The characteristics and outcomes of patients with colorectal cancer in New Zealand, analysed by Cancer Network

Tania Blackmore, Chunhuan Lao, Lynne Chepulis, Blaithin Page, Ross Lawrenson

ABSTRACT

AIM: The incidence of colorectal cancer (CRC) in New Zealand is high by international standards. Approximately 1,200 people in New Zealand die from this disease per year. Outcomes in New Zealand following a CRC diagnosis are poor. We aimed to describe the characteristics and outcomes of patients diagnosed with CRC across the four regional cancer networks in New Zealand.

METHOD: Patient demographics, tumour characteristics and survival outcomes for all patients diagnosed with CRC between 2006 and 2015 were analysed retrospectively from the National Cancer Registry (NZCR) and National Mortality collection and were linked by National Health Index (NHI) number.

RESULTS: A total of 29,221 CRC cases were recorded during the 10-year study period, of which the majority were cancer of the colon (67.9%). In this sample, 42.0% were >75 years, 52.1% were male and 88.1% were New Zealand European. After adjustment for factors such as age, gender, ethnicity year of diagnosis, cancer extent, cancer grade, lymph node and cancer site, cancer-related and all-cause survival were not significantly different by cancer network for those aged <75 but for patients aged >75 years, those living in the Central and Midland Cancer Network had a higher risk of dying of CRC compared to those in the Northern Cancer Network (1.12, 95% CI: 1.03–1.22 and 1.10, 95% CI: 1.02–1.18 respectively). Overall, Māori and Pacific people had worse cancer-specific and all-cause survival than New Zealand European.

CONCLUSION: No regional variations were seen within New Zealand for the characteristics and survival outcomes of patients <75 diagnosed with CRC. The risk of dying from CRC increased for those >75, which is supportive of the international literature regarding outcomes for the elderly and CRC. We continue to show disparity in outcomes for Māori and Pacific patients diagnosed with CRC in New Zealand.

Colorectal cancer (CRC) is the second most common cancer in New Zealand.[1] Almost 3,500 new cases were registered in New Zealand in 2018, with around 1,200 deaths.[2] The incidence of CRC in New Zealand is high by international standards; the GLOBOCAN age-standardised estimated incidence rate shows Australia and New Zealand as having the highest rates of CRC in the world.[2] Outcomes in New Zealand are poor; five-year survival rates in New Zealand following a CRC diagnosis are lower than Australia.[3–5] Stage of disease at diagnosis, Māori ethnicity, deprivation level and rate of presentation to hospital emergency departments[5,6] are contributing factors associated with poorer outcomes.

Worldwide, a higher incidence of CRC occurs in those aged 70 years or more.[7–9] Increasing levels of comorbidity[7,10–13] together with higher risk of functional and cognitive impairment[12] contribute to poorer outcomes for elderly compared to younger patients. Higher rates of comorbidity and increasing frailty results in older patients being less likely to access treatment,[11,14–16]

have higher rates of emergency surgery and have significant risk of mortality at 90 days post-surgery.[17] An assessment of cancer survival in seven high-income countries from 1995–2014 demonstrated an increase in age standardised five-year net survival in New Zealand for both colon and rectal cancer in those aged <75, but a decrease for those aged >75 diagnosed with colon cancer.[18] Thus, New Zealand data are supportive of the international literature, where poor survival is noted with increasing age, particularly for those aged 80 and over[8,16,19] with little improvement over time despite advances in treatment options.

New Zealand is divided into four regional cancer networks: the Northern, Midland, Central and Southern Cancer Networks. Within these regional networks are several district health boards (DHBs) that provide for the health needs of the local population: the Northern Cancer Network covers the Northland, Auckland, Counties Manukau and Waitemata DHBs, the Midland Cancer Network covers Waikato, Lakes, Bay of Plenty and Tairawhiti, and the Central Cancer Network encompasses Taranaki, Whanganui, MidCentral, Hawke's Bay, Wairarapa, Hutt Valley and Capital and Coast DHBs. The Southern Cancer Network encompasses the whole of the South Island. This study aimed to quantify the outcomes of patients diagnosed with CRC in New Zealand using national databases across these four regional networks.

Method

This study retrospectively reviewed patients diagnosed with CRC (ICD-10-AM codes C18–C20) in New Zealand between 01 January 2006 and 31 December 2015. Eligible patients were identified from the New Zealand Cancer Registry (NZCR). Their mortality information was obtained from the Mortality Collection and linked by National Health Index (NHI) number.

The combined dataset consisted of: 1) patient demographics: date of birth, gender, ethnicity and district health board (DHB); 2) tumour characteristics: date of diagnosis, cancer site, cancer extent and number of positive lymph nodes; and 3) date of death and cause of death. Age at diagnosis was categorised into five groups: <55, 55–64, 65–74, 75–84 and 85+ years. Ethnicity was classified into New Zealand European, Māori, Pacific, Asian and others as recorded on the NZCR using prioritisation to manage multiple ethnicities. Patients were grouped into one of the four cancer networks based on their domicile: Central, Midland, Northern or Southern Cancer Network. The NZCR records cancer stage and uses both the Tumour Node Metastases (TNM) staging system[20] and the Surveillance Epidemiology and End Results (SEER) programme of cancer staging definitions.[21] Complete SEER staging was recorded for 81% of CRC patients.

