CANCER EXCESS MORTALITY RATES OVER 2006-2026 FOR ABC-CBA

Burden of Disease Epidemiology, Equity and Cost-Effectiveness Programme (BODE³)

Technical Report: Number 10

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May 2012

A technical report published by the Department of Public Health,
University of Otago, Wellington

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Acknowledgements

Competing Interests

The authors have no competing interests.

Table of Contents

List of Tables

List of Figures

1 Introduction

This Report provides the <u>baseline</u> excess mortality rates for modelling in the Aotearora Burden of Cancer and Comparative Benefit Assessment (ABC-CBA) project, within the Burden of Disease Epidemiology, Equity and Cost-Effectiveness (BODE[3]) programme. These excess mortality rates are then converted to transition probabilities in Markov models, or time to event distributions in discrete event simulation.

An aim of BODE[3] is to estimate impacts of interventions, and cost effectiveness, by sub-populations. Most importantly, this means separate epidemiological parameters by sex, age, ethnicity and deprivation. With respect to cancer, stage or disease severity is an additional strata of heterogeneity. Finally, estimates are required for the baseline year of 2011, but also annually projected out to 2026.

It is intended that the results presented in this report, and the accompanying tables and electronic files, will provide the baseline parameter necessary for the majority of future ABC-CBA analyses. But we cannot foresee all possible analyses. And it would be inefficient to predict excess mortality rates by stage or severity of cancers that are unlikely to require modelling by stage; rather we will use the methods demonstrated in this Report on an as need basis to specify future interventions.

This Report is in four Parts:

1. A brief summary of international and national literature on changes over time in relative survival, and excess mortality, by cancer sites.
2. A brief summary of international and national literature on differences by stage or severity in relative survival, and excess mortality, by selected cancer sites.
3. A review of various cancer staging systems, with recommendations as to what to use in ABC-CBA given data availability.
4. Actual excess mortality rate more outputs using New Zealand data, including coefficients for sex, age, ethnicity, deprivation, time since diagnosis and calendar year of diagnosis, with additional models by stage (or severity) or including stage (or severity) and interactions with key covariates.

Together, four Parts will provide the basis for parameterising future ABC-CBA models.

2 Literature Review of Survival Trends Overtime

Trend data informs us what the situation was, currently is, and possibly what it might be in the future – the latter aspect being particularly important for the purpose of health service planning and evaluation and for the planning, funding and prioritisation of public health research. Previous work from the New Zealand Census-Mortality Study (NZCMS) and the Cancer Trends study have given us estimates for trends by ethnicity and socioeconomic position on cancer incidence and mortality. However, less is known about changes over time in cancer survival. The purpose of this section is to estimate annual percentage changes in cancer survival, expressed as an excess mortality rate, by synthesising findings from selected cancer survival studies.

2.1 Selected studies

Published literature was searched in Medline and PubMed for studies providing estimates of annual changes in cancer survival (either measured as excess mortality or relative survival) across the range of cancer sites including in this report. Studies were excluded a) if excess mortality rates or relative survival ratios were not reported in tabular format in the paper, b) if the paper only assessed changes over time for less than four cancer sites, and c) the time periods assessed in the study were not considered to be relevant to the parameter estimation for the purpose of this report, e.g. survival trends from the 1960s, 1970s, and 1980s.

Six studies were selected for further analyses (see Table 1) (Coleman, Rachet et al. 2004; Yu, O'Connell et al. 2006; Shack, Rachet et al. 2007; Rachet, Maringe et al. 2009; Coleman, Forman et al. 2011; Soeberg, Blakely et al. 2012). Two studies included both excess mortality rate modelling and relative survival analyses (Yu, O'Connell et al. 2006; Soeberg, Blakely et al. 2012). In both these studies, changes over time in cancer patient survival were measured as excess mortality rate ratios. The remaining four studies calculated five-year relative survival ratios but not excess mortality rates or rate ratios. Two studies (Coleman, Rachet et al. 2004; Shack, Rachet et al. 2007) had calculated the average change for every five-year period in the five-year RSRs. One study calculated the average year-on-year change in five-year relative survival (Rachet, Maringe et al. 2009). The other study reported five-year RSRs for three calendar periods but not the difference, either absolute or relative, between the

earliest and most recent period of cancer diagnosis, or the average change in survival over time (Coleman, Forman et al. 2011).

Table 1: Studies selected to estimate annual changes in cancer survival across multiple cancer sites

Author and date	Country	Number of patients included	Number of cancers	Period of incident cases	Follow up period	Survival analysis measures	Comments
Coleman et al., (2004)	England and Wales	2,200,000	20	1986-1999	2001	Five-year RSRs	Stratified by sex. Average change in the five-year RSRs for every 5 calendar years calculated in study
Coleman et al., (2004)	Cross country comparison (Australia, Canada, Denmark, Sweden, Norway, and the UK)	2,500,000	4	1995-2007	2007	Five- year RSRs	Not stratified by sex. No changes over time in the five-year RSRs calculated in the study.
Rachet et al., (2009)	England and Wales	2,163,000	21	1996-2006	2007	Five-year RSRs	Stratified by sex. Average annual change in the five-year RSR calculated in the study
Shack et al., (2007)	Scotland	357,000	18	1986-2000	2004	Five-year RSR	Stratified by sex. Average change in the five-year RSRs for every 5 calendar years calculated in study
Soeberg et al., (2012)	New Zealand	125,567	21	1991-2004	2004	Five-year RSRs EMR modelling for estimate changes every ten years in excess mortality with 1991 as the reference year	Social group life tables used EMR modelling adjusted for ethnicity and/or income, age, sex, follow up since diagnosis, interaction of age and follow up in the first two years
Yu et al., (2006)	Australia	343,000	28	1980-1996	2001	Five-year RSRs. Excess mortality rate modelling (comparison of the 1993-1996 period with the reference category of patients diagnosed 1980-84).	RSRs not stratified by sex. Modelling adjusted for age, sex, extent of disease, years since diagnosis, and histological type

2.2 Methods

Different approaches were required to estimate the annual change over time in each of these studies.

Table 2 summarises the three approaches used to estimate the annual change in cancer survival from the studies listed above. To estimate the year-to-year change (%) in excess mortality by cancer sites, the excess mortality rate ratios over X years were converted to per annum rate ratios, then the annual percentage change (APC) estimated. For example, if the rate ratio for excess mortality in 2006 compared to 1996 was 0.80, then the annual rate ratio is $0.80^{1/10} = 0.978$, and the APC is -2.2%.

If relative survival, and change in relative survival, was the main output in a given study, the following generic approaches were used. First, some studies (e.g. (Rachet, Maringe et al. 2009)) report the <u>absolute</u> annual change in the five-year relative survival ratio (RSR); that is, a percentage point change in the relative survival probability five years after diagnosis. Noting that the proportion of people dying equals $1 - \exp[\text{rate} \times \text{units of time}]$, and that in our case the proportion is 1-RSR and the rate is the excess mortality rate, we can derive the following:

$$1 - RSR = 1 - \exp{-EMR.t}$$

$$\rightarrow EMR = -\frac{\ln RSR}{t}$$

where:

EMR is the annual excess mortality rate (assumed here to be constant over the five years, which is an adequate assumption for determining *changes* in EMR over time as long as one assumed the percentage change over time in the EMR is similar by year of follow up)

t is time (in this case number of years = 5)

RSR is the five year RSR (expressed as a proportion, i.e. 0.80 not 80).

Let EMR_0 be the EMR in the time zero, and EMR_1 be the EMR one year later. Likewise, let RSR_0 and RSR$_1$ be the five-year RSRs at time zero and one year later. Then:

$$APC_{EMR} = 100\% \times \frac{EMR_1 - EMR_0}{EMR_0}$$

$$= 100\% \times \frac{\dfrac{-ln\ RSR_1}{t} - \dfrac{-ln\ RSR_0}{t}}{-\dfrac{ln\ RSR_0}{t}}$$

$$= 100\% \times \frac{ln\ RSR_0 - ln\ RSR_1}{ln\ RSR_0}$$

For example, if the five-year RSR was 0.80 in the initial year, and 0.81 in the subsequent year, then the APC in the EMR is approximated by:

$$100\% \times [-ln(0.80) - -ln(0.81)] / -ln(0.80)$$

$$= 100\% \times [-0.2231 - -0.2107] / 0.2231$$

$$= -5.6\%$$

(Note this magnitude of <u>annual</u> percentage change in the EMR is extremely unlikely in reality.)

For the remaining studies (Coleman, Rachet et al. 2004; Shack, Rachet et al. 2007; Coleman, Forman et al. 2011), the above calculations apply, a five-year RSR was estimated centred between the periods of diagnosis on the study. The average year-to-year change in the five-year RSR was estimated by subtracting the earliest calendar period RSR from the most recent calendar period RSR and then dividing this difference by the number of years in the study.

13

This estimated annual change was then added to the new centred RSR to estimate a RSR equivalent to the centred RSR + 1 year. These RSRs were then converted to excess mortality rates.

Note that all these calculations have some approximations inherent. For example, there is rounding in the reported results, the authors' may have used a linear or multiplicative methods to calculate the change in RSR over time, and we are making assumptions as noted above about the constant proportionality of change over time in the EMR by year of follow-up from diagnosis. And we neither attempt to calculate confidence intervals (random error) nor assess or quantify likely residual systematic error (e.g. incorrect life tables, exclusion or not of death certificate only registrations, choice of underlying analytical methods (e.g. standardisation method, period or cohort)). That all said, by converting the results from these published studies, we can gain a reasonable overview of changes in cancer survival across multiple countries and multiple cancers.

Table 2: Approaches used to estimate the annual change (%) in cancer survival from the seven studies included

Author and date	Survival analysis methods and measures	Author's approach in estimating changes in cancer patient survival	Our approach to converting study results to an estimated APC in EMR
Coleman et al., (2004)	Relative survival Five-year RSRs	The average change every five years in five-year relative survival between calendar periods was calculated using linear regression.	A centred RSR was estimated based on the five-year RSR in the most recent period and the value given in the study for the average change for every five years in relative survival. The centred RSR + 1 year was also estimated by dividing the value given for the average change every five years in relative survival by five. These RSRs were then converted to excess mortality rates.
Coleman et al., (2011)	Relative survival Five-year RSRs	Five-year RSRs for the periods 1995-99, 2000-02, 2005-07 were given but no trends over time were calculated	A centred RSR was estimated based on the five-year RSR for the earliest and most recent calendar periods. The centred RSR + 1 year was calculated by subtracting the difference between 1995-99 and 2005-07 RSRs and dividing this by 9. The RSRs were then converted to excess mortality rates with an estimated annual percentage change calculated.
Rachet et al., (2009)	Relative survival Five-year RSRs	The average year-on-year change in five-year relative survival between calendar periods was calculated using linear regression.	The estimated average year-on-year change in five-year relative survival was transformed on to the excess mortality rate scale.
Shack et al., (2007)	Relative survival Five-year RSRs	The average change every five years in five-year relative survival between calendar periods was calculated using linear regression.	A centred RSR was estimated based on the five-year RSR in the most recent period and the value given in the study for the average change for every five years in relative survival. The centred RSR + 1 year was also estimated by dividing the value given for the average change every five years in relative survival by five. These RSRs were then converted to excess mortality rates.
Soeberg et al., (2011)	Excess mortality rate modelling EMRR	An excess mortality rate ratio was given for the change over time in cancer survival for every ten years compared to 1991.	The annual change (%) over time in excess mortality was calculated as $(1 - RR^{1/10}$ [10]).
Yu et al., (2007)	Excess mortality rate modelling EMRR	An excess mortality rate ratio was given for the change over time in cancer survival for patients diagnosed 1993-96 compared to patients diagnosed 1980-84.	The annual change (%) over time in excess mortality was calculated as $(1 - RR^{1/8}$ [10]).

2.3 Results

Table 3 shows the estimated annual percentage changes (APC) in excess mortality rates by cancer site. These estimated APCs were calculated (using the methods detailed above) from results of population-based cancer survival studies that present changes over time in either relative survival ratios or excess mortality rate ratios in Australia, Canada, Denmark, England and Wales, Norway, Scotland, Sweden, and the United Kingdom.

In Figure 1 and Table 3, an estimated APC below zero indicated that there was a decrease in excess mortality (cancer survival improved for each year of calendar year). For instance, if the excess mortality rate in 2010 was 0.250 and the estimated APC was -5.0% (the estimated decrease in the excess mortality in the next year would be 0.0125) then the excess mortality rate in 2011 would be 0.2375. But in ten years time, the excess mortality rate would be $0.250 \times (1-0.05)^{10} = 0.150$. An estimated APC above 1.00 indicates that there was an increase in excess mortality (cancer survival declined for each calendar year). For example, if the excess mortality rate in 2010 was 0.15 and the estimated APC was 1.5%, then the excess mortality rate in 2011 would be 0.152.

The light circle in Figure 1 represents the estimated APCs from the individual studies; the actual estimated APCs for each study are shown in Table 3. The dark square in Figure 1 represents the average estimated APC, using the estimated APCs from each study. The dark triangle in Figure 1 presents the estimate APC from recent New Zealand data (Soeberg, Blakely et al. 2012).

The average estimated APCs in these excess mortality rates were interpreted in this thesis as falling into one of four groups based on: a) no change in the annual APC (i.e. the APC is 0.00); b) a small annual decrease in excess mortality where the estimated APC is between 0.01 and 1.99; c) a moderate annual decrease in excess mortality where the estimated APC is between 2.00 and 4.99; and d) a large annual decrease in excess mortality where the estimated APC is 5.00 and above.

Using the average estimated APC, Figure 1 and Table 3 show that there was:

1. small annual decrease in excess mortality (cancer survival improvement) for cancers of the bladder, brain, head and neck, lung, oesophagus, pancreas and stomach;

2. moderate annual decrease in excess mortality (cancer survival improvement) for cancers of the female breast, cervix, colon, rectum, colorectum combined, kidney, ovaries, testis and uterus and patients with Hodgkin's lymphoma, leukaemia, melanoma and Non-Hodgkin's lymphoma;

3. large annual decrease in excess mortality (cancer survival improvement) for cancers of the liver, prostate and thyroid gland. (However, the large annual decrease for prostate cancer is probably spurious due to massively increased PSA testing detecting less severe disease.)

Figure 1: Estimated annual percentage changes (APCs) in excess mortality rates by cancer site for cancer survival in Australia, Canada, Denmark, England and Wales, New Zealand, Norway, Scotland, Sweden and the United Kingdom
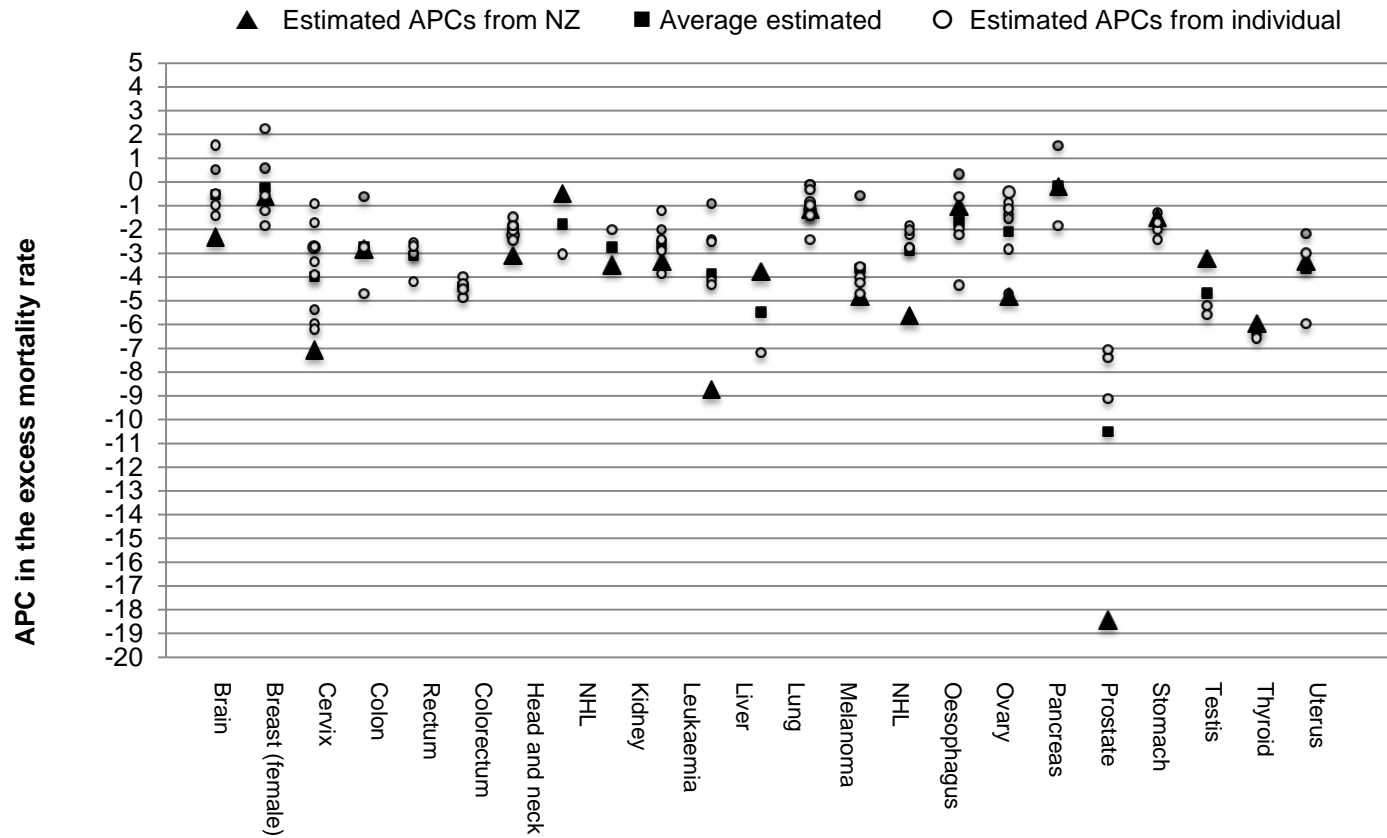
Table 3: Estimated annual percentage changes (APCs) in excess mortality rates by cancer site for cancer survival in Australia, Canada, Denmark, England and Wales, Norway, Scotland, Sweden, and the United Kingdom

Cancer site	Average estimated annual percentage change (APC) in the excess mortality rate	Estimated annual percentage change (APC) in the excess mortality rate by country											
		Australia		Canada	Denmark	England and Wales (males)	England and Wales (males)	New Zealand	Norway	Scotland (males)	Scotland (females)	Sweden	United Kingdom
		Yu et al., 2006	Coleman et al., 2011	Coleman et al., 2011	Coleman et al., 2011	Coleman et al., 2004	Coleman et al., 2004	Soeberg et al., 2012	Coleman et al., 2011	Shack et al., 2007	Shack et al., 2007	Coleman et al., 2011	Coleman et al., 2011
Bladder	-0.54	1.54				-0.51	0.50	-2.33		-0.99	-1.43		
Brain	-0.25	-1.87				2.25	0.57	-0.62		-1.22	-0.60		
Breast	-4.01	-5.99	-2.75	-0.93	-3.36		-5.38	-7.08	-2.75		-6.21	-1.72	-3.91
Cervix	-2.73	-4.71					-0.64	-2.84			-2.76		
Colon	-3.11	-4.19				-3.03	-3.03			-2.55	-2.72		
Rectum	-4.41	-4.88				-3.98	-4.39			-4.27	-4.52		
Colorectum	-2.12	-1.92	-2.24	-2.05	-2.46			-3.10	-1.82			-1.49	-1.86
Head neck	-1.78	-3.06						-0.51					
HL	-2.76	-2.01						-3.50					
Kidney	-2.63	-3.86				-2.44	-2.01	-3.37		-1.20	-2.91		
Leukaemia	-3.86	-2.45				-2.52	-0.92	-8.76		-4.17	-4.32		
Liver	-5.49	-7.20						-3.78					
Lung	-1.03	-2.45	-1.18	-0.99	-1.42	-0.12	-0.11	-1.16	-1.42	-0.33	-0.83	-1.41	-0.98
Melanoma	-3.66	-4.02				-3.56	-0.59	-4.82		-4.71	-4.26		
NHL	-2.89	-1.87				-2.24	-2.05	-5.63		-2.78	-2.77		
Oesophagus	-1.66	-4.36				-1.98	0.31	-1.05		-2.25	-0.64		
Ovary	-2.10	-4.71	-0.42	-1.12	-1.38		-1.57	-4.82	-0.90		-2.84		-1.14
Pancreas	-0.19	-1.87				-0.21	1.53	-0.20					
Prostate	-10.51	-7.41				-9.13		-18.46		-7.06			
Stomach	-1.77	-2.45				-1.63	-1.30	-1.50		-2.01	-1.73		
Testis	-4.69	-5.61				-5.22		-3.23					
Thyroid	-6.28	-6.58						-5.98					
Uterus	-3.64	-5.99					-2.19	-3.37			-3.02		

19

3   Literature Review of Survival Differences by Stage or Disease Severity

This section presents findings of a selected literature review on female breast, colon, rectal, and lung cancer survival by stage. Medline was searched in December 2011 for literature that documented five-year relative survival, excess mortality rates or excess mortality rate ratios for female breast, colon, rectal, colorectal, and lung cancers by stage or extent of disease. Table 4 shows the studies selected in this section of the report (Monnet, Faivre et al. 1999; Mitry, Bouvier et al. 2005; Folkesson, Engholm et al. 2009; Bulow, Harling et al. 2010; Lemmens, van Steenbergen et al. 2010; McKenzie, Ellison-Loschmann et al. 2010; van Steenbergen, Elferink et al. 2010). One study was selected for female breast cancer. Six studies were selected for either colon, rectal or colorectal cancers combined. No studies were identified or selected for differences by stage/extent or extent for lung cancer survival, measured on the excess mortality or relative scales.

