER ADDS

What is already known on this subject?

- Ethnic disparities in cancer survival are observed in many populations and cancer types
- Māori (Indigenous) New Zealanders with colon cancer have poorer survival than patients from other ethnic groups, even after adjustment for stage at diagnosis
- Ethnic disparities in cancer survival may reflect differences in health care access and quality

What does this study add?

- Māori/non-Māori disparities in colon cancer survival are largely accounted for by higher comorbidity levels and poorer access to quality cancer services in Māori patients
- Markers of health service access and quality accounted for over a third of the survival disparity between Māori and non-Māori patients with colon cancer
- Attention to health care delivery is important for addressing ethnic inequalities in cancer outcomes

Acknowledgements

We thank Geetanjali Datta and Brian Cox for advice on analyses and study design, Diane Kenwright and Anne O'Donnell for clinical input, and Emma Britton for assistance in obtaining pathology records.

Competing interests

None.

Funding

This work was supported by the Cancer Society of New Zealand (grant number 05/16) and by Fulbright New Zealand which provided scholarship support to Sarah Hill.

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