Patient and tumour characteristics were compared between the four cancer networks and the differences were examined with Chi-square tests. Patients were considered to be censored on the date of death or the last updated date of Mortality Collection, which was 31 December 2015. Survival analyses were stratified by patients aged less than 75 years and patients aged 75 years or over. The Kaplan-Meier method was used to estimate the colorectal cancer-specific survival and all-cause survival by cancer network. A Cox proportional hazards model was used to estimate the hazard ratios of colorectal cancer-specific survival and all-cause survival by cancer network after adjustment for ethnicity, gender, year of diagnosis, cancer extent, cancer grade, lymph node and cancer site. All data analyses were performed in IBM SPSS statistics 25 (New York, US). The study was approved by the Health and Disability Ethics Committee (HDEC) –17/NTB/156.

Results

Patient and tumour characteristics by cancer network are shown in Table 1. In the 10-year period, 2006–2015, 29,221 people were diagnosed with CRC in New Zealand. Of these, 52.1% of patients were male. Overall, 88.1% were New Zealand European and only 5.4% were Māori. The Midland Cancer Network had the highest proportion of Māori patients (8.7% vs 2.7–6.0%), the Northern Cancer Network had the highest proportion of Asian (6.6% vs 1.0–2.0%) and Pacific patients (4.8% vs 0.3–1.7%), while the Southern Cancer Network was 95% New Zealand European. Patients in the Central and the Midland Cancer Network were younger and less likely to be diagnosed at age >75 years (33.3% and 34.0%, p<0.001)

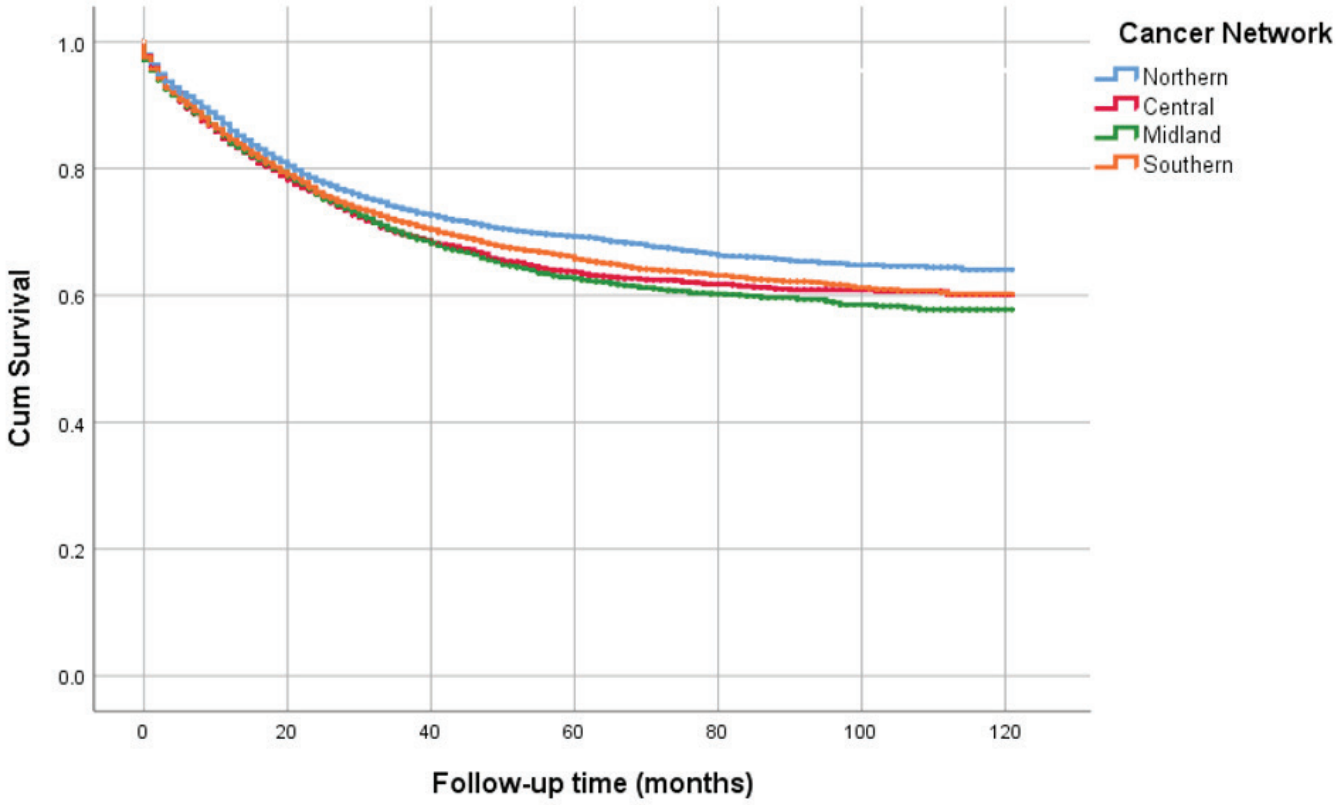
Table 1: Patient and tumour characteristics by Cancer Network.