Table 4: Studies selected describe differences by clinical stage or extent of disease for female breast, colorectal and lung cancers

Author and date	Country	Cancer site	Number of patients included	Period of incident cases	Follow up period	Survival analysis methods	Categories of clinical stage/extent of disease
Bulow et al., 2010	Denmark	Rectum	10,632	1994-2006	2007	Five-year RSR	Stage I, II and III *
Folkesson et al., 2009	Denmark, Finland, Iceland, Norway, Sweden, Scotland	Rectum	3,888	1997	2002	Five-year RSR EMRRs	Stage I, II, III, IV and missing stage *
Lemmens et al., 2010	Netherlands	Colorectum	28,826	1975-2007	2008	EMRRs	Colon stage III * Rectum stage II-III *
Mitry et al., 2005	France	Colorectum	5,847	1976-1989 and 1988-1999	2002	Five-year RSR EMRRs	Stage I-II * Stage III *
McKenzie et al. 2010	New Zealand	Breast	2,968	2005-2007	2009	Four-year RSR EMRRs	RSR: Local, regional, distant, missing + EMRR: local (reference category), regional, distant +
Monnet et al., 1999	Switzerland, France and Spain	Rectum	1,005	1982-87	1992	Five-year RSR EMRRs	Stage I, II, III, IV, loco-regional and not determined *
Van Steenbergen	The Netherlands	Colon	103,744	1989-2006	2006	Five-year	Stage I, II, III, IV *

Author and date	Country	Cancer site	Number of patients included	Period of incident cases	Follow up period	Survival analysis methods	Categories of clinical stage/extent of disease
et al., 2010						RSR EMRRs	

* Based on TNM staging. + SEER summary staging.

The following section briefly describes the results of these studies relating to differences by clinical stage or extent of disease by cancer site for breast, colon, rectum, and colorectum cancers.

3.1 Female breast cancer

Possible explanations for socioeconomic inequalities in female breast cancer survival in New Zealand were investigated using cancer registration data for 2005 to 2007 (see Table 5). Four-year relative survival was estimated by stage. Excess mortality rate ratios (EMRRs) were also calculated by stage with local extent set as the reference category. This study estimated that the four-year relative survival was 0.98 for local extent, 0.86 for regional extent, 0.22 for distant extent and 0.86 for missing extent of disease. Using complete-case data, the EMRRs suggest that patients with regional extent had three times the excess mortality and patients with distant extent had nine times for more excess mortality compared to patients with local extent.

Table 5: Four-year RSRs and EMRRs by extent of disease for female breast cancer patients diagnosed between 2005 to 2007, New Zealand ((McKenzie, Ellison-Loschmann et al. 2010))

Extent of disease	Four-year RSR (95% CI)	Excess mortality rate ratios (95% CI)	
		Imputed data	Complete-case data
Local	0.979 (0.959, 0.990)	1.00	1.00
Regional	0.857 (0.825, 0.883)	5.03 (2.57, 9.84)	3.00 (1.59, 5.68)
Distant	0.221 (0.156, 0.294)	48.53 (23.89, 98.60)	9.22 (2.45, 34.66)
Missing	0.862 (0.816, 0.897)	-	-

3.2 Colon cancer

Changes over time in colon cancer survival were examined for patients diagnosed in the Netherlands between 1989 and 2006, with a focus on the association between cancer survival improvements over time and changes over time in colon cancer treatment and detection (see Table 6). Relative survival was estimated by stage, as well as the estimated annual change in relative survival. In this study, the five-year RSR was estimated to be between 0.91 and 0.96 for stage I male and female colon cancer patients, between 0.74 and 0.80 stage II male and female colon cancer patients, between 0.46 and 0.60 for stage III male and female colon cancer patients, and between 0.05 and 0.07 for stage IV male and female colon cancer patients. For the purpose of this report, these RSR estimates were converted to annual excess mortality rates (EMRs) where it was assumed the EMR was contant for every year after diagnosis. Table 6 shows that the EMRR for stage II patients was between 3.6 and 4.1 compared to stage I patients, for stage III patients the EMRR was between 8.6 and 10.1 compared to stage I patients, and for stage IV patients the EMRR was between 38.6 and 45.5 compared to stage I patients.

Table 6: Five-year RSRs and estimated EMRs for colon cancer patients diagnosed 1989-2006, the Netherlands, by period of diagnosis and stage (Source: (van Steenbergen, Elferink et al. 2010))

Stage	Sex	Five-year relative survival				Annual change
		1989-1993	1994-1998	1999-2003	2004-2006	
Stage I	Male	92	91	94	94	+0.21 (-0.05, 0.46)
	Female	96	94	94	92	-0.28 (-0.59, 0.02)
Stage II	Male	74	74	78	78	+0.36 (0.07, 0.66)
	Female	75	76	80	80	+0.37 (0.13, 0.60)
Stage III	Male	46	49	56	59	+0.97 (0.59, 1.34)
	Female	48	50	57	60	+0.88 (0.65, 1.12)
Stage IV	Male	5	5	5	7	+0.15 (0.02, 0.28)
	Female	6	5	6	7	+0.14 (-0.05, 0.33)

Stage	Sex	EMR [assumed constant per year post diagnosis]				Average across time	RR (by sex)
		1989-1993	1994-1998	1999-2003	2004-2006		
Stage I	Male	0.017	0.019	0.012	0.012	0.015	1
	Female	0.008	0.012	0.012	0.017	0.012	1
Stage II	Male	0.060	0.060	0.050	0.050	0.055	3.6
	Female	0.058	0.055	0.045	0.045	0.050	4.1
Stage III	Male	0.155	0.143	0.116	0.106	0.130	8.6
	Female	0.147	0.139	0.112	0.102	0.125	10.1
Stage IV	Male	0.599	0.599	0.599	0.532	0.582	38.6
	Female	0.563	0.599	0.563	0.532	0.564	45.5

3.3 Rectal cancer

Changes over time in rectal cancer survival in Denmark for patients diagnosed 1994 to 2006 were assessed, particularly with regards to surgical treatment for colorectal cancer. A total of 10, 632 patients were included in the study. Five-year relative survival for rectal cancer patients were estimated by sex and stage at diagnosis (see Table 7). There were substantial increases for male rectal cancer patients in all stages, but more so for stage III patients where the five-year RSR increased from 0.36 (95% CI 0.22, 0.51) in 1994 to 0.71 (0.64, 0.78) in 2006. The five-year RSRs for female stage I and II rectal cancer patients were difficult to

interpret as their survival estimates were close to 1.00 with the confidence intervals extending beyond 1.00. Compared to male patients, female stage III rectal cancer patients only experience a small increase in their five-year relative survival over time, with an RSR of 0.42 (0.25, 0.60) in 1994 and 0.49 in 2006 (95% CI 0.41, 0.56). These RSRs were converted to estimated annual EMRs with an EMRR calculated comparing stage II and III patients to stage I patients. For patients diagnosed in 1994, the EMRR for stage II patients was between 1.28 and 3.10. The EMRR for stage III patients diagnosed in 1994 was between 2.55 and 28.48. For patients diagnosed in 2006, only the male EMRR for stage II and III patients could be calculated due to the negative EMR for Stage I female patients. The EMRR for stage II patients in 1994 was 1.17 and the EMRR for stage III patients diagnosed in 1996 was 1.535.

Table 7: Five-year relative survival for rectal cancer patients diagnosed 1994-2006, Denmark (Source: (Bulow, Harling et al. 2010))

Stage	Sex	Five-year RSR (95% CI)	
		Patients diagnosed 1994	Patients diagnosed 2006
Stage I	Male	0.67 (0.40, 0.88)	0.80 (0.72, 0.88)
	Female	0.97 (0.74, 1.07)	1.01 (0.93, 1.07)
Stage II	Male	0.60 (0.43, 0.75)	0.77 (0.71, 083)
	Female	0.91 (0.70, 1.05)	0.92 (0.83, 0.99)
Stage III	Male	0.36 (0.22, 0.51)	0.71 (0.64, 0.78)
	Female	0.42 (0.25, 0.60)	0.49 (0.41, 0.56)

Stage	Sex	EMR [assumed constant per year post diagnosis]		Stage II and III patients diagnosed 1994 compared to stage I patients diagnosed 1994	Stage II and III patients diagnosed 2006 compared to stage I patients diagnosed 2006
		Patients diagnosed 1994	Patients diagnosed 2006		
Stage I	Male	0.080	0.045	1	1
	Female	0.006	-0.002	1	1
Stage II	Male	0.102	0.052	1.286	1.171
	Female	0.019	0.017	3.106	-
Stage III	Male	0.204	0.068	2.551	1.535
	Female	0.174	0.143	28.481	-

The impact of stage at diagnosis on rectal cancer survival in Switzerland, France and Spain using data for patients diagnosed 1982-1997 was assessed (see Table 8). This study estimated five-year relative survival and calculated excess mortality rate ratios by stage, including sub-categories of TNM staging. The estimated five-year relative survival was 0.79 for stage patients, 0.63 for II patients, 0.28 for stage III patients, 0.05 for loco-regional patients, 0.20 for patients where stage was not determined, and 0.01 for stage IV patients. When examined from an EMR perspective, the EMRR for state IV compared to stage I was 25.4.

Table 8: Excess mortality rate ratio (compared stage II, III, loco-regional, undetermined and IV to stage I) for rectal cancer patients diagnosed in Switzerland, France and Spain, 1982-1987 (Source: (Monnet, Faivre et al. 1999))

Stage	Five-year RSR	EMRR (95% CI)	
I (T_1-T_2 N_0 M_0)	0.79	1	
II (T_3-T_4 N_0 M_0)	0.63	1.88	(1.16, 3.03)
III (N_1-N_2 M_0)	0.28	5.23	(3.36, 8.13)
Loco-regional	0.05	14.10	(8.31, 23.83)
Undetermined (T_x N_x M_0)	0.20	8.80	(5.02, 15.43)
IV (M_1)	0.01	25.40	(16.10, 40.10)

Rectal cancer survival for patients diagnosed in five Nordic countries and in Scotland in 1997 were assessed, with a particular focus on assessing the role of treatment on cancer survival. A total of 3,888 patients were included in the study. Five-year relative survival was calculated by stage at diagnosis and sex. Further, Poisson regression modelling was undertaken to estimate EMRRs for differences in cancer survival by stage and sex (see Table 9). This study found that stage II rectal cancer patients had approximately 3 times more excess mortality than stage I patients, stage III patients had 7 times more excess mortality than stage I patients, and stage IV patients had approximately 36 times more excess mortality than stage I patients. Patients with missing stage data had approximately 15 times more excess mortality than stage I patients.

Table 9: EMRRs (comparing stage II-IV with stage I) for male and female rectal cancer patients five-years post diagnosis for patients diagnosed in Nordic countries and Scotland in 1997 (Source: (Folkesson, Engholm et al. 2009))

Stage	Sex	EMRR
I	Male	1.0
	Female	1.0
II	Male	2.9 (1.7, 4.8)
	Female	3.5 (1.8, 6.8)
III	Male	7.1 (4.3, 11.6)

	Female	7.0 (3.7, 13.3)
IV	Male	34.8 (21.2, 57.2)
	Female	37.4 (19.7, 70.9)
Missing	Male	14.8 (8.9)
	Female	15.3 (7.9, 29.7)

3.4 Colorectal cancer

Changes over time in cancer survival were assessed for colorectal cancer patients diagnosed in a French population between the periods 1976-1987 and 1988-99. A total of 5,874 patients were included in the study. Five-year relative survival ratios were calculated. Poisson regression methods were used to estimate excess mortality rate ratios for changes over time in colorectal cancer survival by stage and age group (see Table 10). This study found that five-year relative survival increased between 1976-87 and 1988-99 for patients aged under 75 years with stage I-II and stage III colorectal cancer and for patients aged above 75 with stage I-II colorectal cancer. This study also found that patients aged below and above 75 years with stage III colorectal cancer had approximately four times more excess mortality compared to stage I-II cancer.

Table 10: Five-year relative survival and excess mortality rate ratios (comparing stage III with stage I-II) for colorectal cancer patients diagnosed 1976-99, Cote D'Or, France (Source: (Mitry, Bouvier et al. 2005))

Five-year relative survival ratios				EMRRs five-years post diagnosis (pooled for years 1976-99)		
Age	Stage	Period of diagnosis		Age	Stage	EMRR
Aged under 75	Stage I-II	1976-1987	0.782 (0.741, 0.817)	Aged under stage 75	I-II	1
		1988-1999	0.827 (0.794, 0.855)		III	4.01 (3.41, 4.72)
	Stage III	1976-1987	0.357 (0.300, 0.415)			
		1988-1999	0.486 (0.428, 0.542)			
Aged above 75	Stage I-II	1976-1987	0.780 (0.696, 0.844)	Aged 75 years and over	I-II	1
		1988-1999	0.822 (0.742, 0.865)		III	3.98 (3.05, 5.21)
	Stage III	1976-1987	0.369 (0.257, 0.480)			
		1988-1999	0.341 (0.258, 0.426)			

Changes over time in colorectal cancer survival, including analyses by stage, in the Netherlands was assessed for colorectal cancer cases registered on the Eindhoven Cancer Registry between 1974 and 2007. A total of 26,826 cases were included in the study. Two-year and five-year RSRs were estimated along with excess mortality rate ratios to assess

cancer survival over time by stage. The 2002-2006 period of cancer diagnosis was used as the reference category. Results were presented separately for colon and rectal cancer patients with stage II and III disease and for those aged below and above 70 years. Poisson regression modelling was undertaken for survival with cancer treatment excluded and then with treatment included in the model. From the regression model including treatment, this study found a steady improvement in cancer survival over time for rectal stage II and III patients aged below and above 70. The change over time in cancer survival was less clear for colon stage III patients, particularly for those aged below 70 years. While this study is useful for assessing trends over time in cancer survival by stage, it does not provide evidence for the magnitude of the rate ratio difference between different stage categories.

Table 11: EMRRs (comparing patients diagnosed in 1975-1999 to patients diagnose 2000-2006) colon and rectal cancer patients in the Netherlands, by cancer site, stage and age (Source: (Lemmens, van Steenbergen et al. 2010))

Cancer site and age	Model	Regression model excluding treatment	Regression model including treatment
Colon stage III, aged less than 70 years	1975-1984	2.00 (1.63, 2.52)	1.00 (0.80, 1.35)
	1985-1994	1.60 (.132, 200)	0.90 (0.71, 1.16)
	1995-1999	1.30 (1.10, 1.64)	1.10 (0.88, 1.33)
	2002-2006	1.00	1.00
Colon, stage III, aged above 70 years	1975-1984	1.80 (1.38, 3.00)	1.40 (1.07, 1.80)
	1985-1994	1.20 (0.96, 1.52)	1.00 (0.77, 1.22)
	1995-1999	1.20 (0.97, 1.48)	1.10 (0.89, 1.36)
	2002-2006	1.00	1.00
Rectal, stage II/III, aged less than 70 years	1975-1984	2.80 (2.24, 3.43)	3.10 (2.42, 3.85)
	1985-1994	1.90 (1.55, 2.29)	2.10 (1.68, 2.53)
	1995-1999	1.30 (1.08, 1.63)	1.40 (1.14, 1.78)
	2002-2006	1.00	1.00
Rectal, stage II/III, aged above 70 years	1975-1984	2.00 (1.51, 2.59)	2.10 (1.51, 2.85)
	1985-1994	1.40 (1.07, 1.73)	1.40 (1.09, 1.92)
	1995-1999	1.20 (0.91, 1.50)	1.20 (0.91, 1.63)
	2002-2006	1.00	1.00

4 Categorisations of Stage or Severity to use in ABC-CBA

4.1 Staging Categories

Staging describes the severity of a person's cancer at diagnosis, based on the extent of the original (primary) tumour and whether or not cancer has spread in the body. Staging is important as it can be used to estimate the person's prognosis (and indicate treatment options).

Staging systems cover many types of cancer; others focus on a particular type. The common elements considered in most staging systems are as follows: size of the primary tumour; lymph node involvement; cell type and tumour grade, and the presence or absence of metastasis.

Many cancer registries, such as the New Zealand Cancer Register and the Surveillance, Epidemiology, and End Results Program (SEER) in the United States, use summary staging. This system is used for all types of cancer. It groups cancer cases into five main categories:

In situ: Abnormal cells are present only in the layer of cells in which they developed. However, note that this group is often discarded for analyses as there is not yet a malignancy.

Localized: Cancer is limited to the organ in which it began, without evidence of spread.

Regional: Cancer has spread beyond the primary site to nearby lymph nodes or organs and tissues.

Distant: Cancer has spread from the primary site to distant organs or distant lymph nodes.

Unknown: There is not enough information to determine the stage.

Summary staging is most often used as a variable to help determine prognosis in population-based cancer patient survival studies, and is often simply referred to as SEER extent of disease or stage.

In addition to summary staging, there is also the TNM staging system. The TNM system is based on the extent of the tumour **(T)**, the extent of spread to the lymph nodes **(N)**, and the

presence of distant metastasis **(M)**. A number is added to each letter to indicate the size or extent of the primary tumour and the extent of cancer spread (see Table 12).

Table 12: Categories in the TNM staging system

Primary tumour (T)	
TX	Primary tumour cannot be evaluated
T0	No evidence of primary tumour
Tis	Carcinoma in situ (CIS; abnormal cells are present but have not spread to neighboring tissue; although not cancer, CIS may become cancer and is sometimes called preinvasive cancer)
T1, T2, T3, T4	Size and/or extent of the primary tumour
Regional lymph nodes (N)	
NX	Regional lymph nodes cannot be evaluated
N0	No regional lymph node involvement
N1, N2, N3	Involvement of regional lymph nodes (number of lymph nodes and/or extent of spread)
Distant metastasis (M)	
MX	Distant metastasis cannot be evaluated
M0	No distant metastasis
M1	Distant metastasis is present

For example, breast cancer classified as T3 N2 M0 refers to a large tumour that has spread outside the breast to nearby lymph nodes but not to other parts of the body. Prostate cancer T2 N0 M0 means that the tumour is located only in the prostate and has not spread to the lymph nodes or any other part of the body.

For many cancers, TNM combinations correspond to one of five stages. Criteria for stages differ for different types of cancer. For example, bladder cancer T3 N0 M0 is stage III, whereas colon cancer T3 N0 M0 is stage II (see Table 13).

Table 13: Categories in the overall stage category

Stage	Definition
Stage 0	Carcinoma in situ.
Stage I, Stage II, and Stage III	Higher numbers indicate more extensive disease: Larger tumour size and/or spread of the cancer beyond the organ in which it first developed to nearby lymph nodes and/or organs adjacent to the location of the primary tumour.
Stage IV	The cancer has spread to another organ(s).

4.2 Overview of current New Zealand Cancer Register data

4.2.1 Summary staging

Extent of disease is the Cancer Register variable that approximates clinical stage at diagnosis. In 1999 there was a change in extent of disease variable, with the Cancer Register moving to the SEER Guide to Summary Staging (see Table 14). The category 'invasion of adjacent tissue/organ or regional lymph nodes' spilt into more clinically relevant 'invasion of adjacent tissue/organ' and 'regional lymph nodes'. In order to allow consistent analysis of this information in the excess mortality rate modelling reported here, codes C and D are often combined – and indeed, it is unclear whether C and D codes in the NZCR are accurately enough coded to be useful (see Table 14). We also use this aggregation, but the underlying values remain on files so the SEER extent classification on the post 1 Jan 1999 registrations can be used if required.

Table 14: Change to extent of disease classification in the New Zealand Cancer Register

Pre-1999	Post-1999
0 In situ	A In situ
1 Localised and confined to organ of origin	B Localised and confined to organ of origin
2 Invasion of adjacent tissue/organ or regional lymph nodes	C Invasion of adjacent tissue/organ
	D Invasion of regional lymph nodes
3 Distant metastases or lymph nodes	E Distant metastases or lymph nodes
5 Not known	F Not known
6 Not applicable lymphoma, leukaemia, myeloma	G Not applicable lymphoma, leukaemia, myeloma

There are a number of well-established limitations to the extent of disease variable. Firstly there are differences in the availability of this information, with Māori being less likely to have extent recorded in many cancers, including colon, rectal, lung and breast (Robson, Purdie et al. 2005). Secondly investigation of the cancer registry data shows that extent of disease recorded is not entirely consistent with other cancer details, for example cancers coded on ICD-10 as A codes (in-situ cancers) do not always have the 'in-situ' extent of disease code selected. Finally, extent of disease is filled out by the cancer registrars at the New Zealand Cancer Register and is (by necessity) based on the information available to them which is pathology and laboratory specimens and death certificates, but not other

investigations such as ultrasound and CT scans. A recent audit examining the accuracy of information on people with lung cancer on the NZCR showed that only 58% had the extent of disease information available. (This was more likely to be missing for those with locally advanced disease, older ages or co-morbidity). For those that had the information available 77% were concordant with a hospital notes review. The discordant cases were more likely to be over staged (i.e. diagnosed with distant metastases) on the Cancer Register (Stevens, Stevens et al. 2008). An audit of colon cancer records showed a similar proportion of discrepancies between the Cancer Register and clinical records. However this review showed that the Cancer Register down staged tumours (i.e. they were more likely to be diagnosed with regional disease when they had metastatic) (Cunningham, Sarfati et al. 2008).

4.2.2 TNM staging

The NZCR contains one variable for each component of the TNM staging system. It is primarily sourced from pathology reports of metastases or from clinical information.

The TNM and summary stage systems are not directly comparable. In a study on New Zealand colon cancer patient data between 1996 and 2003, it was shown that the distinction between localised and regional disease in the SEER system divides the T3N0M0 (IIa) category in two for colon cancer, with some cancers in this category counting as localised and some as regionally advanced (Table 15). The authors of the colon cancer data audit suggest that the TNM and SEER summary staging systems have different strengths with the SEER system having greater stability over time compared to the TNM system (Cunningham, Sarfati et al. 2008).

Table 15: SEER summary stage and equivalent for TNM stage for colon cancer

SEER summary stage	Description	Equivalent TNM stage
Localised	Invasive tumour confined to colon. Includes tumour extension through musclaris propria and subserosal tissue, but not serosal surface	Stage I and IIa: T1-T3 N0 M0
Regional	Tumour extension outside conol and/or invasion of regional lymph nodes. Includes local tumour extension into serosal surface, pericolic or mesenteric fat.	Stge Iia, Iib and III: T3-T4/Any N Any T/N1,2 M0
Distant	Tumour spread to distant organs or lymph nodes	Stage IV: Any T

	Any N
	M1

4.2.3 Cancer site-specific staging variables

In addition to the extent of disease variable, there also variables on the NZCR for extent of disease or staging or severity for some specific cancer sites (see Table 16). Namely, they are:

Breast - Size of tumour which is defined as the tumour at widest point, expressed in millimetres. Introduced in 1998.

Cervical - FIGO staging, which is defined as a code for staging specific to tumours of the cervical. This is usually a clinical staging code, which is assigned prior to treatment. It should not change, regardless of the results of operation or biopsy. Therefore the FIGO staging code may not correlate with the extent of disease code. Introduced in 2001.

Colorectal - The Astler and Coller staging system code specifies the extent of the colorectal tumour and was introduced in in the NZCR in 2001. The Duke's staging system code specifies the extent of the colorectal tumour and is based on the Duke's staging system, the most commonly used staging system for colorectal cancer. It was introduced in 2001, but the information was previously held in the comments field on the NZCR.

Prostate - The Gleason which is defined as the result of adding the primary and secondary Gleason pattern codes.

Table 16: Cancer site-specific staging variables on the New Zealand Cancer Register

	Breast	Cervical	Colon	Rectum	Colorectum	Lung	Prostate
Extent of disease (SEER)	✓	✓	✓	✓	✓	✓	✓
TNM	✓	✓	✓	✓	✓	✓	✓
Size of tumour	✓						
FIGO		✓					
Astler and Coller					✓		
Duke's staging					✓		
Gleason score							✓

4.3 Staging used in clinical trial studies for cancer treatment

These overall stage categories vary by site. Table 17 shows the overall stage categories used in the United States' cancer treatment clinical trials database for cancers of the female breast, cervical, colon, rectum, lung and prostate.

Table 17: Overall stage categorisation used in the United States' NCI clinical trials database by cancer site

	Breast	Cervical	Colon	Rectum	Lung (non-small cell)	Lung (small cell)	Prostate
Stage 0		✔	✔	✔	✔		
stage I	✔	✔	✔	✔	✔		✔
stage IA	✔	✔			✔		
stage IB	✔	✔			✔		
stage II	✔	✔	✔	✔	✔		✔
stage IIA		✔		✔	✔		✔
stage IIB		✔		✔	✔		✔
stage IIC				✔			
stage III	✔	✔	✔	✔	✔		✔
stage IIIA	✔		✔	✔	✔		
stage IIIB	✔		✔	✔	✔		
stage IIIC	✔		✔	✔			
stage IV	✔	✔	✔	✔	✔		✔
stage IVA		✔	✔	✔			
stage IVB		✔	✔	✔			
recurrent	✔	✔	✔	✔	✔	✔	✔
Limited stage small cell lung cancer						✔	
Extensive stage small cell lung cancer						✔	

4.4 Missingness of extent at diagnosis

Table 18 to Table 24 show the distribution by SEER stage, and missingness, using NZCR data for breast, colorectal, colon, rectal, lung, cervical and prostate cancer, respectively. The distributions are presented separately by ethnicity and deprivation, but pooled by sex and age.

Thus, some of the apparent differences across ethnic groups (say) in stage distribution may be due to confounding by age.

Focusing on missingness of extent of diagnosis or stage, colon cancer had the least missing stage (<10% in recent years), followed by breast (about 10%). Lung and cervical cancer missingness remains poor at around 40%. Prostate cancer is very poor at over 70% missing – although other disease characteristics (e.g. Gleeson grade) may be more important for management, survival and prognosis.

Given the missingness for prostate cancer, undertaking survival analyses by stage for prostate cancer using NZCR data is prone to error – results must be interpreted with considerable caution, and probably is not wise at all. Caution will also be required for lung and cervical cancers.

Table 18: Number and percentage of patients by severity and year of diagnosis for (female) breast cancer by ethnicity, deprivation and ethnicity and deprivation

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
Total	1994-1996	1,986	36.2	1,680	30.6	366	6.7	1,458	26.6	5,490	100
			49.3		41.7		9.1				100
	1997-2000	3,841	45.1	2,819	33.1	345	4.1	1,504	17.7	8,509	100
			54.8		40.2		4.9				100
	2001-2004	4,367	47.6	3,125	34.0	349	3.8	1,342	14.6	9,183	100
			55.7		39.9		4.5				100
	2005-2008	5,152	51.2	3,500	34.8	394	3.9	1,024	10.2	10,070	100
			57.0		38.7		4.4				100
	2001-2008	9,519	49.4	6,625	34.4	743	3.9	2,366	12.3	19,253	100
			56.4		39.2		4.4				100
Non-Māori	1994-1996	1,801	35.8	1,510	30.1	342	6.8	1,371	27.3	5,024	100
			49.3		41.3		9.4				100
	1997-2000	3,528	45.8	2,501	32.5	299	3.9	1,371	17.8	7,699	100
			55.8		39.5		4.7				100
	2001-2004	4,006	48.4	2,748	33.2	312	3.8	1,218	14.7	8,284	100
			56.7		38.9		4.4				100
	2005-2008	4,631	51.8	3,073	34.4	331	3.7	909	10.2	8,944	100
			57.6		38.2		4.1				100
	2001-2008	8,637	50.1	5,821	33.8	643	3.7	2,127	12.3	17,228	100
			57.2		38.5		4.3				100
Māori	1994-1996	185	39.7	170	36.5	24	5.2	87	18.7	466	100
			48.8		44.9		6.3				100
	1997-2000	313	38.6	318	39.3	46	5.7	133	16.4	810	100
			46.2		47.0		6.8				100
	2001-2004	361	40.2	377	41.9	37	4.1	124	13.8	899	100
			46.6		48.6		4.8				100
	2005-2008	521	46.3	427	37.9	63	5.6	115	10.2	1,126	100
			51.5		42.2		6.2				100
	2001-2008	882	43.6	804	39.7	100	4.9	239	11.8	2,025	100
			49.4		45.0		5.6				100
Dep 1_3	1994-1996	559	35.4	449	28.5	93	5.9	476	30.2	1,577	100
			50.8		40.8		8.4				100
	1997-2000	1,041	47.0	733	33.1	70	3.2	369	16.7	2,213	100
			56.5		39.8		3.8				100
	2001-2004	1,293	51.2	830	32.9	72	2.9	329	13.0	2,524	100
			58.9		37.8		3.3				100
	2005-2008	1,460	52.9	966	35.0	85	3.1	249	9.0	2,760	100
			58.1		38.5		3.4				100
	2001-2008	2,753	52.1	1,796	34.0	157	3.0	578	10.9	5,284	100
			58.5		38.2		3.3				100
Dep 4_7	1994-1996	847	36.7	726	31.4	161	7.0	577	25.0	1,602	100
			48.8		41.9		9.3				100
	1997-2000	1,654	45.8	1,170	32.4	158	4.4	629	17.4	2,685	100
			55.5		39.2		5.3				100
	2001-2004	1,826	46.9	1,322	33.9	156	4.0	593	15.2	2,762	100
			55.3		40.0		4.7				100
	2005-2008	2,153	52.2	1,406	34.1	154	3.7	414	10.0	3,183	100
			58.0		37.9		4.1				100
	2001-2008	3,979	49.6	2,728	34.0	310	3.9	1,007	12.5	5,945	100
			56.7		38.9		4.4				100
Dep 8_10	1994-1996	580	36.2	505	31.5	112	7.0	405	25.3	2,311	100
			48.5		42.2		9.4				100
	1997-2000	1,146	42.7	916	34.1	117	4.4	506	18.8	3,611	100
			52.6		42.0		5.4				100
	2001-2004	1,248	45.2	973	35.2	121	4.4	420	15.2	3,897	100
			53.3		41.5		5.2				100
	2005-2008	1,539	48.4	1,128	35.4	155	4.9	361	11.3	4,127	100
			54.5		40.0		5.5				100
	2001-2008	2,787	46.9	2,101	35.3	276	4.6	781	13.1	8,024	100
			54.0		40.7		5.3				100
Non-Māori Dep 1_3											

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
	1994-1996	538	35.4	421	27.7	92	6.0	470	30.9	1,331	100
			51.2		40.1		8.8				100
	1997-2000	1,011	47.3	701	32.8	61	2.9	364	17.0	2,186	100
			57.0		39.5		3.4				100
	2001-2004	1,245	51.2	801	32.9	71	2.9	316	13.0	2,244	100
			58.8		37.8		3.4				100
	2005-2008	1,414	53.4	917	34.6	80	3.0	237	9.0	2,507	100
			58.6		38.0		3.3				100
	2001-2008	2,659	52.3	1,718	33.8	151	3.0	553	10.9	4,751	100
			58.7		37.9		3.3				100
Non-Māori Dep 4_7											
	1994-1996	789	36.3	674	31.0	151	7.0	558	25.7	1,521	100
			48.9		41.8		9.4				100
	1997-2000	1,559	46.2	1,087	32.2	141	4.2	589	17.4	2,137	100
			55.9		39.0		5.1				100
	2001-2004	1,722	47.7	1,188	32.9	143	4.0	554	15.4	2,433	100
			56.4		38.9		4.7				100
	2005-2008	1,998	52.7	1,273	33.6	132	3.5	386	10.2	2,648	100
			58.7		37.4		3.9				100
	2001-2008	3,720	50.3	2,461	33.3	275	3.7	940	12.7	5,081	100
			57.6		38.1		4.3				100
Non-Māori Dep 8_10											
	1994-1996	474	35.6	415	31.2	99	7.4	343	25.8	139	100
			48.0		42.0		10.0				100
	1997-2000	958	43.8	713	32.6	97	4.4	418	19.1	235	100
			54.2		40.3		5.5				100
	2001-2004	1,039	46.3	759	33.8	98	4.4	348	15.5	290	100
			54.8		40.0		5.2				100
	2005-2008	1,219	48.6	883	35.2	119	4.7	286	11.4	338	100
			54.9		39.8		5.4				100
	2001-2008	2,258	47.5	1,642	34.6	217	4.6	634	13.3	628	100
			54.8		39.9		5.3				100
Māori Dep 1_3											
	1994-1996	21	37.5	28	50.0	1	1.8	6	10.7	2,172	100
			42.0		56.0		2.0				100
	1997-2000	30	39.5	32	42.1	9	11.8	5	6.6	3,376	100
			42.3		45.1		12.7				100
	2001-2004	48	52.7	29	31.9	1	1.1	13	14.3	3,607	100
			61.5		37.2		1.3				100
	2005-2008	46	41.1	49	43.8	5	4.5	12	10.7	3,789	100
			46.0		49.0		5.0				100
	2001-2008	94	46.3	78	38.4	6	3.0	25	12.3	7,396	100
			52.8		43.8		3.4				100
Māori Dep 4_7											
	1994-1996	58	41.7	52	37.4	10	7.2	19	13.7	271	100
			48.3		43.3		8.3				100
	1997-2000	95	40.4	83	35.3	17	7.2	40	17.0	499	100
			48.7		42.6		8.7				100
	2001-2004	104	35.9	134	46.2	13	4.5	39	13.4	518	100
			41.4		53.4		5.2				100
	2005-2008	155	45.9	133	39.3	22	6.5	28	8.3	676	100
			50.0		42.9		7.1				100
	2001-2008	259	41.2	267	42.5	35	5.6	67	10.7	1,194	100
			46.2		47.6		6.2				100
Māori Dep 8_10											
	1994-1996	106	39.1	90	33.2	13	4.8	62	22.9	56	100
			50.7		43.1		6.2				100
	1997-2000	188	37.7	203	40.7	20	4.0	88	17.6	76	100
			45.7		49.4		4.9				100
	2001-2004	209	40.3	214	41.3	23	4.4	72	13.9	91	100
			46.9		48.0		5.2				100
	2005-2008	320	47.3	245	36.2	36	5.3	75	11.1	112	100
			53.2		40.8		6.0				100
	2001-2008	529	44.3	459	38.4	59	4.9	147	12.3	203	100
			50.5		43.8		5.6				100

Table 19: Number and percentage of patients by severity and year of diagnosis for colorectal cancer by ethnicity, deprivation and ethnicity and deprivation