Characteristics	Central		Midland		Northern		Southern		P-value	Unknown		Total	
Gender													
Female	2,778	48.6%	2,886	47.8%	4,112	46.8%	4,201	48.7%	0.065	25	43.1%	14,002	47.9%
Male	2,941	51.4%	3,156	52.2%	4,665	53.2%	4,424	51.3%		33	56.9%	15,219	52.1%
Ethnicity									<0.001				
Asian	116	2.0%	67	1.1%	575	6.6%	83	1.0%		3	5.2%	844	2.9%
European	5,078	88.8%	5,336	88.3%	7,093	80.8%	8,205	95.1%		39	67.2%	25,751	88.1%
Māori	344	6.0%	523	8.7%	493	5.6%	229	2.7%		1	1.7%	1,590	5.4%
Pacific	99	1.7%	31	0.5%	421	4.8%	29	0.3%		10	17.2%	451	1.5%
Others	82	1.4%	85	1.4%	195	2.2%	79	0.9%		5	8.6%	585	2.0%
Age group									<0.001				
<55	669	11.7%	644	10.7%	1,169	13.3%	838	9.7%		12	20.7%	3,332	11.4%
55–64	929	16.2%	947	15.7%	1,591	18.1%	1,460	16.9%		18	31.0%	4,945	16.9%
65–74	1,644	28.7%	1,795	29.7%	2,534	28.9%	2,735	31.7%		17	29.3%	8,725	29.9%
75–84	1,743	30.5%	1,946	32.2%	2,446	27.9%	2,576	29.9%		9	15.5%	8,720	29.8%
85+	734	12.8%	710	11.8%	1,037	11.8%	1,016	11.8%		2	3.4%	3,499	12.0%
Cancer site									<0.001				
C18	3,884	67.9%	4,191	69.4%	5,810	66.2%	5,919	68.6%		40	69.0%	19,844	67.9%
C19	336	5.9%	411	6.8%	699	8.0%	562	6.5%		2	3.4%	2,010	6.9%
C20	1,499	26.2%	1,440	23.8%	2,268	25.8%	2,144	24.9%		16	27.6%	7,367	25.2%
Extent									<0.001				
B	1,261	28.2%	1,544	30.7%	2,122	29.6%	1,997	28.2%		9	19.1%	6,933	29.1%
C	778	17.4%	801	15.9%	1,307	18.2%	1,281	18.1%		10	21.3%	4,177	17.5%
D	1,291	28.9%	1,476	29.3%	2,075	28.9%	1,996	28.2%		15	31.9%	6,853	28.8%
E	1,141	25.5%	1,216	24.1%	1,677	23.4%	1,816	25.6%		13	27.7%	5,863	24.6%
F	1,248		1,005		1,596		1,535			11		5,395	
Grade									<0.001				
1	238	5.0%	577	11.4%	1,317	19.0%	460	7.0%		9	20.9%	2,601	11.1%
2	3,610	75.7%	3,503	69.2%	4,550	65.6%	4,517	68.7%		27	62.8%	16,207	69.3%
3	861	18.1%	896	17.7%	852	12.3%	1,524	23.2%		6	14.0%	4,139	17.7%
4	59	1.2%	88	1.7%	215	3.1%	75	1.1%		1	2.3%	438	1.9%
Unknown	951		978		1,843		2,049			15		5,836	
Lymph nodes									0.115				
No positive nodes	1,964	55.9%	2,206	56.8%	3,212	57.4%	3,232	58.4%		20	52.6%	10,634	57.3%
Positive nodes	1,549	44.1%	1,678	43.2%	2,381	42.6%	2,303	41.6%		18	47.4%	7,929	42.7%
Unknown	2,206		2,158		3,184		3,090			20		10,658	
Total	**5,719**		**6,042**		**8,777**		**8,625**			**58**		**29,221**	

C18: Malignant neoplasm of colon,
C19: Malignant neoplasm of rectosigmoid junction
C20: Malignant neoplasm of rectum
Extent
B: Localised to organ of origin
C: Invasion of adjacent tissue or organ
D: Regional lymph nodes
E: Distant
F: Unknown

Figure 1: Colorectal cancer-specific survival by cancer network: (a) <75 years (p=0.000); (b) ≥75 years (p=0.005).

a)



b)