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
Total	1994-1996	2,295	32.1	2,376	33.2	1,311	18.3	1,166	16.3	7,148	100
			38.4		39.7		21.9				100
	1997-2000	2,430	25.1	4,582	47.2	1,758	18.1	928	9.6	9,698	100
			27.7		52.2		20.0				100
	2001-2004	2,840	27.2	4,499	43.1	2,133	20.4	963	9.2	10,435	100
			30.0		47.5		22.5				100
	2005-2008	2,776	25.9	4,341	40.5	1,924	17.9	1,684	15.7	10,725	100
			30.7		48.0		21.3				100
	2001-2008	5,616	26.5	8,840	41.8	4,057	19.2	2,647	12.5	21,160	100
			30.3		47.8		21.9				100
Non-Māori	1994-1996	63	30.0	65	31.0	43	20.5	39	18.6	210	100
			36.8		38.0		25.1				100
	1997-2000	57	16.7	160	46.8	81	23.7	44	12.9	342	100
			19.1		53.7		27.2				100
	2001-2004	83	18.9	177	40.2	134	30.5	46	10.5	440	100
			21.1		44.9		34.0				100
	2005-2008	105	21.4	158	32.2	129	26.3	99	20.2	491	100
			26.8		40.3		32.9				100
	2001-2008	188	20.2	335	36.0	263	28.2	145	15.6	931	100
			23.9		42.6		33.5				100
Māori	1994-1996	2,232	32.2	2,311	33.3	1,268	18.3	1,127	16.2	6,938	100
			38.4		39.8		21.8				100
	1997-2000	2,373	25.4	4,422	47.3	1,677	17.9	884	9.4	9,356	100
			28.0		52.2		19.8				100
	2001-2004	2,757	27.6	4,322	43.2	1,999	20.0	917	9.2	9,995	100
			30.4		47.6		22.0				100
	2005-2008	2,671	26.1	4,183	40.9	1,795	17.5	1,585	15.5	10,234	100
			30.9		48.4		20.8				100
	2001-2008	5,428	26.8	8,505	42.0	3,794	18.8	2,502	12.4	20,229	100
			30.6		48.0		21.4				100
Dep 1_3	1994-1996	638	32.7	645	33.1	354	18.2	313	16.1	1,950	100
			39.0		39.4		21.6				100
	1997-2000	606	25.8	1,105	47.0	421	17.9	220	9.4	2,352	100
			28.4		51.8		19.7				100
	2001-2004	717	27.0	1,171	44.0	520	19.6	251	9.4	2,659	100
			29.8		48.6		21.6				100
	2005-2008	706	25.8	1,137	41.6	441	16.1	448	16.4	2,732	100
			30.9		49.8		19.3				100
	2001-2008	1,423	26.4	2,308	42.8	961	17.8	699	13.0	5,391	100
			30.3		49.2		20.5				100
Dep 4_7	1994-1996	996	31.6	1,042	33.1	563	17.9	547	17.4	2,050	100
			38.3		40.1		21.6				100
	1997-2000	1,111	25.5	2,056	47.2	801	18.4	391	9.0	2,987	100
			28.0		51.8		20.2				100
	2001-2004	1,240	27.0	2,004	43.6	953	20.7	400	8.7	3,179	100
			29.5		47.7		22.7				100
	2005-2008	1,236	26.0	1,927	40.6	868	18.3	719	15.1	3,243	100
			30.7		47.8		21.5				100
	2001-2008	2,476	26.5	3,931	42.1	1,821	19.5	1,119	12.0	6,422	100
			30.1		47.8		22.1				100
Dep 8_10	1994-1996	661	32.2	689	33.6	394	19.2	306	14.9	3,148	100
			37.9		39.5		22.6				100
	1997-2000	713	23.9	1,421	47.6	536	17.9	317	10.6	4,359	100
			26.7		53.2		20.1				100
	2001-2004	883	27.8	1,324	41.6	660	20.8	312	9.8	4,597	100

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
			30.8		46.2		23.0				100
	2005-2008	834	25.7	1,277	39.4	615	19.0	517	15.9	4,750	100
			30.6		46.8		22.6				100
	2001-2008	1,717	26.7	2,601	40.5	1,275	19.9	829	12.9	9,347	100
			30.7		46.5		22.8				100
Non-Māori Dep 1_3											
	1994-1996	632	32.8	640	33.2	353	18.3	304	15.8	123	100
			38.9		39.4		21.7				100
	1997-2000	601	25.9	1,091	46.9	415	17.9	217	9.3	202	100
			28.5		51.8		19.7				100
	2001-2004	708	27.2	1,150	44.1	505	19.4	243	9.3	249	100
			30.0		48.7		21.4				100
	2005-2008	690	25.7	1,124	41.8	433	16.1	439	16.3	278	100
			30.7		50.0		19.3				100
	2001-2008	1,398	26.4	2,274	43.0	938	17.7	682	12.9	527	100
			30.3		49.3		20.3				100
Non-Māori Dep 4_7											
	1994-1996	6	28.6	5	23.8	1	4.8	9	42.9	1,929	100
			50.0		41.7		8.3				100
	1997-2000	5	17.9	14	50.0	6	21.4	3	10.7	2,324	100
			20.0		56.0		24.0				100
	2001-2004	9	17.0	21	39.6	15	28.3	8	15.1	2,606	100
			20.0		46.7		33.3				100
	2005-2008	16	34.8	13	28.3	8	17.4	9	19.6	2,686	100
			43.2		35.1		21.6				100
	2001-2008	25	25.3	34	34.3	23	23.2	17	17.2	5,292	100
			30.5		41.5		28.0				100
Non-Māori Dep 8_10											
	1994-1996	42	34.1	36	29.3	28	22.8	17	13.8	1,927	100
			39.6		34.0		26.4				100
	1997-2000	36	17.8	99	49.0	41	20.3	26	12.9	2,785	100
			20.5		56.3		23.3				100
	2001-2004	49	19.7	101	40.6	76	30.5	23	9.2	2,930	100
			21.7		44.7		33.6				100
	2005-2008	52	18.7	95	34.2	76	27.3	55	19.8	2,965	100
			23.3		42.6		34.1				100
	2001-2008	101	19.2	196	37.2	152	28.8	78	14.8	5,895	100
			22.5		43.7		33.9				100
Māori Dep 1_3											
	1994-1996	15	22.7	24	36.4	14	21.2	13	19.7	21	100
			28.3		45.3		26.4				100
	1997-2000	16	14.3	47	42.0	34	30.4	15	13.4	28	100
			16.5		48.5		35.1				100
	2001-2004	25	18.1	55	39.9	43	31.2	15	10.9	53	100
			20.3		44.7		35.0				100
	2005-2008	37	22.2	50	29.9	45	26.9	35	21.0	46	100
			28.0		37.9		34.1				100
	2001-2008	62	20.3	105	34.4	88	28.9	50	16.4	99	100
			24.3		41.2		34.5				100
Māori Dep 4_7											
	1994-1996	619	32.1	653	33.9	366	19.0	289	15.0	3,082	100
			37.8		39.9		22.3				100
	1997-2000	677	24.3	1,322	47.5	495	17.8	291	10.4	4,247	100
			27.1		53.0		19.8				100
	2001-2004	834	28.5	1,223	41.7	584	19.9	289	9.9	4,459	100
			31.6		46.3		22.1				100
	2005-2008	782	26.4	1,182	39.9	539	18.2	462	15.6	4,583	100
			31.2		47.2		21.5				100
	2001-2008	1,616	27.4	2,405	40.8	1,123	19.1	751	12.7	9,042	100
			31.4		46.8		21.8				100
Māori Dep 8_10											
	1994-1996	981	31.8	1,018	33.0	549	17.8	534	17.3	66	100
			38.5		40.0		21.5				100
	1997-2000	1,095	25.8	2,009	47.3	767	18.1	376	8.9	112	100
			28.3		51.9		19.8				100

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
	2001-2004	1,215	27.2	1,949	43.7	910	20.4	385	8.6	138	100
			29.8		47.8		22.3				100
	2005-2008	1,199	26.2	1,877	41.0	823	18.0	684	14.9	167	100
			30.8		48.1		21.1				100
	2001-2008	2,414	26.7	3,826	42.3	1,733	19.2	1,069	11.8	305	100
			30.3		48.0		21.7				100

Table 20: Number and percentage of patients by severity and year of diagnosis for colon cancer by ethnicity, deprivation and ethnicity and deprivation

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
Total	1994-1996	1,375	29.2	1,617	34.4	930	19.8	781	16.6	4,703	100
			35.1		41.2		23.7				100
	1997-2000	1,443	22.6	3,243	50.7	1,252	19.6	458	7.2	6,396	100
			24.3		54.6		21.1				100
	2001-2004	1,790	26.1	3,124	45.5	1,541	22.4	414	6.0	6,869	100
			27.7		48.4		23.9				100
	2005-2008	1,866	26.3	3,199	45.1	1,409	19.9	621	8.8	7,095	100
			28.8		49.4		21.8				100
	2001-2008	3,656	26.2	6,323	45.3	2,950	21.1	1,035	7.4	13,964	100
			28.3		48.9		22.8				100
Non-Māori	1994-1996	32	27.6	36	31.0	27	23.3	21	18.1	116	100
			33.7		37.9		28.4				100
	1997-2000	29	14.9	97	49.7	54	27.7	15	7.7	195	100
			16.1		53.9		30.0				100
	2001-2004	52	19.9	110	42.1	89	34.1	10	3.8	261	100
			20.7		43.8		35.5				100
	2005-2008	58	20.9	116	41.7	84	30.2	20	7.2	278	100
			22.5		45.0		32.6				100
	2001-2008	110	20.4	226	41.9	173	32.1	30	5.6	539	100
			21.6		44.4		34.0				100
Māori	1994-1996	1,343	29.3	1,581	34.5	903	19.7	760	16.6	4,587	100
			35.1		41.3		23.6				100
	1997-2000	1,414	22.8	3,146	50.7	1,198	19.3	443	7.1	6,201	100
			24.6		54.6		20.8				100
	2001-2004	1,738	26.3	3,014	45.6	1,452	22.0	404	6.1	6,608	100
			28.0		48.6		23.4				100
	2005-2008	1,808	26.5	3,083	45.2	1,325	19.4	601	8.8	6,817	100
			29.1		49.6		21.3				100
	2001-2008	3,546	26.4	6,097	45.4	2,777	20.7	1,005	7.5	13,425	100
			28.6		49.1		22.4				100
Dep 1_3	1994-1996	391	29.5	463	34.9	253	19.1	220	16.6	1,327	100
			35.3		41.8		22.9				100
	1997-2000	356	22.7	782	49.9	312	19.9	118	7.5	1,568	100
			24.6		53.9		21.5				100
	2001-2004	454	25.9	819	46.7	384	21.9	95	5.4	1,752	100
			27.4		49.4		23.2				100
	2005-2008	477	26.5	852	47.3	317	17.6	156	8.7	1,802	100
			29.0		51.8		19.3				100
	2001-2008	931	26.2	1,671	47.0	701	19.7	251	7.1	3,554	100
			28.2		50.6		21.2				100
Dep 4_7	1994-1996	604	29.1	695	33.5	405	19.5	370	17.8	1,302	100
			35.4		40.8		23.8				100
	1997-2000	644	22.3	1,462	50.7	569	19.7	208	7.2	1,945	100
			24.1		54.7		21.3				100
	2001-2004	769	25.4	1,377	45.5	688	22.8	190	6.3	2,093	100
			27.1		48.6		24.3				100
	2005-2008	831	26.2	1,421	44.9	645	20.4	271	8.6	2,125	100
			28.7		49.1		22.3				100
	2001-2008	1,600	25.8	2,798	45.2	1,333	21.5	461	7.4	4,218	100
			27.9		48.8		23.3				100
Dep 8_10	1994-1996	380	29.2	459	35.3	272	20.9	191	14.7	2,074	100
			34.2		41.3		24.5				100
	1997-2000	443	22.8	999	51.4	371	19.1	132	6.8	2,883	100
			24.4		55.1		20.5				100
	2001-2004	567	27.1	928	44.3	469	22.4	129	6.2	3,024	100
			28.9		47.3		23.9				100
	2005-2008	558	26.3	926	43.6	447	21.0	194	9.1	3,168	100

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
			28.9		48.0		23.1				100
	2001-2008	1,125	26.7	1,854	44.0	916	21.7	323	7.7	6,192	100
			28.9		47.6		23.5				100
Non-Māori Dep 1_3											
	1994-1996	5	33.3	2	13.3	0	0.0	8	53.3	1,240	100
			71.4		28.6		0.0				100
	1997-2000	2	11.1	10	55.6	5	27.8	1	5.6	1,831	100
			11.8		58.8		29.4				100
	2001-2004	6	17.6	16	47.1	10	29.4	2	5.9	1,941	100
			18.8		50.0		31.3				100
	2005-2008	9	33.3	11	40.7	6	22.2	1	3.7	1,971	100
			34.6		42.3		23.1				100
	2001-2008	15	24.6	27	44.3	16	26.2	3	4.9	3,912	100
			25.9		46.6		27.6				100
Non-Māori Dep 4_7											
	1994-1996	8	20.5	15	38.5	9	23.1	7	17.9	15	100
			25.0		46.9		28.1				100
	1997-2000	6	9.5	29	46.0	20	31.7	8	12.7	18	100
			10.9		52.7		36.4				100
	2001-2004	13	17.3	34	45.3	26	34.7	2	2.7	34	100
			17.8		46.6		35.6				100
	2005-2008	19	19.6	43	44.3	24	24.7	11	11.3	27	100
			22.1		50.0		27.9				100
	2001-2008	32	18.6	77	44.8	50	29.1	13	7.6	61	100
			20.1		48.4		31.4				100
Non-Māori Dep 8_10											
	1994-1996	361	29.1	440	35.5	254	20.5	185	14.9	2,035	100
			34.2		41.7		24.1				100
	1997-2000	422	23.0	941	51.4	342	18.7	126	6.9	2,820	100
			24.8		55.2		20.1				100
	2001-2004	534	27.5	868	44.7	416	21.4	123	6.3	2,949	100
			29.4		47.7		22.9				100
	2005-2008	528	26.8	864	43.8	393	19.9	186	9.4	3,071	100
			29.6		48.4		22.0				100
	2001-2008	1,062	27.1	1,732	44.3	809	20.7	309	7.9	6,020	100
			29.5		48.1		22.5				100
Māori Dep 1_3											
	1994-1996	386	29.4	461	35.1	253	19.3	212	16.2	39	100
			35.1		41.9		23.0				100
	1997-2000	354	22.8	772	49.8	307	19.8	117	7.5	63	100
			24.7		53.9		21.4				100
	2001-2004	448	26.1	803	46.7	374	21.8	93	5.4	75	100
			27.6		49.4		23.0				100
	2005-2008	468	26.4	841	47.4	311	17.5	155	8.7	97	100
			28.9		51.9		19.2				100
	2001-2008	916	26.2	1,644	47.1	685	19.6	248	7.1	172	100
			28.2		50.7		21.1				100
Māori Dep 4_7											
	1994-1996	596	29.3	680	33.4	396	19.5	363	17.8	62	100
			35.6		40.7		23.7				100
	1997-2000	638	22.6	1,433	50.8	549	19.5	200	7.1	114	100
			24.4		54.7		21.0				100
	2001-2004	756	25.6	1,343	45.5	662	22.4	188	6.4	152	100
			27.4		48.6		24.0				100
	2005-2008	812	26.4	1,378	44.9	621	20.2	260	8.5	154	100
			28.9		49.0		22.1				100
	2001-2008	1,568	26.0	2,721	45.2	1,283	21.3	448	7.4	306	100
			28.1		48.8		23.0				100
Māori Dep 8_10											
	1994-1996	19	30.6	19	30.6	18	29.0	6	9.7	1,312	100
			33.9		33.9		32.1				100
	1997-2000	21	18.4	58	50.9	29	25.4	6	5.3	1,550	100
			19.4		53.7		26.9				100
	2001-2004	33	21.7	60	39.5	53	34.9	6	3.9	1,718	100
			22.6		41.1		36.3				100
	2005-2008	30	19.5	62	40.3	54	35.1	8	5.2	1,775	100
			20.5		42.5		37.0				100
	2001-2008	63	20.6	122	39.9	107	35.0	14	4.6	3,493	100

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
			21.6		41.8		36.6				100

Table 21: Number and percentage of patients by severity and year of diagnosis for rectal cancer by ethnicity, deprivation and ethnicity and deprivation

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
Total	1994-1996	920	37.6	759	31.0	381	15.6	385	15.7	2,445	100
			44.7		36.8		18.5				100
	1997-2000	987	29.9	1,339	40.6	506	15.3	470	14.2	3,302	100
			34.9		47.3		17.9				100
	2001-2004	1,050	29.4	1,375	38.6	592	16.6	549	15.4	3,566	100
			34.8		45.6		19.6				100
	2005-2008	910	25.1	1,142	31.5	515	14.2	1,063	29.3	3,630	100
			35.4		44.5		20.1				100
	2001-2008	1,960	27.2	2,517	35.0	1,107	15.4	1,612	22.4	7,196	100
			35.1		45.1		19.8				100
Non-Māori	1994-1996	31	33.0	29	30.9	16	17.0	18	19.1	94	100
			40.8		38.2		21.1				100
	1997-2000	28	19.0	63	42.9	27	18.4	29	19.7	147	100
			23.7		53.4		22.9				100
	2001-2004	31	17.3	67	37.4	45	25.1	36	20.1	179	100
			21.7		46.9		31.5				100
	2005-2008	47	22.1	42	19.7	45	21.1	79	37.1	213	100
			35.1		31.3		33.6				100
	2001-2008	78	19.9	109	27.8	90	23.0	115	29.3	392	100
			28.2		39.4		32.5				100
Māori	1994-1996	889	37.8	730	31.1	365	15.5	367	15.6	2,351	100
			44.8		36.8		18.4				100
	1997-2000	959	30.4	1,276	40.4	479	15.2	441	14.0	3,155	100
			35.3		47.0		17.6				100
	2001-2004	1,019	30.1	1,308	38.6	547	16.1	513	15.1	3,387	100
			35.5		45.5		19.0				100
	2005-2008	863	25.3	1,100	32.2	470	13.8	984	28.8	3,417	100
			35.5		45.2		19.3				100
	2001-2008	1,882	27.7	2,408	35.4	1,017	14.9	1,497	22.0	6,804	100
			35.5		45.4		19.2				100
Dep 1_3	1994-1996	247	39.6	182	29.2	101	16.2	93	14.9	623	100
			46.6		34.3		19.1				100
	1997-2000	250	31.9	323	41.2	109	13.9	102	13.0	784	100
			36.7		47.4		16.0				100
	2001-2004	263	29.0	352	38.8	136	15.0	156	17.2	907	100
			35.0		46.9		18.1				100
	2005-2008	229	24.6	285	30.6	124	13.3	292	31.4	930	100
			35.9		44.7		19.4				100
	2001-2008	492	26.8	637	34.7	260	14.2	448	24.4	1,837	100
			35.4		45.9		18.7				100
Dep 4_7	1994-1996	392	36.5	347	32.3	158	14.7	177	16.5	748	100
			43.7		38.7		17.6				100
	1997-2000	467	31.6	594	40.2	232	15.7	183	12.4	1,042	100
			36.1		45.9		17.9				100
	2001-2004	471	29.9	627	39.9	265	16.8	210	13.4	1,086	100
			34.6		46.0		19.4				100
	2005-2008	405	25.6	506	32.0	223	14.1	448	28.3	1,118	100
			35.7		44.6		19.7				100
	2001-2008	876	27.8	1,133	35.9	488	15.5	658	20.9	2,204	100
			35.1		45.4		19.5				100
Dep 8_10	1994-1996	281	37.6	230	30.7	122	16.3	115	15.4	1,074	100
			44.4		36.3		19.3				100
	1997-2000	270	25.9	422	40.5	165	15.8	185	17.8	1,476	100
			31.5		49.2		19.3				100
	2001-2004	316	29.1	396	36.5	191	17.6	183	16.9	1,573	100
			35.0		43.9		21.2				100