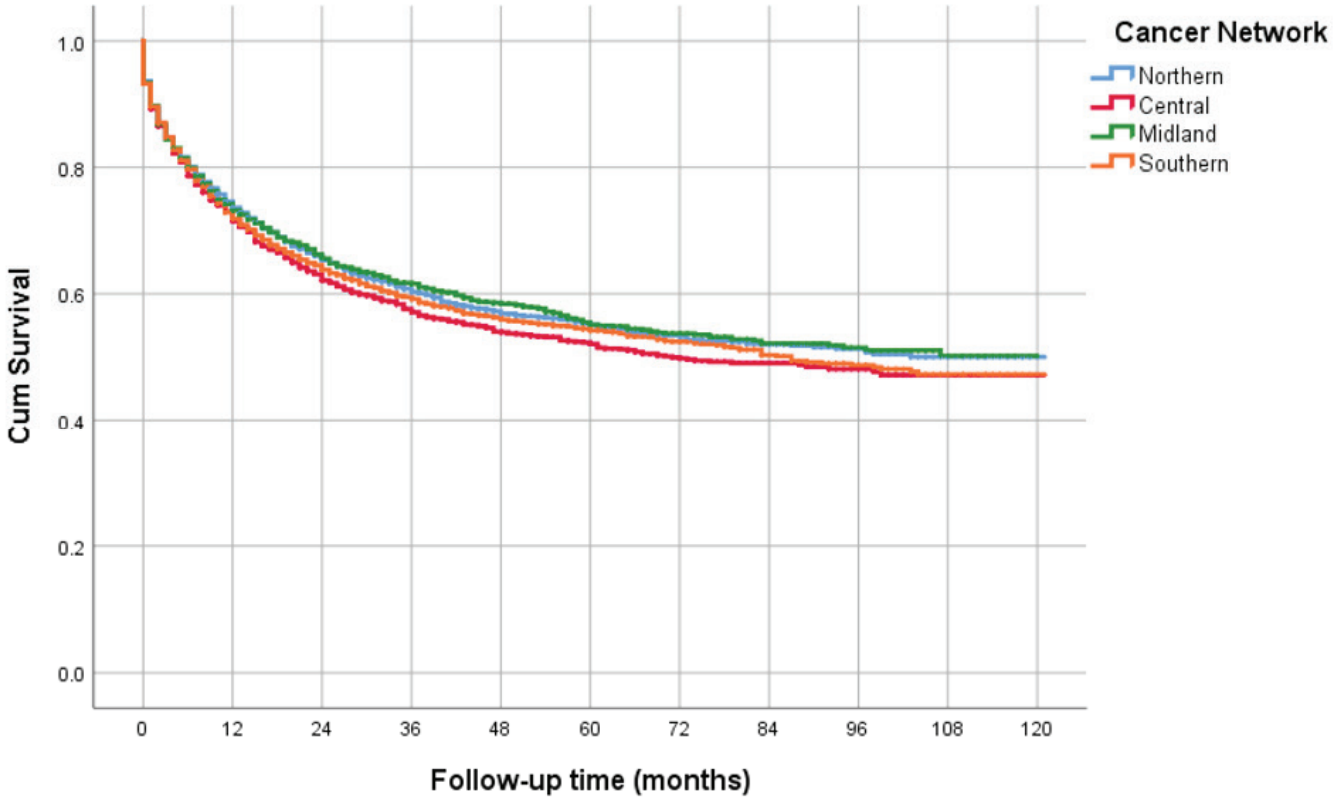


Figure 2: All-cause survival by cancer network: (a) <75 years (p=0.000); (b) ≥75 years (p=0.114).

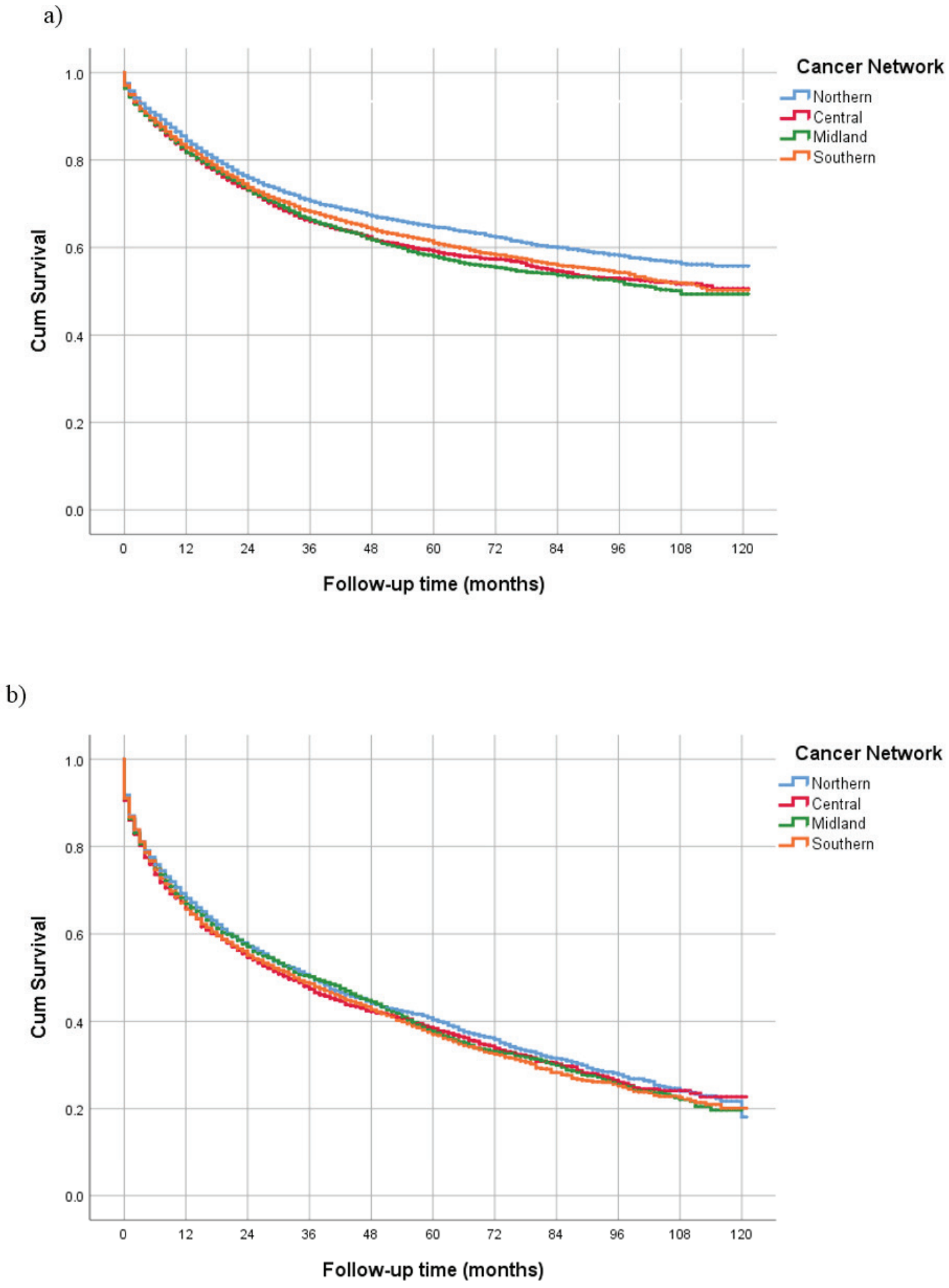


Table 2: Hazard ratios for cancer-specific mortality and all-cause mortality for patients aged <75.

	Cancer-specific mortality				All-cause mortality			
Factors	**p-value**	**Hazard ratio**	**95% CI**		**p-value**	**Hazard ratio**	**95% CI**	
			Lower	**Upper**			**Lower**	**Upper**
Age (continuous)	<0.001	1.02	1.01	1.02	<0.001	1.02	1.02	1.03
Ethnicity								
European	Ref				Ref			
Māori	<0.001	1.30	1.18	1.43	<0.001	1.41	1.30	1.54
Pacific	0.170	1.12	0.95	1.31	0.027	1.18	1.02	1.37
Asian	0.001	0.73	0.60	0.88	<0.001	0.69	0.58	0.83
Others	<0.001	0.35	0.25	0.49	<0.001	0.30	0.22	0.42
Gender								
Female	Ref				Ref			
Male	0.003	1.09	1.03	1.16	<0.001	1.13	1.07	1.19
Year (continuous)	<0.001	0.94	0.93	0.95	<0.001	0.95	0.94	0.96
Cancer Network								
Central	0.330	1.04	0.96	1.13	0.082	1.07	0.99	1.16
Midland	0.452	1.03	0.95	1.12	0.306	1.04	0.96	1.12
Northern	Ref				Ref			
Southern	0.052	0.93	0.86	1.00	0.147	0.95	0.89	1.02
Extent								
B	Ref				Ref			
C	<0.001	2.92	2.43	3.52	<0.001	1.75	1.53	2.00
D	<0.001	4.46	3.74	5.31	<0.001	2.42	2.11	2.77
E	<0.001	21.84	18.67	25.55	<0.001	10.83	9.67	12.12
Grade								
1	Ref				Ref			
2	0.011	1.17	1.04	1.33	0.028	1.13	1.01	1.26
3	<0.001	2.16	1.90	2.46	<0.001	1.96	1.75	2.20
4	0.008	1.57	1.12	2.21	0.002	1.60	1.18	2.16
Lymph node								
No positive nodes	Ref				Ref			
Positive nodes	<0.001	1.69	1.48	1.93	<0.001	1.45	1.29	1.63
Cancer site								
C18	Ref				Ref			
C19	0.043	0.90	0.81	1.00	0.043	0.91	0.83	1.00
C20	<0.001	0.71	0.66	0.77	<0.001	0.71	0.67	0.77

C18: Malignant neoplasm of colon,
C19: Malignant neoplasm of rectosigmoid junction
C20: Malignant neoplasm of rectum
Extent
B: Localised to organ of origin
C: Invasion of adjacent tissue or organ
D: Regional lymph nodes
E: Distant
F: Unknown

Table 3: Hazard ratios for cancer-specific mortality and all-cause mortality for patients aged ≥75 years.

	Cancer-specific mortality				All-cause mortality			
Factors	**p-value**	**Hazard ratio**	**95% CI**		**p-value**	**Hazard ratio**	**95% CI**	
			Lower	**Upper**			**Lower**	**Upper**
Age (continuous)	<0.001	1.04	1.04	1.05	<0.001	1.06	1.05	1.06
Ethnicity								
European	Ref				Ref			
Māori	0.564	1.06	0.88	1.27	<0.001	1.29	1.12	1.49
Pacific	0.026	1.35	1.04	1.75	0.020	1.32	1.04	1.66
Asian	0.030	0.76	0.60	0.97	0.011	0.77	0.63	0.94
Others	0.001	0.45	0.27	0.73	<0.001	0.36	0.23	0.55
Gender								
Female	Ref				Ref			
Male	0.572	1.02	0.96	1.08	<0.001	1.12	1.06	1.17
Year (continuous)	<0.001	0.96	0.95	0.97	<0.001	0.97	0.96	0.98
Cancer Network								
Central	0.006	1.12	1.03	1.22	0.016	1.09	1.02	1.17
Midland	0.098	1.07	0.99	1.17	0.008	1.10	1.02	1.18
Northern	Ref				Ref			
Southern	0.892	1.01	0.93	1.09	0.256	1.04	0.97	1.11
Extent								
B	Ref				Ref			
C	<0.001	2.46	2.10	2.88	<0.001	1.39	1.26	1.53
D	<0.001	3.81	3.19	4.55	<0.001	1.99	1.75	2.27
E	<0.001	13.18	11.32	15.36	<0.001	5.81	5.24	6.43
Grade								
1	Ref				Ref			
2	<0.001	1.33	1.15	1.54	0.002	1.17	1.06	1.30
3	<0.001	1.94	1.66	2.26	<0.001	1.56	1.39	1.75
4	<0.001	1.94	1.47	2.56	0.002	1.48	1.16	1.89
Lymph node								
No positive nodes	Ref				Ref			
Positive nodes	<0.001	1.42	1.22	1.65	0.030	1.14	1.01	1.29
Cancer site								
C18	Ref				Ref			
C19	0.136	0.91	0.80	1.03	0.046	0.90	0.81	1.00
C20	<0.001	0.80	0.73	0.86	<0.001	0.78	0.73	0.83