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
	2005-2008	276	24.7	351	31.4	168	15.0	323	28.9	1,582	100
			34.7		44.2		21.1				100
	2001-2008	592	26.9	747	33.9	359	16.3	506	23.0	3,155	100
			34.9		44.0		21.1				100
Non-Māori Dep 1_3											
	1994-1996	246	39.9	179	29.0	100	16.2	92	14.9	27	100
			46.9		34.1		19.0				100
	1997-2000	247	31.9	319	41.2	108	14.0	100	12.9	49	100
			36.6		47.3		16.0				100
	2001-2004	260	29.3	347	39.1	131	14.8	150	16.9	63	100
			35.2		47.0		17.8				100
	2005-2008	222	24.4	283	31.1	122	13.4	284	31.2	70	100
			35.4		45.1		19.5				100
	2001-2008	482	26.8	630	35.0	253	14.1	434	24.1	133	100
			35.3		46.2		18.5				100
Non-Māori Dep 4_7											
	1994-1996	23	37.7	17	27.9	10	16.4	11	18.0	617	100
			46.0		34.0		20.0				100
	1997-2000	15	17.0	41	46.6	12	13.6	20	22.7	774	100
			22.1		60.3		17.6				100
	2001-2004	16	16.5	41	42.3	23	23.7	17	17.5	888	100
			20.0		51.3		28.8				100
	2005-2008	22	17.7	33	26.6	22	17.7	47	37.9	911	100
			28.6		42.9		28.6				100
	2001-2008	38	17.2	74	33.5	45	20.4	64	29.0	1,799	100
			24.2		47.1		28.7				100
Non-Māori Dep 8_10											
	1994-1996	7	25.9	9	33.3	5	18.5	6	22.2	687	100
			33.3		42.9		23.8				100
	1997-2000	10	20.4	18	36.7	14	28.6	7	14.3	954	100
			23.8		42.9		33.3				100
	2001-2004	12	19.0	21	33.3	17	27.0	13	20.6	989	100
			24.0		42.0		34.0				100
	2005-2008	18	25.7	7	10.0	21	30.0	24	34.3	994	100
			39.1		15.2		45.7				100
	2001-2008	30	22.6	28	21.1	38	28.6	37	27.8	1,983	100
			31.3		29.2		39.6				100
Māori Dep 1_3											
	1994-1996	1	16.7	3	50.0	1	16.7	1	16.7	61	100
			20.0		60.0		20.0				100
	1997-2000	3	30.0	4	40.0	1	10.0	2	20.0	88	100
			37.5		50.0		12.5				100
	2001-2004	3	15.8	5	26.3	5	26.3	6	31.6	97	100
			23.1		38.5		38.5				100
	2005-2008	7	36.8	2	10.5	2	10.5	8	42.1	124	100
			63.6		18.2		18.2				100
	2001-2008	10	26.3	7	18.4	7	18.4	14	36.8	221	100
			41.7		29.2		29.2				100
Māori Dep 4_7											
	1994-1996	258	37.6	213	31.0	112	16.3	104	15.1	1,047	100
			44.3		36.5		19.2				100
	1997-2000	255	26.7	381	39.9	153	16.0	165	17.3	1,427	100
			32.3		48.3		19.4				100
	2001-2004	300	30.3	355	35.9	168	17.0	166	16.8	1,510	100
			36.5		43.1		20.4				100
	2005-2008	254	25.6	318	32.0	146	14.7	276	27.8	1,512	100
			35.4		44.3		20.3				100
	2001-2008	554	27.9	673	33.9	314	15.8	442	22.3	3,022	100
			36.0		43.7		20.4				100
Māori Dep 8_10											
	1994-1996	385	36.8	338	32.3	153	14.6	171	16.3	6	100
			43.9		38.6		17.5				100
	1997-2000	457	32.0	576	40.4	218	15.3	176	12.3	10	100
			36.5		46.0		17.4				100
	2001-2004	459	30.4	606	40.1	248	16.4	197	13.0	19	100
			35.0		46.2		18.9				100

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
	2005-2008	387	25.6	499	33.0	202	13.4	424	28.0	19	100
			35.6		45.9		18.6				100
	2001-2008	846	28.0	1,105	36.6	450	14.9	621	20.5	38	100
			35.2		46.0		18.7				100

Table 22: Number and percentage of patients by severity and year of diagnosis for lung cancer by ethnicity, deprivation and ethnicity and deprivation

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
Total											
	1994-1996	433	9.4	592	12.9	1,361	29.6	2,214	48.1	4,600	100
			18.1		24.8		57.0				100
	1997-2000	325	5.3	512	8.4	2,079	34.1	3,176	52.1	6,092	100
			11.1		17.6		71.3				100
	2001-2004	346	5.3	481	7.3	2,679	40.8	3,058	46.6	6,564	100
			9.9		13.7		76.4				100
	2005-2008	373	5.6	580	8.6	2,958	44.1	2,803	41.7	6,714	100
			9.5		14.8		75.6				100
	2001-2008	719	5.4	1,061	8.0	5,637	42.5	5,861	44.1	13,278	100
			9.7		14.3		76.0				100
Non-Māori											
	1994-1996	385	9.6	516	12.9	1,197	29.8	1,917	47.7	4,015	100
			18.4		24.6		57.1				100
	1997-2000	301	5.9	444	8.7	1,748	34.1	2,639	51.4	5,132	100
			12.1		17.8		70.1				100
	2001-2004	310	5.6	413	7.5	2,234	40.5	2,559	46.4	5,516	100
			10.5		14.0		75.5				100
	2005-2008	318	5.8	481	8.7	2,448	44.4	2,268	41.1	5,515	100
			9.8		14.8		75.4				100
	2001-2008	628	5.7	894	8.1	4,682	42.4	4,827	43.8	11,031	100
			10.1		14.4		75.5				100
Māori											
	1994-1996	48	8.2	76	13.0	164	28.0	297	50.8	585	100
			16.7		26.4		56.9				100
	1997-2000	24	2.5	68	7.1	331	34.5	537	55.9	960	100
			5.7		16.1		78.3				100
	2001-2004	36	3.4	68	6.5	445	42.5	499	47.6	1,048	100
			6.6		12.4		81.1				100
	2005-2008	55	4.6	99	8.3	510	42.5	535	44.6	1,199	100
			8.3		14.9		76.8				100
	2001-2008	91	4.0	167	7.4	955	42.5	1,034	46.0	2,247	100
			7.5		13.8		78.7				100
Dep 1_3											
	1994-1996	146	8.6	198	11.7	497	29.4	848	50.2	1,689	100
			17.4		23.5		59.1				100
	1997-2000	118	4.6	188	7.4	851	33.5	1,382	54.4	2,539	100
			10.2		16.2		73.6				100
	2001-2004	130	4.9	171	6.4	1,060	40.0	1,291	48.7	2,652	100
			9.6		12.6		77.9				100
	2005-2008	138	5.0	211	7.6	1,217	44.0	1,202	43.4	2,768	100
			8.8		13.5		77.7				100
	2001-2008	268	4.9	382	7.0	2,277	42.0	2,493	46.0	5,420	100
			9.2		13.1		77.8				100
Dep 4_7											
	1994-1996	89	9.5	127	13.5	272	28.9	453	48.1	1,970	100
			18.2		26.0		55.7				100
	1997-2000	72	6.6	99	9.1	395	36.2	525	48.1	2,462	100
			12.7		17.5		69.8				100
	2001-2004	75	6.4	106	9.1	474	40.8	508	43.7	2,749	100
			11.5		16.2		72.4				100
	2005-2008	85	7.5	120	10.6	491	43.4	436	38.5	2,814	100
			12.2		17.2		70.5				100
	2001-2008	160	7.0	226	9.8	965	42.0	944	41.1	5,563	100
			11.8		16.7		71.4				100
Dep 8_10											
	1994-1996	198	10.1	267	13.6	592	30.1	913	46.3	941	100
			18.7		25.3		56.0				100
	1997-2000	135	5.5	225	9.1	833	33.8	1,269	51.5	1,091	100
			11.3		18.9		69.8				100
	2001-2004	141	5.1	204	7.4	1,145	41.7	1,259	45.8	1,163	100

		Local		Regional		Distant		Missing		Total	
		n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
			9.5		13.7		76.8				100
	2005-2008	150	5.3	249	8.8	1,250	44.4	1,165	41.4	1,132	100
			9.1		15.1		75.8				100
	2001-2008	291	5.2	453	8.1	2,395	43.1	2,424	43.6	2,295	100
			9.3		14.4		76.3				100
Non-Māori Dep 1_3											
	1994-1996	177	10.0	243	13.7	536	30.1	822	46.2	1,336	100
			18.5		25.4		56.1				100
	1997-2000	124	5.7	200	9.1	746	34.0	1,124	51.2	1,925	100
			11.6		18.7		69.7				100
	2001-2004	128	5.2	184	7.5	1,021	41.5	1,125	45.8	1,975	100
			9.6		13.8		76.6				100
	2005-2008	138	5.6	217	8.8	1,095	44.2	1,025	41.4	1,983	100
			9.5		15.0		75.5				100
	2001-2008	266	5.4	401	8.1	2,116	42.9	2,150	43.6	3,958	100
			9.6		14.4		76.0				100
Non-Māori Dep 4_7											
	1994-1996	24	6.8	43	12.2	104	29.5	182	51.6	1,778	100
			14.0		25.1		60.8				100
	1997-2000	13	2.1	37	6.0	214	34.9	350	57.0	2,194	100
			4.9		14.0		81.1				100
	2001-2004	21	3.1	42	6.2	289	42.7	325	48.0	2,458	100
			6.0		11.9		82.1				100
	2005-2008	38	4.8	60	7.6	327	41.7	360	45.9	2,475	100
			8.9		14.1		76.9				100
	2001-2008	59	4.0	102	7.0	616	42.1	685	46.9	4,933	100
			7.6		13.1		79.3				100
Non-Māori Dep 8_10											
	1994-1996	122	9.1	155	11.6	393	29.4	666	49.9	192	100
			18.2		23.1		58.7				100
	1997-2000	105	5.5	151	7.8	637	33.1	1,032	53.6	268	100
			11.8		16.9		71.3				100
	2001-2004	109	5.5	129	6.5	771	39.0	966	48.9	291	100
			10.8		12.8		76.4				100
	2005-2008	100	5.0	151	7.6	890	44.9	842	42.5	339	100
			8.8		13.2		78.0				100
	2001-2008	209	5.3	280	7.1	1,661	42.0	1,808	45.7	630	100
			9.7		13.0		77.3				100
Māori Dep 1_3											
	1994-1996	86	9.5	118	13.1	268	29.7	429	47.6	353	100
			18.2		25.0		56.8				100
	1997-2000	72	7.1	93	9.2	365	36.0	483	47.7	614	100
			13.6		17.5		68.9				100
	2001-2004	73	6.7	100	9.2	442	40.8	468	43.2	677	100
			11.9		16.3		71.9				100
	2005-2008	80	7.6	113	10.7	463	43.8	401	37.9	785	100
			12.2		17.2		70.6				100
	2001-2008	153	7.1	213	10.0	905	42.3	869	40.6	1,462	100
			12.0		16.8		71.2				100
Māori Dep 4_7											
	1994-1996	21	10.9	24	12.5	56	29.2	91	47.4	40	100
			20.8		23.8		55.4				100
	1997-2000	11	4.1	25	9.3	87	32.5	145	54.1	78	100
			8.9		20.3		70.7				100
	2001-2004	13	4.5	20	6.9	124	42.6	134	46.0	80	100
			8.3		12.7		79.0				100
	2005-2008	12	3.5	32	9.4	155	45.7	140	41.3	75	100
			6.0		16.1		77.9				100
	2001-2008	25	4.0	52	8.3	279	44.3	274	43.5	155	100
			7.0		14.6		78.4				100
Māori Dep 8_10											
	1994-1996	3	7.5	9	22.5	4	10.0	24	60.0	901	100
			18.8		56.3		25.0				100
	1997-2000	0	0.0	6	7.7	30	38.5	42	53.8	1,013	100
			0.0		16.7		83.3				100
	2001-2004	2	2.5	6	7.5	32	40.0	40	50.0	1,083	100

47

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
			5.0		15.0		80.0				100
	2005-2008	5	6.7	7	9.3	28	37.3	35	46.7	1,057	100
			12.5		17.5		70.0				100
	2001-2008	7	4.5	13	8.4	60	38.7	75	48.4	2,140	100
			8.8		16.3		75.0				100

Table 23: Number and percentage of patients by severity and year of diagnosis for cervical cancer by ethnicity, deprivation and ethnicity and deprivation

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
Total	1994-1996	268	42.9	79	12.7	39	6.3	238	38.1	624	100
			69.4		20.5		10.1				100
	1997-2000	381	47.0	102	12.6	46	5.7	281	34.7	810	100
			72.0		19.3		8.7				100
	2001-2004	325	47.9	67	9.9	62	9.1	225	33.1	679	100
			71.6		14.8		13.7				100
	2005-2008	235	38.0	54	8.7	71	11.5	258	41.7	618	100
			65.3		15.0		19.7				100
	2001-2008	560	43.2	121	9.3	133	10.3	483	37.2	1,297	100
			68.8		14.9		16.3				100
Non-Māori	1994-1996	225	45.4	64	12.9	27	5.4	180	36.3	496	100
			71.2		20.3		8.5				100
	1997-2000	307	47.7	81	12.6	31	4.8	224	34.8	643	100
			73.3		19.3		7.4				100
	2001-2004	276	50.2	56	10.2	43	7.8	175	31.8	550	100
			73.6		14.9		11.5				100
	2005-2008	197	39.3	46	9.2	53	10.6	205	40.9	501	100
			66.6		15.5		17.9				100
	2001-2008	473	45.0	102	9.7	96	9.1	380	36.2	1,051	100
			70.5		15.2		14.3				100
Māori	1994-1996	43	33.6	15	11.7	12	9.4	58	45.3	128	100
			61.4		21.4		17.1				100
	1997-2000	74	44.3	21	12.6	15	9.0	57	34.1	167	100
			67.3		19.1		13.6				100
	2001-2004	49	38.0	11	8.5	19	14.7	50	38.8	129	100
			62.0		13.9		24.1				100
	2005-2008	38	32.5	8	6.8	18	15.4	53	45.3	117	100
			59.4		12.5		28.1				100
	2001-2008	87	35.4	19	7.7	37	15.0	103	41.9	246	100
			60.8		13.3		25.9				100
Dep 1_3	1994-1996	95	42.4	32	14.3	19	8.5	78	34.8	224	100
			65.1		21.9		13.0				100
	1997-2000	147	47.7	36	11.7	18	5.8	107	34.7	308	100
			73.1		17.9		9.0				100
	2001-2004	121	46.0	36	13.7	19	7.2	87	33.1	263	100
			68.8		20.5		10.8				100
	2005-2008	102	43.2	20	8.5	26	11.0	88	37.3	236	100
			68.9		13.5		17.6				100
	2001-2008	223	44.7	56	11.2	45	9.0	175	35.1	499	100
			68.8		17.3		13.9				100
Dep 4_7	1994-1996	60	43.5	20	14.5	8	5.8	50	36.2	262	100
			68.2		22.7		9.1				100
	1997-2000	91	54.5	20	12.0	5	3.0	51	30.5	335	100
			78.4		17.2		4.3				100
	2001-2004	86	53.1	19	11.7	13	8.0	44	27.2	254	100
			72.9		16.1		11.0				100
	2005-2008	53	43.4	13	10.7	10	8.2	46	37.7	260	100
			69.7		17.1		13.2				100
	2001-2008	139	48.9	32	11.3	23	8.1	90	31.7	514	100
			71.6		16.5		11.9				100
Dep 8_10	1994-1996	113	43.1	27	10.3	12	4.6	110	42.0	138	100
			74.3		17.8		7.9				100
	1997-2000	143	42.7	46	13.7	23	6.9	123	36.7	167	100
			67.5		21.7		10.8				100
	2001-2004	118	46.5	12	4.7	30	11.8	94	37.0	162	100

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
			73.8		7.5		18.8				
	2005-2008	80	30.8	21	8.1	35	13.5	124	47.7	122	100
			58.8		15.4		25.7				100
	2001-2008	198	38.5	33	6.4	65	12.6	218	42.4	284	100
			66.9		11.1		22.0				100
Non-Māori Dep 1_3											
	1994-1996	82	43.2	28	14.7	13	6.8	67	35.3	179	100
			66.7		22.8		10.6				100
	1997-2000	129	48.3	34	12.7	13	4.9	91	34.1	227	100
			73.3		19.3		7.4				100
	2001-2004	111	49.8	28	12.6	16	7.2	68	30.5	176	100
			71.6		18.1		10.3				100
	2005-2008	91	44.8	16	7.9	19	9.4	77	37.9	190	100
			72.2		12.7		15.1				100
	2001-2008	202	47.4	44	10.3	35	8.2	145	34.0	366	100
			71.9		15.7		12.5				100
Non-Māori Dep 4_7											
	1994-1996	27	32.5	9	10.8	5	6.0	42	50.6	190	100
			65.9		22.0		12.2				100
	1997-2000	46	42.6	15	13.9	10	9.3	37	34.3	267	100
			64.8		21.1		14.1				100
	2001-2004	33	42.3	2	2.6	14	17.9	29	37.2	223	100
			67.3		4.1		28.6				100
	2005-2008	18	25.7	2	2.9	9	12.9	41	58.6	203	100
			62.1		6.9		31.0				100
	2001-2008	51	34.5	4	2.7	23	15.5	70	47.3	426	100
			65.4		5.1		29.5				100
Non-Māori Dep 8_10											
	1994-1996	86	48.0	18	10.1	7	3.9	68	38.0	34	100
			77.5		16.2		6.3				100
	1997-2000	97	42.7	31	13.7	13	5.7	86	37.9	41	100
			68.8		22.0		9.2				100
	2001-2004	85	48.3	10	5.7	16	9.1	65	36.9	40	100
			76.6		9.0		14.4				100
	2005-2008	62	32.6	19	10.0	26	13.7	83	43.7	33	100
			57.9		17.8		24.3				100
	2001-2008	147	40.2	29	7.9	42	11.5	148	40.4	73	100
			67.4		13.3		19.3				100
Māori Dep 1_3											
	1994-1996	57	44.9	18	14.2	7	5.5	45	35.4	83	100
			69.5		22.0		8.5				100
	1997-2000	81	54.4	16	10.7	5	3.4	47	31.5	108	100
			79.4		15.7		4.9				100
	2001-2004	80	53.0	18	11.9	11	7.3	42	27.8	78	100
			73.4		16.5		10.1				100
	2005-2008	44	40.7	11	10.2	8	7.4	45	41.7	70	100
			69.8		17.5		12.7				100
	2001-2008	124	47.9	29	11.2	19	7.3	87	33.6	148	100
			72.1		16.9		11.0				100
Māori Dep 4_7											
	1994-1996	13	38.2	4	11.8	6	17.6	11	32.4	11	100
			56.5		17.4		26.1				100
	1997-2000	18	43.9	2	4.9	5	12.2	16	39.0	18	100
			72.0		8.0		20.0				100
	2001-2004	10	25.0	8	20.0	3	7.5	19	47.5	11	100
			47.6		38.1		14.3				100
	2005-2008	11	33.3	4	12.1	7	21.2	11	33.3	14	100
			50.0		18.2		31.8				100
	2001-2008	21	28.8	12	16.4	10	13.7	30	41.1	25	100
			48.8		27.9		23.3				100
Māori Dep 8_10											
	1994-1996	3	27.3	2	18.2	1	9.1	5	45.5	127	100
			50.0		33.3		16.7				100
	1997-2000	10	55.6	4	22.2	0	0.0	4	22.2	149	100
			71.4		28.6		0.0				100
	2001-2004	6	54.5	1	9.1	2	18.2	2	18.2	151	100

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
			66.7		11.1		22.2				100
	2005-2008	9	64.3	2	14.3	2	14.3	1	7.1	108	100
			69.2		15.4		15.4				100
	2001-2008	15	60.0	3	12.0	4	16.0	3	12.0	259	100
			68.2		13.6		18.2				100

Table 24: Number and percentage of patients by severity and year of diagnosis for prostate cancer by ethnicity, deprivation and ethnicity and deprivation

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
Total	1994-1996	1,710	25.4	312	4.6	684	10.2	4,016	59.7	6,722	100
			63.2		11.5		25.3				100
	1997-2000	888	8.8	367	3.6	662	6.5	8,220	81.1	10,137	100
			46.3		19.1		34.5				100
	2001-2004	1,586	14.7	522	4.8	515	4.8	8,182	75.7	10,805	100
			60.5		19.9		19.6				100
	2005-2008	1,611	15.3	636	6.0	611	5.8	7,697	72.9	10,555	100
			56.4		22.3		21.4				100
	2001-2008	3,197	15.0	1,158	5.4	1,126	5.3	15,879	74.3	21,360	100
			58.3		21.1		20.5				100
Non-Māori	1994-1996	65	27.5	13	5.5	38	16.1	120	50.8	236	100
			56.0		11.2		32.8				100
	1997-2000	27	6.2	7	1.6	66	15.0	339	77.2	439	100
			27.0		7.0		66.0				100
	2001-2004	39	7.5	17	3.3	27	5.2	436	84.0	519	100
			47.0		20.5		32.5				100
	2005-2008	50	9.4	33	6.2	54	10.2	394	74.2	531	100
			36.5		24.1		39.4				100
	2001-2008	89	8.5	50	4.8	81	7.7	830	79.0	1,050	100
			40.5		22.7		36.8				100
Māori	1994-1996	1,645	25.4	299	4.6	646	10.0	3,896	60.1	6,486	100
			63.5		11.5		24.9				100
	1997-2000	861	8.9	360	3.7	596	6.1	7,881	81.3	9,698	100
			47.4		19.8		32.8				100
	2001-2004	1,547	15.0	505	4.9	488	4.7	7,746	75.3	10,286	100
			60.9		19.9		19.2				100
	2005-2008	1,561	15.6	603	6.0	557	5.6	7,303	72.9	10,024	100
			57.4		22.2		20.5				100
	2001-2008	3,108	15.3	1,108	5.5	1,045	5.1	15,049	74.1	20,310	100
			59.1		21.1		19.9				100
Dep 1_3	1994-1996	508	24.7	96	4.7	190	9.3	1,259	61.3	2,053	100
			64.0		12.1		23.9				100
	1997-2000	256	9.4	102	3.7	149	5.5	2,219	81.4	2,726	100
			50.5		20.1		29.4				100
	2001-2004	507	16.9	160	5.3	98	3.3	2,238	74.5	3,003	100
			66.3		20.9		12.8				100
	2005-2008	544	17.8	214	7.0	124	4.1	2,166	71.1	3,048	100
			61.7		24.3		14.1				100
	2001-2008	1,051	17.4	374	6.2	222	3.7	4,404	72.8	6,051	100
			63.8		22.7		13.5				100
Dep 4_7	1994-1996	724	25.3	140	4.9	293	10.2	1,705	59.6	1,807	100
			62.6		12.1		25.3				100
	1997-2000	346	8.0	171	4.0	262	6.1	3,549	82.0	3,083	100
			44.4		22.0		33.6				100
	2001-2004	690	14.7	243	5.2	210	4.5	3,545	75.6	3,114	100
			60.4		21.3		18.4				100
	2005-2008	686	15.4	273	6.1	262	5.9	3,244	72.7	3,042	100
			56.2		22.4		21.5				100
	2001-2008	1,376	15.0	516	5.6	472	5.2	6,789	74.2	6,156	100
			58.2		21.8		20.0				100
Dep 8_10	1994-1996	478	26.5	76	4.2	201	11.1	1,052	58.2	2,862	100
			63.3		10.1		26.6				100
	1997-2000	286	9.3	94	3.0	251	8.1	2,452	79.5	4,328	100
			45.3		14.9		39.8				100
	2001-2004	389	12.5	119	3.8	207	6.6	2,399	77.0	4,688	100
			54.4		16.6		29.0				100
	2005-2008	381	12.5	149	4.9	225	7.4	2,287	75.2	4,465	100
			50.5		19.7		29.8				100

		Local		Regional		Distant		Missing		Total	
		n	%	n	%	n	%	n	%	n	%
	2001-2008	770	12.5	268	4.4	432	7.0	4,686	76.1	9,153	100
			52.4		18.2		29.4				100
Non-Māori Dep 1_3											
	1994-1996	36	28.3	7	5.5	23	18.1	61	48.0	1,680	100
			54.5		10.6		34.8				100
	1997-2000	18	6.6	4	1.5	41	15.0	210	76.9	2,810	100
			28.6		6.3		65.1				100
	2001-2004	20	6.6	12	3.9	17	5.6	255	83.9	2,810	100
			40.8		24.5		34.7				100
	2005-2008	30	9.7	18	5.8	33	10.7	228	73.8	2,733	100
			37.0		22.2		40.7				100
	2001-2008	50	8.2	30	4.9	50	8.2	483	78.8	5,543	100
			38.5		23.1		38.5				100
Non-Māori Dep 4_7											
	1994-1996	702	25.3	135	4.9	281	10.1	1,660	59.8	127	100
			62.8		12.1		25.1				100
	1997-2000	339	8.1	169	4.0	247	5.9	3,444	82.0	273	100
			44.9		22.4		32.7				100
	2001-2004	675	14.9	238	5.3	200	4.4	3,410	75.4	304	100
			60.6		21.4		18.0				100
	2005-2008	668	15.6	263	6.1	245	5.7	3,109	72.6	309	100
			56.8		22.4		20.8				100
	2001-2008	1,343	15.2	501	5.7	445	5.1	6,519	74.0	613	100
			58.7		21.9		19.4				100
Non-Māori Dep 8_10											
	1994-1996	442	26.3	69	4.1	178	10.6	991	59.0	2,028	100
			64.2		10.0		25.8				100
	1997-2000	268	9.5	90	3.2	210	7.5	2,242	79.8	2,689	100
			47.2		15.8		37.0				100
	2001-2004	369	13.1	107	3.8	190	6.8	2,144	76.3	2,953	100
			55.4		16.1		28.5				100
	2005-2008	351	12.8	131	4.8	192	7.0	2,059	75.3	3,006	100
			52.1		19.4		28.5				100
	2001-2008	720	13.0	238	4.3	382	6.9	4,203	75.8	5,959	100
			53.7		17.8		28.5				100
Māori Dep 1_3											
	1994-1996	22	26.2	5	6.0	12	14.3	45	53.6	2,778	100
			56.4		12.8		30.8				100
	1997-2000	7	5.4	2	1.6	15	11.6	105	81.4	4,199	100
			29.2		8.3		62.5				100
	2001-2004	15	9.1	5	3.0	10	6.1	135	81.8	4,523	100
			50.0		16.7		33.3				100
	2005-2008	18	10.0	10	5.6	17	9.4	135	75.0	4,285	100
			40.0		22.2		37.8				100
	2001-2008	33	9.6	15	4.3	27	7.8	270	78.3	8,808	100
			44.0		20.0		36.0				100
Māori Dep 4_7											
	1994-1996	501	24.7	95	4.7	187	9.2	1,245	61.4	25	100
			64.0		12.1		23.9				100
	1997-2000	254	9.4	101	3.8	139	5.2	2,195	81.6	37	100
			51.4		20.4		28.1				100
	2001-2004	503	17.0	160	5.4	98	3.3	2,192	74.2	50	100
			66.1		21.0		12.9				100
	2005-2008	542	18.0	209	7.0	120	4.0	2,135	71.0	42	100
			62.2		24.0		13.8				100
	2001-2008	1,045	17.5	369	6.2	218	3.7	4,327	72.6	92	100
			64.0		22.6		13.4				100
Māori Dep 8_10											
	1994-1996	7	28.0	1	4.0	3	12.0	14	56.0	84	100
			63.6		9.1		27.3				100
	1997-2000	2	5.4	1	2.7	10	27.0	24	64.9	129	100
			15.4		7.7		76.9				100
	2001-2004	4	8.0	0	0.0	0	0.0	46	92.0	165	100
			100.0		0.0		0.0				100
	2005-2008	2	4.8	5	11.9	4	9.5	31	73.8	180	100
			18.2		45.5		36.4				100
	2001-2008	6	6.5	5	5.4	4	4.3	77	83.7	345	100
			40.0		33.3		26.7				100

4.5 Conclusion on staging systems to use in ABC-CBA

Often an intervention will be stage specific (e.g. chemotherapy for stage III colon cancer), or the interventions itself will change the stage distribution (e.g. screening). The actual staging system to be used in such economic decision modelling will be intervention specific. But general guidance includes:

1. At this point, reliable and generalizable staging data on the NZCR is only available for SEER extent of disease, and only for some cancers.
2. It is possible to roughly cross-classify TNM and other staging systems with SEER extent of disease.
3. It is likely that we will use SEER summary staging and NZCR data as a starting point:
4. for distribution of incident cases, and hence stage-specific incidence rates
5. for approximate excess mortality rate analyses and equations (see next Section of this Report).
6. However, it is also likely – if not inevitable – that there will often be the need to adjust or amend NZCR SEER output for specific models.

Regarding the latter point, an example is the modelling of care coordinators where we have used a combination of NZCR analyse and other data (and literature) to specify TNM-consistent stage III incidence rates and survival. It will be important to document the assumptions and methods in each intervention analysis.

5 Excess Mortality Rate Modelling of New Zealand Data

This section outlines excess mortality rate modelling on NZCR data to generate baseline inputs for ABC-CBA modelling.

5.1 Methods

5.1.1 Data description

Analysis included all Cancer Registry (NZCR) individual records for 1994-2008 with mortality follow-up up to December 2010[1]. Ethnicity was categorised as Māori: non-Māori, and deprivation as deciles 1-3, 4-7 and 8-10. Cancer site definitions in terms of ICD-10 codes were the same as the Burden of Cancer report (Blakely, Costilla et al. 2010), but with additional analyses for colon and rectal cancer separately. Data was excluded if there was death certificate only (DCO) registration or zero follow-up time from diagnosis to death.

We also ran models adjusting for, and by, SEER extent of disease, but only for colon, rectal, colorectal, breast, cervical and prostate cancers. These analyses excluded those with missing stage.

Lifetables by age, sex, ethnicity, and deprivation over 1994-2010 were used to source the background mortality rates. They are part of BODE[3] as well and are described elsewhere (Kvizhinadze and Blakely 2011)

Table 25 and Table 26 present the final numbers of cases for each cancer site by age, sex, ethnicity, deprivation and calendar of diagnosis, used in the modelling for all the cases and those with non-missing SEER extent of disease, respectively.

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[1] Whilst 2011 mortality data is linked to the cancer registry data, it is not sufficiently complete for robust analyses.

Table 25: Number of cases by age, sex, ethnicity, deprivation, calendar year of diagnosis for each cancer site over 1994-2010

	Bladder	Bone and connective tissue	Brain	Breast	Cervical	Childhood	Colorectal	Colon	Rectal	Uterus	Gallbladder	Hodgkin's	Kidney	Laryngeal	Leukaemia
Age															
0-4	0	0	0	0	0	890	0	0	0	0	0	0	0	0	0
5-9	0	0	0	0	0	506	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	540	0	0	0	0	0	0	0	0	0
25-44	224	224	744	4,994	1,215	0	1,229	732	497	299	36	631	389	30	880
45-54	494	0	546	8,500	567	0	3,167	1,781	1,386	813	107	131	808	121	796
55-64	1,123	0	680	7,939	387	0	7,760	4,775	2,985	1,435	236	124	1,252	326	1,289
65-74	2,294	0	732	5,818	309	0	12,076	7,980	4,096	1,166	368	120	1,634	384	2,045
75+	3,238	0	651	6,001	253	0	13,774	9,795	3,979	957	551	86	1,572	295	2,823
45+	0	242	0	0	0	0	0	0	0	0	0	0	0	0	0
Sex															
Male	5,417	281	1,955	0	0	1,036	19,318	11,755	7,563	0	541	629	3,562	997	4,493
Female	1,956	185	1,398	33,252	2,731	900	18,688	13,308	5,380	4,670	757	463	2,093	159	3,340
Ethnicity															
Non-Māori	7,124	406	3,143	29,951	2,190	1,518	36,523	24,213	12,310	4,151	1,177	1,003	5,239	1,035	7,259
Māori	249	60	210	3,301	541	418	1,483	850	633	519	121	89	416	121	574
Deprivation															
1-3 deciles	1,900	126	935	9,074	589	482	9,693	6,449	3,244	1,053	315	288	1,406	207	1,967
4-7 deciles	3,236	192	1,339	13,946	1,031	710	16,854	11,149	5,705	1,858	511	443	2,418	485	3,348
8-10 deciles	2,237	148	1,079	10,232	1,111	744	11,459	7,465	3,994	1,759	472	361	1,831	464	2,518
Stage															
Local	848	106	2,988	15,346	1,209	548	10,341	6,474	3,867	2,776	172	n.a.	2,484	143	n.a.
Regional	510	65	11	11,124	302	110	15,798	11,183	4,615	849	269	n.a.	907	198	n.a.
Distant	381	83	30	1,454	218	159	7,126	5,132	1,994	435	344	n.a.	1,290	67	n.a.
Missing	5,634	212	324	5,328	1,002	1,119	4,741	2,274	2,467	610	513	n.a.	974	748	n.a.
Calendar year of diagnosis															
1994	544	46	185	1,770	206	125	2,365	1,551	814	219	92	47	304	79	407
1995	506	23	185	1,824	212	141	2,381	1,551	830	231	95	63	297	74	423
1996	532	33	247	1,896	206	142	2,402	1,601	801	277	60	67	317	80	474
1997	496	30	207	1,980	199	150	2,281	1,505	776	271	69	55	364	90	504
1998	573	45	224	2,037	195	117	2,386	1,581	805	277	85	63	324	72	528
1999	548	30	211	2,214	214	132	2,520	1,673	847	313	71	63	356	62	456
2000	551	28	222	2,278	202	163	2,511	1,637	874	272	78	67	335	82	540
2001	577	26	228	2,269	180	129	2,584	1,719	865	307	68	85	365	79	572
2002	570	33	256	2,320	174	112	2,549	1,682	867	310	95	84	368	76	632
2003	570	25	222	2,295	174	135	2,623	1,699	924	315	118	71	390	68	692
2004	587	37	239	2,299	151	117	2,679	1,769	910	334	115	77	446	65	624
2005	319	32	234	2,429	148	110	2,659	1,777	882	377	74	93	411	83	515
2006	306	30	236	2,497	152	125	2,698	1,759	939	356	71	77	394	83	475
2007	351	31	240	2,500	153	106	2,696	1,770	926	395	94	78	471	75	494
2008	343	17	217	2,644	165	132	2,672	1,789	883	416	113	102	513	88	497
Total	7,373	466	3,353	33,252	2,731	1,936	38,006	25,063	12,943	4,670	1,298	1,092	5,655	1,156	7,833

	Lip, mouth and pharynx	Liver	Lung, trachea and bronchus	Melanoma	Myeloma	Non-Hodgkin's	Oesophageal	Other	Ovary	Pancreatic	Prostate	Stomach	Testis	Thyroid
Age														
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25-44	379	171	512	5,326	105	1,016	65	0	633	150	91	352	1,621	980
45-54	667	366	1,978	4,745	356	1,182	224	1,775	733	389	1,804	562	0	0
55-64	913	550	5,255	5,146	653	1,809	631	2,894	901	895	8,938	955	0	0
65-74	886	654	8,364	5,425	995	2,275	981	4,429	871	1,468	15,088	1,569	0	0
75+	779	617	7,861	5,616	1,330	2,520	1,437	6,751	991	2,069	12,298	2,101	0	0
45+	0	0	0	0	0	0	0	0	0	0	0	0	414	1,462
Sex														
Male	2,370	1,595	14,182	13,450	1,922	4,680	2,194	8,225	0	2,453	38,219	3,441	2,035	629
Female	1,254	763	9,788	12,808	1,517	4,122	1,144	7,624	4,129	2,518	0	2,098	0	1,813
Ethnicity														
Non-Māori	3,302	1,864	20,178	25,922	3,153	8,256	3,092	14,710	3,766	4,501	36,494	4,685	1,622	2,087
Māori	322	494	3,792	336	286	546	246	1,139	363	470	1,725	854	413	355
Deprivation														
1-3 deciles	793	447	4,327	7,938	908	2,309	730	3,746	1,065	1,154	10,830	1,191	489	599
4-7 deciles	1,503	853	9,995	11,467	1,419	3,767	1,470	6,835	1,694	2,153	16,343	2,257	806	948
8-10 deciles	1,328	1,058	9,648	6,853	1,112	2,726	1,138	5,268	1,370	1,664	11,046	2,091	740	895
Stage														
Local	778	202	1,477	22,416	n.a.	n.a.	223	2,394	1,024	149	5,795	642	1,447	1,429
Regional	1,235	71	2,165	1,490	n.a.	n.a.	368	1,109	448	438	1,837	1,382	243	571
Distant	235	493	9,077	1,203	n.a.	n.a.	692	8,496	2,313	2,287	2,472	1,560	209	150
Missing	1,376	1,592	11,251	1,149	n.a.	n.a.	2,055	3,850	344	2,097	28,115	1,955	136	292
Calendar year of diagnosis														
1994	203	112	1,558	1,428	158	415	191	1,027	246	280	1,945	345	121	89
1995	210	96	1,496	1,649	208	479	197	1,019	290	287	2,427	359	116	112
1996	207	128	1,546	1,488	211	531	186	1,046	279	314	2,350	391	120	114
1997	221	135	1,488	1,458	207	552	198	1,093	259	306	2,265	386	133	159
1998	226	136	1,464	1,536	229	593	158	1,126	281	318	2,332	406	127	145
1999	235	128	1,537	1,532	217	549	216	1,021	308	287	2,537	378	124	166
2000	233	130	1,603	1,678	241	537	226	1,126	287	319	3,003	359	140	160
2001	228	138	1,489	1,721	242	598	214	1,098	296	296	2,979	370	128	138
2002	229	158	1,571	1,803	265	618	235	1,020	305	315	2,581	406	166	148
2003	251	177	1,716	1,815	235	592	252	1,084	244	337	2,635	373	133	175
2004	250	153	1,788	1,862	236	623	250	1,017	267	351	2,610	356	135	185
2005	246	213	1,615	2,003	240	659	217	1,030	298	377	2,444	337	142	161
2006	293	220	1,633	1,952	251	657	254	1,073	263	370	2,394	359	161	218
2007	293	213	1,715	2,135	250	669	272	975	230	397	2,856	357	143	245
2008	299	221	1,751	2,198	249	730	272	1,094	276	417	2,861	357	146	227
Total	3,624	2,358	23,970	26,258	3,439	8,802	3,338	15,849	4,129	4,971	38,219	5,539	2,035	2,442

Table 26: Number of cases with non-missing stage by age, sex, ethnicity, deprivation, year of diagnosis for each cancer site