C18: Malignant neoplasm of colon,
C19: Malignant neoplasm of rectosigmoid junction
C20: Malignant neoplasm of rectum
Extent
B: Localised to organ of origin
C: Invasion of adjacent tissue or organ
D: Regional lymph nodes
E: Distant
F: Unknown

than patients in the Northern and Southern Cancer Network (39.7% and 41.7%, p<0.001). Patients in the Central Cancer Network were more likely to have rectal cancer (C20: 26.2% vs 23.8–25.8%, p<0.001) than the other cancer networks. Patients in the Northern Cancer Network had more grade 1 cancer (19.0% vs 5.0–11.4%), but more grade 4 cancer (3.1% vs 1.1–1.7%) than other regions (p<0.001). The proportion of patients reporting positive lymph nodes were similar across the four cancer networks.

The observed regional difference in survival was greater in patients under 75 years than in patients aged 75 years or older (Figures 1 and 2). Patients aged less than 75 years in the Northern Cancer Network had the best survival: five-year cancer-specific survival of 69.2% (67.7–70.6%) and five-year all-cause survival of 64.9% (63.4–66.3%); while their counterparts in the Midland Cancer Network had the worst survival: five-year cancer-specific survival of 62.9% (61.0–64.8%) and five-year all-cause survival of 58.3% (56.4–60.2%). For patients aged 75 years or older, the five-year all-cause survival between the four cancer networks was similar (p=0.114) (Figure 2B) while there were small differences in cancer-specific survival between regions (Figure 1B).

Cancer-specific survival and all-cause survival improved over time for both patients under 75 years and patients aged 75 years or older, after adjustment for other factors (Tables 2 and 3). The risk of dying of CRC and the risk of dying from other causes both increased with age. Men under 75 years were more likely to die of CRC compared to women, but men aged 75 years or older had a similar risk. For patients aged under 75 years, Māori had the highest hazard ratio of cancer-specific mortality (1.30, 95% CI: 1.18–1.43) and the highest hazard ratio of all-cause mortality (1.41, 95% CI: 1.30–1.54) compared to New Zealand European (Table 2). However, for patients age 75 years or older, Pacific patients had the highest hazard ratio of cancer-specific mortality (1.35, 95% CI: 1.04–1.75) and the highest hazard ratio of all-cause mortality (1.32, 95% CI: 1.04–1.66) compared to New Zealand European (Table 3). After adjustment in a multivariate analysis for other factors (age, ethnicity, gender, year of diagnosis, cancer extent, cancer grade, lymph node and cancer site), the differences in the cancer-specific mortality and all-cause mortality for patients aged less than 75 years between the four cancer networks disappeared. However, for patients aged 75 years or older, those resident in the Central and Midland Cancer Network had a higher risk of dying of CRC compared to patients in the Northern Cancer Network (1.12, 95% CI: 1.03–1.22 and 1.10, 95% CI: 1.02–1.18 respectively). For both cancer-specific mortality and all-cause mortality for patients under 75 years and patients aged 75 years or older, the risk was higher in patients with colon cancer, patients with more extensive cancer, patients with higher grade of cancer and patients with positive lymph nodes.

Discussion

New Zealand has high rates of CRC, and poorer outcomes compared to International Cancer Benchmarking Partnership (ICPB) and GLOBOCAN data.[2,18] After adjustment for patient and tumour factors, there was no significant difference in survival between regions for those aged <75, but for those aged >75 there were small regional differences.

Cancer-specific and all-cause mortality increased with age. Poor CRC survival with increasing age has been reported internationally,[8,16,19] and is attributed to higher levels of functional limitation[12] and multi-comorbidity in older patients.[7,10,11] Patients aged <75 and living in the Northern Cancer Network had the best five-year all cause and cancer-specific survival, and patients living in the Midland Cancer Network had the worst. However, after adjustment for patient and tumour-related factors these regional variations were no longer important. One important factor was that although Māori only account for 5.4% of cases, outcomes for Māori are poor, with an unadjusted HR for cancer-specific survival of 1.3 and all-cause survival of 1.41 in patients <75. The Midland region had the highest proportion of Māori and this may account for some of the disparity in outcomes. Another factor was tumour characteristics. The Midland region also had a greater proportion of colon cases. Cancer-specific outcomes for rectal cancer were 20% better than outcomes for colon cancer. Thus after adjustment for a number of patient and tumour factors, including

ethnicity and tumour location, we can see that the impact of the health services in each region seems to result in equitable outcomes, especially for those <75.

Māori and Pacific patients <75 had worse all-cause and cancer-specific survival than New Zealand European. Historically, Māori have a lower incidence of CRC compared to New Zealand European,[22–24] but this incidence has been rising.[5] Our data are consistent with poorer health outcomes often observed in Māori and Pacific cancer patients in New Zealand[6,25–28] and is in line with reported survival rates of indigenous and ethnic minority populations in other countries.[23,29–32] Of interest was the finding that in the over 75 year age group, while Pacific patients had poorer survival (OR 1.35) compared with New Zealand European, outcomes for Māori were similar (OR 1.06). Factors contributing to the ethnic disparities seen in New Zealand cancer care are well documented; Māori experience more inequalities/barriers when accessing health services than non-Māori,[27,28] experience a lower level of care from those services[26] and do not get the same access to treatment.[33] Māori and Pacific patients are also more likely to present with metastatic disease,[6,28,34,35] experience delays to diagnosis[6] and present to the emergency department compared to non-Māori /non-Pacific patients.[6] Disease biology and culture (eg, diet, help-seeking behaviour),[27] deprivation level,[6] and higher levels of comorbidity for Māori and Pacific patients[6,28,31,33,36] are also factors that contribute to these disparities.