	Bladder	Bone and connective tissue	Brain	Breast	Cervical	Childhood	Colorectal	Colon	Rectal	Uterus	Gallbladder	Hodgkin's	Kidney	Laryngeal	Leukaemia
Age															
0-4	0	0	0	0	0	395	0	0	0	0	0	0	0	0	0
5-9	0	0	0	0	0	187	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	235	0	0	0	0	0	0	0	0	0
25-44	70	137	684	4,415	947	0	1,082	695	387	250	31	631	359	11	880
45-54	141	0	513	7,470	356	0	2,772	1,672	1,100	733	88	131	745	50	796
55-64	317	0	629	7,054	223	0	6,993	4,484	2,509	1,328	188	124	1,116	111	1,289
65-74	589	0	654	5,091	138	0	10,930	7,463	3,467	1,037	259	120	1,379	142	2,045
75+	622	0	549	3,894	65	0	11,488	8,475	3,013	712	219	86	1,082	94	2,823
45+	0	117	0	0	0	0	0	0	0	0	0	0	0	0	0
Sex															
Male	1,274	163	1,785	0	0	413	16,959	10,740	6,219	0	325	629	2,947	352	4,493
Female	465	91	1,244	27,924	1,729	404	16,306	12,049	4,257	4,060	460	463	1,734	56	3,340
Ethnicity															
Non-Māori	1,659	219	2,840	25,082	1,406	637	32,010	22,005	10,005	3,609	708	1,003	4,320	362	7,259
Māori	80	35	189	2,842	323	180	1,255	784	471	451	77	89	361	46	574
Deprivation															
1-3 deciles	459	69	843	7,651	398	215	8,461	5,860	2,601	918	199	288	1,171	81	1,967
4-7 deciles	738	92	1,211	11,733	671	302	14,797	10,110	4,687	1,624	306	443	2,002	154	3,348
8-10 deciles	542	93	975	8,540	660	300	10,007	6,819	3,188	1,518	280	361	1,508	173	2,518
Stage															
Local	848	106	2,988	15,346	1,209	548	10,341	6,474	3,867	2,776	172	n.a.	2,484	143	n.a.
Regional	510	65	11	11,124	302	110	15,798	11,183	4,615	849	269	n.a.	907	198	n.a.
Distant	381	83	30	1,454	218	159	7,126	5,132	1,994	435	344	n.a.	1,290	67	n.a.
Missing	0	0	0	0	0	0	0	0	0	0	0	n.a.	0	0	n.a.
Calendar year of diagnosis															
1994	342	26	77	1,342	119	63	1,801	1,111	690	159	50	47	203	45	407
1995	335	18	131	1,198	127	66	2,078	1,369	709	167	60	63	222	24	423
1996	83	19	158	1,492	140	65	2,103	1,442	661	236	33	67	257	36	474
1997	66	17	153	1,704	129	67	2,068	1,376	692	240	39	55	313	40	504
1998	62	20	221	1,627	125	55	2,132	1,459	673	247	52	63	279	27	528
1999	82	11	210	1,809	140	62	2,286	1,573	713	267	43	63	293	24	456
2000	45	12	222	1,865	135	74	2,284	1,530	754	232	47	67	276	23	540
2001	72	17	225	1,945	130	61	2,368	1,618	750	278	37	85	291	24	572
2002	101	14	256	1,965	109	48	2,305	1,567	738	276	54	84	319	29	632
2003	103	14	222	1,959	109	50	2,368	1,592	776	284	77	71	337	25	692
2004	86	19	235	1,972	106	46	2,431	1,678	753	303	72	77	376	16	624
2005	78	21	228	2,182	85	37	2,316	1,644	672	333	51	93	346	27	515
2006	93	18	235	2,255	93	49	2,276	1,597	679	321	37	77	333	29	475
2007	102	19	239	2,246	80	32	2,234	1,608	626	338	60	78	409	17	494
2008	89	9	217	2,363	102	42	2,215	1,625	590	379	73	102	427	22	497
Total	1,739	254	3,029	27,924	1,729	817	33,265	22,789	10,476	4,060	785	1,092	4,681	408	7,833

	Lip, mouth and pharynx	Liver	Lung, trachea and bronchus	Melanoma	Myeloma	Non-Hodgkin's	Oesophageal	Other	Ovary	Pancreatic	Prostate	Stomach	Testis	Thyroid
Age														
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25-44	251	69	363	5,092	105	1,016	42	0	583	122	43	287	1,513	882
45-54	452	142	1,349	4,550	356	1,182	132	1,354	680	292	734	445	0	0
55-64	587	184	3,252	4,927	653	1,809	336	2,205	856	625	3,187	729	0	0
65-74	530	222	4,485	5,209	995	2,275	437	3,412	815	922	3,855	1,111	0	0
75+	428	149	3,270	5,331	1,330	2,520	336	5,028	851	913	2,285	1,012	0	0
45+	0	0	0	0	0	0	0	0	0	0	0	0	386	1,268
Sex														
Male	1,476	492	7,399	12,863	1,922	4,680	938	6,008	0	1,469	10,104	2,268	1,899	550
Female	772	274	5,320	12,246	1,517	4,122	345	5,991	3,785	1,405	0	1,316	0	1,600
Ethnicity														
Non-Māori	2,036	600	10,795	24,791	3,153	8,256	1,182	11,071	3,450	2,584	9,668	2,975	1,518	1,833
Māori	212	166	1,924	318	286	546	101	928	335	290	436	609	381	317
Deprivation														
1-3 deciles	501	159	2,405	7,585	908	2,309	278	2,792	980	685	2,948	772	455	543
4-7 deciles	930	262	5,389	11,004	1,419	3,767	583	5,129	1,540	1,247	4,300	1,486	746	833
8-10 deciles	817	345	4,925	6,520	1,112	2,726	422	4,078	1,265	942	2,856	1,326	698	774
Stage														
Local	778	202	1,477	22,416	n.a.	n.a.	223	2,394	1,024	149	5,795	642	1,447	1,429
Regional	1,235	71	2,165	1,490	n.a.	n.a.	368	1,109	448	438	1,837	1,382	243	571
Distant	235	493	9,077	1,203	n.a.	n.a.	692	8,496	2,313	2,287	2,472	1,560	209	150
Missing	0	0	0	0	n.a.	n.a.	0	0	0	0	0	0	0	0
Calendar year of diagnosis														
1994	109	62	925	1,028	158	415	104	825	201	171	1,291	234	70	55
1995	131	47	711	1,621	208	479	98	850	251	168	919	238	109	97
1996	109	44	750	1,422	211	531	52	835	243	163	496	259	107	88
1997	139	52	714	1,388	207	552	87	850	234	174	380	253	125	136
1998	138	38	762	1,483	229	593	49	856	266	170	248	260	118	127
1999	136	30	708	1,503	217	549	69	766	274	152	564	232	118	154
2000	150	25	732	1,635	241	537	79	828	270	151	725	230	132	147
2001	147	39	774	1,690	242	598	87	834	286	175	655	244	123	129
2002	153	54	835	1,784	265	618	94	787	286	195	578	269	155	135
2003	160	49	981	1,751	235	592	92	804	226	181	722	239	130	158
2004	150	41	916	1,806	236	623	93	764	249	212	668	237	132	172
2005	159	69	936	1,950	240	659	94	748	278	227	663	226	137	140
2006	182	80	936	1,903	251	657	101	784	244	229	626	235	158	186
2007	197	67	975	2,111	250	669	99	704	218	237	743	216	142	220
2008	188	69	1,064	2,034	249	730	85	764	259	269	826	212	143	206
Total	2,248	766	12,719	25,109	3,439	8,802	1,283	11,999	3,785	2,874	10,104	3,584	1,899	2,150

5.1.2   Count regression models for excess mortality in the context of relative survival

Count regression models were used to estimate the excess mortality rates of persons diagnosed with cancer. Models were run in the context of relative survival using the complete approach over 1994-2010 (Brenner and Racher 2004). In particular, analysis included incident cases over 1994-2008 with follow-up to 2010. These patients were then followed *up to* 10 years after diagnosis. For example, a case diagnosed in 1994 had the full ten years of follow-up data, but a case diagnosed in 2008 had only two to three years follow-up (i.e. till the end of 2010. Table 27 shows this diagrammatically, with the cases by year of diagnosis (rows) and follow-up (across the row to the right) contributing to the analysis. The inclusion of a continuous variable for calendar year in the regression means that the excess mortality rates beyond 2010 by year of follow-up (e.g. for cases diagnosed in 2008 followed-up for 3-4 years or more, cases diagnosed in 2007 followed up for 4-5 years or more, etc) were based on 1994-2010 data extrapolated out (grey cells).

Table 27: Cases included in the Complete Approach to estimate the Excess Mortality Rates

		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	1994	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17
	1995		0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16
	1996			0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15
	1997				0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14
	1998					0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13
	1999						0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12
	2000							0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11
	2001								0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
	2002									0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9
	2003										0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8
	2004											0-1	1-2	2-3	3-4	4-5	5-6	6-7
	2005												0-1	1-2	2-3	3-4	4-5	5-6
	2006													0-1	1-2	2-3	3-4	4-5
	2007														0-1	1-2	2-3	3-4
	2008															0-1	1-2	2-3

(Row labels under "Year of diagnosis"; column header "Calendar year of follow-up")

Four sets of models were run for each cancer:

1. The <u>baseline model</u>, namely excess mortality as a function of sex, age, ethnicity, deprivation and time since diagnosis. The exact model and specification follow.

2. Same as baseline model, but with the <u>dataset restricted</u> to those with complete data on stage or severity. This allows inspection for any possible selection bias by excluding those with missing stage, which may impact also on the *complete case* analyses including stage as a covariate.

3. Additionally <u>including stage</u> as a main effect.

4. And finally, the baseline model run separately <u>by stage</u>. Running the model separately by stage has two advantages – it allows the shape of the excess mortality rate curve by time since diagnosis to vary by stage (i.e. advanced stage cancers may have a peak excess mortality immediately after diagnosis, but early stage cancer may have their peak excess mortality rate some years after diagnosis – see examples of output later in this Report). The disadvantage is reducing statistical power.

Assuming that the mortality rate due to cancer is an additive component to the total mortality rate (Dickman, Sloggett et al. 2004), we have that:

$$\lambda(x) = \lambda^*(x) + \exp(x\beta) \qquad ....(I)$$

where:

x = vector of variables that predict mortality

$\lambda\ (x)$ = total mortality rate given "x"

$\lambda^*(x)$ = mortality rate due to causes other than cancer given "x" (i.e. expected mortality from life tables)

$exp(x\beta)$ = excess mortality rate due to cancer given "x"

This equates to assuming a Poisson distribution of excess deaths due to cancer on the log-scale. Therefore, the excess mortality model can also be written as:

$$\ln(u_j - d_j^*) = \ln(y_j) + x\beta \qquad ...(II)$$

where:

$u_j =$ expected number of all deaths d_j; using the Complete Approach over 1994-2010 for observation j

$d^*_j =$ expected number of deaths for observation j, due to causes other than the cancer of interest and estimated from general population mortality rates (i.e. lifetables, in our case by sex, ethnicity and deprivation)

$y_j =$ person time for observation j (ie, offset)

$x =$ vector of variables that predict excess mortality.

5.1.3 Modelling survival over time since diagnosis

For future ABC-CBA modelling, it is important to have smoothed excess mortality rates over time since diagnosis. This was achieved by incorporating restricted cubic splines to model time since diagnosis as a continuous variable (Durrleman and Simon 1989; Lambert and Royston 2009; Royston and Lambert 2009). Restricted cubic splines are piecewise polynomials that are constrained to be smooth at their juncture points (knots) and are linear before the first and after the last knot (Durrleman and Simon 1989; Lambert and Royston 2009; Royston and Lambert 2009). Splines also need derived variables called "basis functions" related to their number of knots. For instance, if we use three interior knots (or five knots in total including the minimum and maximum, i.e. 0.0833 (end of the first month of follow-up) and the survival time), we need to calculate four basis functions. Expressing the excess mortality rate in the log-scale we have:

$$\ln \lambda(t; x) = \gamma_0 + \gamma_1 z_1 + \gamma_2 z_2 + \gamma_3 z_3 + \gamma_4 z_4 + x\beta \qquad ...(Ia)$$

$$z_1 = t$$

$$z_2 = (t - k_2)^3_+ - \frac{(k_5 - k_2)}{(k_5 - k_1)}(t - k_1)^3_+ - \left[1 - \frac{(k_5 - k_2)}{(k_5 - k_1)}\right](t - k_5)^3_+$$

$$z_3 = (t - k_3)^3_+ - \frac{(k_5 - k_3)}{(k_5 - k_1)}(t - k_1)^3_+ - \left[1 - \frac{(k_5 - k_3)}{(k_5 - k_1)}\right](t - k_5)^3_+$$

$$z_4 = (t - k_4)^3_+ - \frac{(k_5 - k_4)}{(k_5 - k_1)}(t - k_1)^3_+ - \left[1 - \frac{(k_5 - k_4)}{(k_5 - k_1)}\right](t - k_5)^3_+$$

Where: t   = Time since diagnosis (years)

k_1 = knot at start (i.e. 0.083 in our instance)

k_2 = first interior knot

k_5 = knot at end (i.e. minimum of 10 years, or survival time)

For example, if our five knots are placed at years 0.0833, 2, 4.0833, 6.6667 and 10 (i.e. months 1, 24, 49, 80 and 120) the basis functions would be:

$$z_1 = t$$

$$z_2 = (t-2)^3_+ - \frac{(10-2)}{(10-0.0833)}(t-0.0833)^3_+ - \left[1 - \frac{(10-2)}{(10-0.0833)}\right](t-10)^3_+$$

$$= (t-2)^3_+ - 0.8067(t-0.0833)^3_+ - 0.1933(t-10)^3_+$$

$$z_3 = (t-4.083)^3_+ - \frac{(10-4.0833)}{(10-0.0833)}(t-0.0833)^3_+ - \left[1 - \frac{(10-4.0833)}{(10-0.0833)}\right](t-10)^3_+$$

$$= (t-4.083)^3_+ - 0.5966(t-0.0833)^3_+ - 0.4034(t-10)^3_+$$

$$z_4 = (t-6.667)^3_+ - \frac{(10-6.6667)}{(10-0.0833)}(t-0.0833)^3_+ - \left[1 - \frac{(10-6.6667)}{(10-0.0833)}\right](t-10)^3_+$$

$$= (t-6.667)^3_+ - 0.3361(t-0.0833)^3_+ - 0.6639(t-10)^3_+$$

In words, our excess mortality rate function became a piece-wise function with different forms for each region defined by restricted cubic spline functions given the location of the knots. The conditions imposed on the splines force it to be a smoothed function of time since diagnosis. With the five (three internal) knots defined above, the excess mortality rate is fully described by:

$$\ln \lambda(t;x) = \begin{cases} \gamma_0 + \gamma_1 t + x\beta, & t \le 0.0833 \\[2ex] \begin{aligned} \gamma_0 + \gamma_1 t &- \gamma_2 0.8067(t-0.0833)^3 \\ &- \gamma_3 0.5966(t-0.0833)^3 \\ &- \gamma_4 0.3361(t-0.0833)^3 + x\beta, \end{aligned} & 0.0833 < t \le 2 \\[3ex] \begin{aligned} \gamma_0 + \gamma_1 t &- \gamma_2 \left\{ 0.8067(t-0.0833)^3 - (t-2)^3 \right\} \\ &- \gamma_3 0.5966(t-0.0833)^3 \\ &- \gamma_4 0.3361(t-0.0833)^3 + x\beta, \end{aligned} & 2 < t \le 4.083 \\[3ex] \begin{aligned} \gamma_0 + \gamma_1 t &- \gamma_2 \left\{ 0.8067(t-0.0833)^3 - (t-2)^3 \right\} \\ &- \gamma_3 \left\{ 0.5966(t-0.0833)^3 - (t-4.0833)^3 \right\} \\ &- \gamma_4 0.3361(t-0.0833)^3 + x\beta, \end{aligned} & 4.083 < t \le 6.667 \\[3ex] \begin{aligned} \gamma_0 + \gamma_1 t &- \gamma_2 \left\{ 0.8067(t-0.0833)^3 - (t-2)^3 \right\} \\ &- \gamma_3 \left\{ 0.5966(t-0.0833)^3 - (t-4.0833)^3 \right\} \\ &- \gamma_4 \left\{ 0.3361(t-0.0833)^3 - (t-6.6667)^3 \right\} + x\beta, \end{aligned} & 6.667 < t \le 10 \\[3ex] \begin{aligned} \gamma_0 + \gamma_1 t &- \gamma_2 \left\{ 0.8067(t-0.0833)^3 - (t-2)^3 + 0.1933(t-10)^3 \right\} \\ &- \gamma_3 \left\{ 0.5966(t-0.0833)^3 - (t-4.083)^3 + 0.4034(t-10)^3 \right\} \\ &- \gamma_4 \left\{ 0.3361(t-0.0833)^3 - (t-6.667)^3 + 0.6639(t-10)^3 \right\} + x\beta, \end{aligned} & t > 10 \end{cases}$$

The above knots and base functions are those actually used in this Report for breast cancer (model 1). When such a model was run for all cancers with non-missing demographics (i.e. the baseline model), the estimated model coefficients were as shown in Table 28.

Table 28: Baseline model coefficients for breast cancer – example

	Breast (female)
Type of Regression	Poisson
Years after diagnosis (Basis functions)	
$\gamma 1$	0.254 [0.158,0.351]
$\gamma 2$	0.043 [0.022,0.064]
$\gamma 3$	-0.023 [-0.045,-0.001]
$\gamma 4$	0.000 [-0.013,0.013]
Year of diagnosis	
(centered in 2006)	-0.049 [-0.056,-0.042]
Ethnicity	
Non-Māori (reference)	
Māori	0.467 [0.382,0.551]
Age	

Type of Regression	Breast (female) Poisson
25–44 (reference) [1]	
45–54 [2]	-0.332 [-0.412,-0.252]
55–64	-0.364 [-0.450,-0.277]
65–74	-0.156 [-0.275,-0.038]
75+	0.247 [0.107,0.388]
Deprivation	
Deciles 1-3 (reference)	
Deciles 4-7	0.153 [0.080,0.225]
Deciles 8-10	0.198 [0.120,0.275]
Interactions	
Other (reference)	
65-74 and 1st year after diagnosis	0.305 [0.108,0.501]
65-74 and 2nd year after diagnosis	0.108 [-0.083,0.299]
75+ and 1st year after diagnosis	0.809 [0.625,0.993]
75+ and 2nd year after diagnosis	0.086 [-0.131,0.303]
Constant	-3.834 [-3.977,-3.692]
Person-time (years)	41,795
Number of cases	33252
AIC	42,161
BIC	42,308
Log-likelihood	-21,064
Deviance/DF	0.60
Pearson/DF	2.23
Over dispersion parameter	0.02
Ho: a=0	0.17
Knot positions for years after diagnosis	
Knot at start	0.08
Knot at percentile 25	2.00
Knot at percentile 50	4.08
Knot at percentile 75	6.67
Knot at end	10

Consider breast cancer excess mortality by time since diagnosis among 55-64 year old non-Māori, diagnosed in 2006 and living in areas with deprivation deciles 1-3. Using the above coefficients and basis functions, one can calculate the excess mortality rate by time since diagnosis as laid out in Table 30 and graphed in Figure 2.