Strengths/limitations

The New Zealand Cancer Registry (NZCR) is a large, population-based register of all cancer registrations in New Zealand. Accuracy of the demographic data in the NZCR is high.[37] Combining with data from the Mortality Collection increases the robustness of the dataset used. However, a limitation of this study was that we were unable to access surgical and other treatment data, which was missing from the dataset. It would be worthwhile to evaluate whether CRC outcomes also differ with regard to treatment in future studies.

Conclusions

No regional variations were seen within New Zealand for the characteristics and survival outcomes of patients <75 diagnosed with CRC. However, the risk of dying from CRC increased for those >75, which is supportive of the international literature regarding outcomes for elderly patients. We continue to show disparity in outcomes for Māori and Pacific patients diagnosed with CRC in New Zealand.

Competing interests:
Nil.

Author information:
Tania Blackmore, Medical Research Centre, University of Waikato, Hamilton;
Chunhuan Lao, Medical Research Centre, University of Waikato, Hamilton;
Lynne Chepulis, Medical Research Centre, University of Waikato, Hamilton;
Blaithin Page, Department of Surgery, Lakes District Health Board, Rotorua;
Ross Lawrenson, Medical Research Centre, University of Waikato, Hamilton.
Corresponding author:
Professor Ross Lawrenson, Medical Research Centre, University of Waikato, Hamilton.
ross.lawrenson@waikato.ac.nz

URL:
www.nzma.org.nz/journal-articles/the-characteristics-and-outcomes-of-patients-with-colorectal-cancer-in-new-zealand-analysed-by-cancer-network

REFERENCES:

1. Health, M.o., Bowel cancer: Information for people at increased risk of bowel cancer, N.Z.G. Group, Editor. 2012, Ministry of Health: Wellington.
2. Ferlay J, EM, Lam F, Colombet M, Mery L, Piñeros M, Znaor A, Soerjomataram I, Bray F. Global Cancer Observatory: Cancer Today. 2018 [cited 2019 Available from: http://gco.iarc.fr/today, accessed [02/09/2019].].
3. Allemani C, Matsuda T, Di Carlo V, Harewood R, Matz M, Nikšić M, Bonaventure A, Valkov M, Johnson CJ, Estève J, Ogunbiyi OJ, Azevedo e Silva O, Chen W, Eser S, Engholm G, Stiller CA, Monnereau A, Woods RR, Visser O, Lim GH, Aitken J, Weir HK, Coleman MP, CONCORD Working Group. Global surveillance of trends in cancer survival 2000–14 (CONCORD-3): analysis of individual records for 37513025 patients diagnosed with one of 18 cancers from 322 population-based registries in 71 countries. The Lancet, 2018. 391.
4. Aye P, Elwood M, Stevanovic V. Comparison of cancer survival in New Zealand and Australia, 2006–2010 NZ Medical Journal 2014. 127.
5. Jackson C, Sharples K, Firth M, Hinder V, Jeffery M, Keating J, Secker A, Derrett S, Atmore C, Bramley D, De Groot C, Stevens W, Sarfati D, Brown C, Hill A, Reid P, Lawrenson R, Findlay M. The PIPER Project: An Internal Examination of Colorectal Cancer Management in New Zealand. 2015, Health Research Council and Ministry of Health.
6. Sharples K, Firth M, Hinder V, Hill A, et al. The New Zealand PIPER Project: colorectal cancer survival according to rurality, ethnicity and socioeconomic deprivation-results from a retrospective cohort study. NZ Med J, 2018; 131(1476):24–39.
7. Papamichael D, Audisio RA, Glimelius B, de Gramont A, Glynne-Jones R, Haller D, Köhne CH, Rostoft S, Lemmens V, Mitry E, Rutten H, Sargent D, Sastre J, Seymour M, Starling N, Van Cutsem E, Aapro M. Treatment of colorectal cancer in older patients: International Society of Geriatric Oncology (SIOG) consensus recommendations 2013. Annals of Oncology, 2014. 26:463–476.
8. Patel SS, Nelson R, Sanchez J, Lee W, et al. Elderly patients with colon cancer have unique tumor characteristics and poor survival. Cancer, 2013; 119(4):739–747.
9. Esteva M, Ruiz A, Ramos M, Casamitjana M, et al. Age differences in presentation, diagnosis pathway and management of colorectal cancer. Cancer epidemiology, 2014; 38(4):346–353.
10. Bojer A, Roikjær O. Elderly patients with colorectal cancer are oncologically undertreated. European Journal of Surgical Oncology (EJSO), 2015; 41(3):421–425.
11. Millan M, Merino S, Caro A, Feliu F, et al. Treatment of colorectal cancer in the elderly. World journal of gastrointestinal oncology, 2015; 7(10):204.
12. Aparicio T, Pamoukdjian F, Quero L, Manfredi S, et al. Colorectal cancer care in elderly patients: unsolved issues. Digestive and Liver Disease, 2016; 48(10):1112–1118.
13. Murchie P, Raja E, Brewster D, Campbell N, et al. Time from first presentation in primary care to treatment of symptomatic colorectal cancer: effect on disease stage and survival. British journal of cancer, 2014; 111(3):461.
14. Doat S, Thiébaut A, Samson S, Ricordeau P, et al. Elderly patients with colorectal cancer: treatment modalities and survival in France. National data from the ThInDiT cohort study. European Journal of Cancer, 2014; 50(7):1276–1283.
15. Aparicio T, Navazesh A, Boutron I, Bouarioua N, et al. Half of elderly patients routinely treated for colorectal cancer receive a sub-standard treatment. Critical reviews in oncology/hematology, 2009; 71(3):249–257.
16. Parakh S, Wong HL, Rai R, Ali S, et al. Patterns of care and outcomes for elderly patients with metastatic colorectal cancer in Australia. Journal of geriatric oncology, 2015; 6(5):387–394.
17. Ministry of Health, Bowel Cancer Quality Improvement Report. 2019, Ministry of Health: Wellington.
18. Arnold M, Rutherford MJ, Bardot A, Ferlay J, et al. Progress in cancer survival, mortality, and incidence in seven high-income countries 1995–2014 (ICBP SURVMARK-2): a population-based study. The Lancet Oncology, 2019.
19. Al-Abed Y, Parker M, Arulampalam T, Tutton M. Survival following rectal cancer surgery: does the age matter? Acta Chirurgica Belgica, 2018:1–7.
20. Weisenberg E. TNM staging of colorectal carcinoma (AJCC 8th edition). . 2019: Available from: PathologyOutlines.com website. http://www.pathologyoutlines.com/topic/colontumorstaging8ed.html

21. National Institutes of Health, N.C.I. SEER Training Modules, Summary Staging. SEER Training Modules 2018 [cited 2019 17/12/2019].

22. Shah AB, Sarfati D, Blakely T, Atkinson J, et al. Trends in colorectal cancer incidence rates in New Zealand, 1981–2004. ANZ journal of surgery, 2012; 82(4):258–264.

23. Dachs GU, Currie MJ, McKenzie F, Jeffreys M, et al. Cancer disparities in indigenous Polynesian populations: Māori, Native Hawaiians, and Pacific people. The lancet oncology, 2008; 9(5):473–484.

24. Sutton TD, Eide TJ, Jass JR. Trends in colorectal cancer incidence and histologic findings in Maori and Polynesian residents of New Zealand. Cancer, 1993; 71(12):3839–3845.

25. Hill S, Sarfati D, Blakely T, Robson B, et al. Survival disparities in Indigenous and non-Indigenous New Zealanders with colon cancer: the role of patient comorbidity, treatment and health service factors. Journal of Epidemiology & Community Health, 2010; 64(2):117–123.

26. Jeffreys M, Stevanovic V, Tobias M, Lewis C, et al. Ethnic inequalities in cancer survival in New Zealand: linkage study. American Journal of Public Health, 2005; 95(5):834–837.

27. Haynes R, Pearce J, Barnett R. Cancer survival in New Zealand: ethnic, social and geographical inequalities. Social science & medicine, 2008; 67(6):928–937.

28. Hill S, Sarfati D, Robson B, Blakely T. Indigenous inequalities in cancer: what role for health care? ANZ journal of surgery, 2013; 83(1–2):36–41.

29. Jackson CS, Oman M, Patel AM, Vega KJ. Health disparities in colorectal cancer among racial and ethnic minorities in the United States. Journal of gastrointestinal oncology, 2016. 7(Suppl 1):S32.

30. Tawk R, Abner A, Ashford A, Brown C. Differences in colorectal cancer outcomes by race and insurance. International journal of environmental research and public health, 2016; 13(1):48.

31. Hill S, Sarfati D, Blakely T, Robson B, et al. Ethnicity and management of colon cancer in New Zealand: do indigenous patients get a worse deal? Cancer, 2010; 116(13):3205–3214.

32. Liss DT, Baker DW. Understanding current racial/ethnic disparities in colorectal cancer screening in the United States: the contribution of socioeconomic status and access to care. American journal of preventive medicine, 2014; 46(3):228–236.

33. Swart EM, Sarfati D, Cunningham R, Dennett E, et al. Ethnicity and rectal cancer management in New Zealand. NZ Med J, 2013; 126(1384):42–52.

34. Shaw C, Blakely T, Sarfati D, Fawcett J, et al. Trends in colorectal cancer mortality by ethnicity and socio-economic position in New Zealand, 1981–99: one country, many stories. Australian and New Zealand journal of public health, 2006; 30(1):64–70.

35. Robson B, Cormack D, Purdie G. Unequal Impact II: Māori and Non-Māori Cancer Statistics by Deprivation and Rural-Urban Status 2002–2006. 2010: Te Rōpū Rangahu Hauora a Eru Pōmare, University of Otago, Wellington.

36. Sarfati D, Tan L, Blakely T, Pearce N. Comorbidity among patients with colon cancer in New Zealand. The New Zealand Medical Journal, 2011; 124:1338.

37. Lawrenson R, Lao C, Brown L, Wong J, et al. Characteristics of lung cancers and accuracy and completeness of registration in the New Zealand Cancer Registry. NZ Med J, 2018. 131(1479):13–23.