Table 29: Workings for the excess mortality rate (EMR) among 55-64 year old non-Māori, diagnosed in 2006 and living in areas with deprivation deciles 1-3

Time (in years) since diagnosis	Linear Prediction, ln(EMR)	EMR
0.0	-4.198	0.01503
0.2	-4.14723	0.01581
0.4	-4.09707	0.01662
0.6	-4.04849	0.01745
0.8	-4.00252	0.01827
1.0	-3.96015	0.01906
1.2	-3.92239	0.01979
1.4	-3.89026	0.02044
1.6	-3.86475	0.02097
1.8	-3.84687	0.02135
2.0	-3.83763	0.02154
2.2	-3.83769	0.02154
2.4	-3.84633	0.02136
2.6	-3.86251	0.02102
2.8	-3.88515	0.02054
3.0	-3.91322	0.01998
3.2	-3.94563	0.01934
3.4	-3.98135	0.01866
3.6	-4.01931	0.01797
3.8	-4.05845	0.01728
4.0	-4.09772	0.01661
4.2	-4.13609	0.01599
4.4	-4.17313	0.01540
4.6	-4.20887	0.01486
4.8	-4.24336	0.01436
5.0	-4.27665	0.01389
Note change in unit increase		
5.5	-4.35488	0.01284
6.0	-4.4266	0.01196
6.5	-4.49251	0.01119
7.0	-4.55335	0.01053
7.5	-4.60984	0.00995
8.0	-4.66271	0.00944
8.5	-4.71268	0.00898
9.0	-4.76048	0.00856
9.5	-4.80682	0.00817
10.0	-4.85244	0.00781

As it can be seen, in this case both predictions are no-monotonic on time since diagnosis. Figure 2 shows the function graphically. That is, the excess mortality rate for breast cancer is highly time-dependant: it increases for the first 2 years after diagnosis and then starts to

decrease; reaching a very low level, although not completely disappeared, after 10 years of diagnosis.

Figure 2: Plot by time (years) since diagnosis of breast cancer: a) linear prediction, ln(EMR); and b) EMR
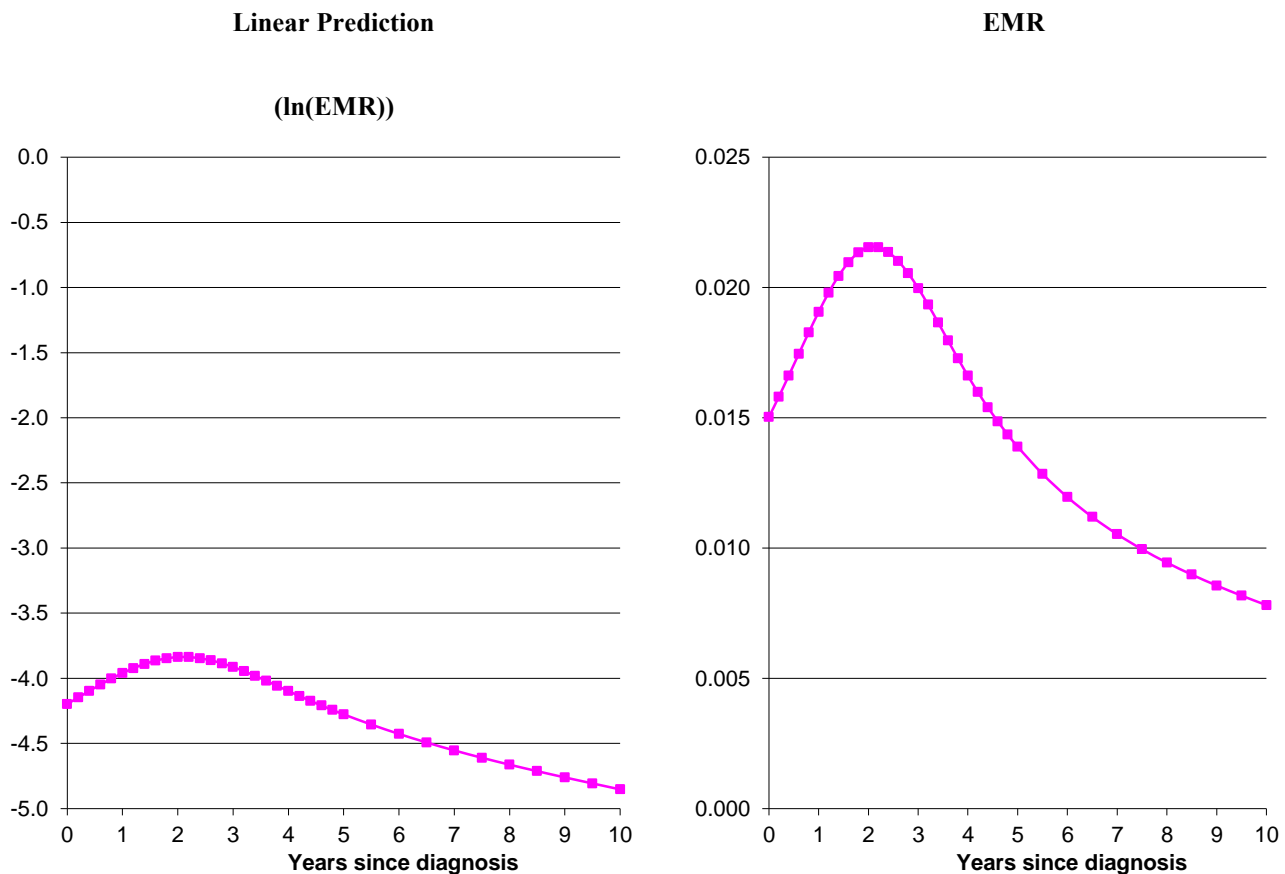
Of note is the issue of location and number of knots for the restricted cubic splines. In general the recommendation is to use sensible default locations. In practice, one could achieve this by placing the knots at the centiles of the distribution of the variable that is being smoothed, i.e. time since diagnosis. Following (Durrleman and Simon 1989; Lambert and Royston 2009; Royston and Lambert 2009), five knots (or 3 interior knots[2]) were chosen and placed at the minimum, percentiles 25, 50, and 75, and the maximum of time since diagnosis. As mentioned before, the minimum was always the first month after diagnosis, or the 0.0083

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[2] An exception to this was the case of cervical cancer where 2 knots, at percentiles 33 and 67, were used.

year, and the maximum was survival time or 10 years after diagnosis[3]. This procedure allowed us to have enough flexibility to capture the shape of the excess mortality rate function while preserving parsimony and avoiding over-fitting. The exact locations of the knots for each cancer site are reported together with the regression outputs (i.e. see end of Table 28 for example).

5.1.4   Over dispersion

As discussed in section 5.1.2, grouped Poisson regressions were used for all cancer sites. Over dispersion of the following form was tested:

$$V[y|x] = E[y|x] + a*(E[y|x]^2)$$

where:

y = excess deaths due to cancer

x = vector of variables that predict excess mortality

V[y|x] = Variance of y given x

E[y|x] = Expected value of y given x

Whenever the coefficient "a" was found to be statistically significant (at the 5% level) an additional Negative Binomial model was estimated[4]. The procedure improved the model fit (lower Log-likelihood, AIC and BIC) although there was still some evidence of lack of fit for some cancer sites (i.e. ratios of Deviance over degrees of freedom and Pearson over degrees of freedom different from 1).

5.2 Results

This section presents the estimated model's coefficients and predictions, both excess mortality rates and relative survival, for all cancer sites.

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[3] 5 years for Testicular cancer.
[4] See: Cameron, A., & Trivedi, P. (2005). *Microeconometrics: Methods and Applications*. New York: Cambridge University Press, Chapter 20 for details on this over dispersion test.

The regression outputs also include: type of regression (Poisson/Binomial, together with the over dispersion parameter and its statistical significance), several regression's statistics (person-time and cases included), measures of model fit (AIC, BIC, Log-likelihood, Deviance and Pearson statistic divided by the number of degrees of freedom), and the positions of the knots for time since diagnosis.

5.2.1 Baseline models (model 1)

As detailed in the methods, this first set of models (model 1) include all non-missing data on sex, age, ethnicity, and deprivation, incorporating also calendar year and time since diagnosis. Interactions for the oldest age groups (65-74 and 75+) and follow-up time are also included. This set of models does not include stage/severity; it is incorporated in the following sections (models 3 and 4).

As an example, in the case of bladder cancer the first column of Table 30 shows the coefficients for the covariates described above. These coefficients were estimated using 7,373 patients diagnosed between 1994 and 2008, a total of 51,216 person-years. The over dispersion parameter was not significant (p-value of 0.64) and Poisson regression was used as a consequence. The knots for the splines for time since diagnosis were placed at years 0.08, 1.92, 4.08, 6.67 and 10 after diagnosis. The Deviance and Pearson statistic divided by the number of degrees of freedom are lower and higher than one, 0.28 and 1.68 respectively, indicating some degree of model misfit (a ratio of 1 indicates a perfect fit). This is a likely consequence of the omission of important covariates, e.g. stage/severity at diagnosis.

Table 30: Regressions for all cancer sites (baseline model, model 1)

Type of Regression	Bladder Poisson	Bone and connective tissue Poisson	Brain Poisson
Years after diagnosis (Basis functions)			
γ1	-0.623 [-0.781,-0.464]	-0.390 [-0.784,0.003]	0.319 [0.106,0.532]
γ2	0.010 [-0.036,0.056]	-0.003 [-0.138,0.131]	0.715 [0.416,1.014]
γ3	-0.042 [-0.100,0.016]	0.048 [-0.101,0.197]	-0.396 [-0.703,-0.088]
γ4	0.035 [-0.006,0.076]	-0.062 [-0.151,0.027]	0.030 [-0.170,0.230]
Year of diagnosis			
(centered in 2006)	0.051 [0.040,0.063]	-0.006 [-0.041,0.029]	-0.010 [-0.018,-0.001]
Ethnicity			
Non-Māori (reference)			
Māori	0.491 [0.277,0.704]	0.456 [0.073,0.840]	0.273 [0.111,0.435]
Age			
25–44 (reference) [1]			
45–54 [2]	0.006 [-0.375,0.388]	0.202 [-0.088,0.493]	0.883 [0.741,1.024]
55–64	0.565 [0.230,0.899]		1.341 [1.207,1.475]
65–74	0.932 [0.562,1.301]		0.511 [-0.118,1.141]
75+	1.370 [1.004,1.737]		0.437 [-0.693,1.566]
Sex			
Male (reference)			
Female	0.277 [0.183,0.372]	-0.186 [-0.485,0.113]	-0.007 [-0.085,0.070]
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	0.011 [-0.103,0.125]	0.455 [0.064,0.846]	0.013 [-0.080,0.107]
Deciles 8-10	0.179 [0.059,0.299]	0.454 [0.040,0.867]	0.011 [-0.089,0.111]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	-0.152 [-0.429,0.126]		1.375 [0.741,2.010]
65-74 and 2nd year after diagnosis	-0.054 [-0.330,0.222]		0.824 [0.140,1.508]
75+ and 1st year after diagnosis	0.029 [-0.231,0.289]		1.862 [0.730,2.995]
75+ and 2nd year after diagnosis	-0.264 [-0.528,0.001]		0.641 [-0.591,1.872]
Constant	-2.130 [-2.490,-1.769]	-1.747 [-2.258,-1.237]	-1.390 [-1.559,-1.220]
Person-time (years)	51,216	15,265	19,652
Number of cases	7,373	466	3353
AIC	22,046	2,406	13,422
BIC	22,205	2,490	13,564
Log-likelihood	-11,005	-1,192	-6,693
Deviance/DF	0.28	0.13	0.44
Pearson/DF	1.68	2.98	2.71
Over dispersion parameter	0.01	0.31	0.05
Ho: a=0	0.64	0.34	0.07
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	1.92	1.75	0.83
Knot at percentile 50	4.08	3.75	1.92
Knot at percentile 75	6.67	6.33	3.33
Knot at end	10	10	5

[1] 15–44 for bone and connective issue, brain, hogdkins, leukaemia, melanoma, non-hodgkins, ovarian, testicular, thyroid and other cancer sites
[2] 45+ for bone and connective tissue, testicular and thyroid
[3] 0-4 (reference), 5-9 and 10-14 age groups for childhood

Cancer excess mortality rates over 2006-2026 for ABC-CBA

Type of Regression	Breast (female) Poisson	Cervical Poisson	Chilhood[3] Poisson
Years after diagnosis (Basis functions)			
γ1	0.254 [0.158,0.351]	-0.130 [-0.504,0.243]	-0.474 [-0.919,-0.029]
γ2	0.043 [0.022,0.064]	0.151 [-0.170,0.473]	0.058 [-0.322,0.439]
γ3	-0.023 [-0.045,-0.001]	-0.054 [-0.480,0.372]	-0.077 [-0.619,0.465]
γ4	0.000 [-0.013,0.013]	-0.064 [-0.393,0.266]	0.055 [-0.413,0.524]
Year of diagnosis			
(centered in 2006)	-0.049 [-0.056,-0.042]	-0.004 [-0.021,0.014]	-0.040 [-0.063,-0.017]
Ethnicity			
Non-Māori (reference)			
Māori	0.467 [0.382,0.551]	0.554 [0.375,0.732]	0.322 [0.097,0.546]
Age			
25–44 (reference) [1]			
45–54 [2]	-0.332 [-0.412,-0.252]	0.778 [0.559,0.997]	0.166 [-0.071,0.404]
55–64	-0.364 [-0.450,-0.277]	1.060 [0.827,1.293]	0.292 [0.065,0.520]
65–74	-0.156 [-0.275,-0.038]	1.730 [1.352,2.107]	
75+	0.247 [0.107,0.388]	2.299 [1.855,2.742]	
Sex			
Male (reference)			
Female			0.079 [-0.114,0.271]
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	0.153 [0.080,0.225]	0.114 [-0.099,0.327]	0.058 [-0.200,0.317]
Deciles 8-10	0.198 [0.120,0.275]	0.191 [-0.021,0.403]	0.119 [-0.139,0.377]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	0.305 [0.108,0.501]	-0.262 [-0.719,0.196]	
65-74 and 2nd year after diagnosis	0.108 [-0.083,0.299]	-0.357 [-0.865,0.152]	
75+ and 1st year after diagnosis	0.809 [0.625,0.993]	-0.150 [-0.650,0.351]	
75+ and 2nd year after diagnosis	0.086 [-0.131,0.303]	-0.229 [-0.783,0.325]	
Constant	-3.834 [-3.977,-3.692]	-3.010 [-3.341,-2.680]	-2.478 [-2.864,-2.093]
Person-time (years)	41,795	19,246	24,991
Number of cases	33252	2731	1936
AIC	42,161	6,681	4,080
BIC	42,308	6,814	4,177
Log-likelihood	-21,064	-3,323	-2,028
Deviance/DF	0.60	0.26	0.13
Pearson/DF	2.23	1.83	2.01
Over dispersion parameter	0.02	0.19	0.55
Ho: a=0	0.17	0.19	0.16
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	2.00	1.17	1.17
Knot at percentile 50	4.08	2.33	2.42
Knot at percentile 75	6.67	3.58	
Knot at end	10	5	

[1] 15–44 for bone and connective issue, brain, hogdkins, leukaemia, melanoma, non-hodgkins, ovarian, testicular, thyroid and other cancer sites

[2] 45+ for bone and connective tissue, testicular and thyroid

[3] 0-4 (reference), 5-9 and 10-14 age groups for childhood

	Colorectal	Colon	Rectal
	Negative Binomial	Negative Binomial	Negative Binomial
Years after diagnosis (Basis functions)			
$\gamma 1$	-0.982 [-1.053,-0.911]	-1.175 [-1.262,-1.088]	-0.681 [-0.798,-0.563]
$\gamma 2$	-0.192 [-0.223,-0.160]	-0.225 [-0.267,-0.184]	-0.143 [-0.191,-0.096]
$\gamma 3$	0.178 [0.138,0.218]	0.202 [0.149,0.256]	0.142 [0.086,0.197]
$\gamma 4$	-0.078 [-0.106,-0.051]	-0.085 [-0.124,-0.047]	-0.071 [-0.109,-0.033]
Year of diagnosis			
(centered in 2006)	-0.013 [-0.017,-0.008]	-0.009 [-0.015,-0.004]	-0.018 [-0.026,-0.011]
Ethnicity			
Non-Māori (reference)			
Māori	0.453 [0.373,0.533]	0.435 [0.330,0.540]	0.488 [0.367,0.610]
Age			
25–44 (reference) [1]			
45–54 [2]	0.071 [-0.037,0.179]	0.183 [0.041,0.325]	-0.087 [-0.252,0.079]
55–64	0.070 [-0.030,0.170]	0.171 [0.040,0.302]	-0.098 [-0.251,0.056]
65–74	0.084 [-0.036,0.205]	0.125 [-0.035,0.285]	0.043 [-0.136,0.222]
75+	-0.009 [-0.154,0.136]	-0.024 [-0.219,0.171]	0.092 [-0.116,0.300]
Sex			
Male (reference)			
Female	-0.069 [-0.107,-0.031]	-0.067 [-0.114,-0.020]	-0.092 [-0.154,-0.031]
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	0.048 [0.001,0.095]	0.059 [0.002,0.117]	0.025 [-0.052,0.102]
Deciles 8-10	0.104 [0.054,0.155]	0.071 [0.009,0.133]	0.175 [0.094,0.257]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	0.092 [-0.011,0.195]	0.070 [-0.063,0.202]	0.093 [-0.066,0.251]
65-74 and 2nd year after diagnosis	0.163 [0.050,0.277]	0.213 [0.067,0.359]	0.085 [-0.089,0.258]
75+ and 1st year after diagnosis	0.594 [0.464,0.723]	0.585 [0.413,0.756]	0.547 [0.360,0.735]
75+ and 2nd year after diagnosis	0.306 [0.158,0.453]	0.357 [0.164,0.549]	0.210 [-0.006,0.425]
Constant	-1.264 [-1.378,-1.151]	-1.092 [-1.237,-0.947]	-1.570 [-1.750,-1.390]
Person-time (years)	62,195	56,286	52,366
Number of cases	38006	25063	12943
AIC	61,539	47,204	33,733
BIC	61,702	47,365	33,893
Log-likelihood	-30,751	-23,584	-16,849
Deviance/DF	0.51	0.46	0.41
Pearson/DF	3.05	3.67	2.09
Over dispersion parameter	0.14	0.16	0.04
Ho: a=0	0.00	0.00	0.02
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	1.67	1.67	1.58
Knot at percentile 50	3.33	3.33	3.33
Knot at percentile 75	5.42	5.42	5.42
Knot at end	8	8	8

[1] 15–44 for bone and connective issue, brain, hogdkins, leukaemia, melanoma, non-hodgkins, ovarian, testicular, thyroid and other cancer sites

[2] 45+ for bone and connective tissue, testicular and thyroid

[3] 0-4 (reference), 5-9 and 10-14 age groups for childhood

	Uterus Negative Binomial	Gallbladder Poisson	Hodgkins Negative Binomial
Years after diagnosis (Basis functions)			
γ1	-0.756 [-1.058,-0.453]	-1.135 [-1.449,-0.822]	-0.713 [-1.209,-0.218]
γ2	-0.149 [-0.343,0.045]	-0.110 [-0.408,0.188]	-0.107 [-0.243,0.029]
γ3	0.152 [-0.109,0.413]	-0.027 [-0.287,0.234]	0.077 [-0.055,0.208]
γ4	-0.086 [-0.295,0.122]	0.056 [-0.082,0.195]	-0.024 [-0.090,0.043]
Year of diagnosis			
(centered in 2006)	-0.023 [-0.038,-0.007]	-0.009 [-0.023,0.006]	0.007 [-0.029,0.042]
Ethnicity			
Non-Māori (reference)			
Māori	0.511 [0.309,0.714]	0.253 [0.038,0.469]	0.233 [-0.359,0.825]
Age			
25–44 (reference) [1]			
45–54 [2]	0.181 [-0.171,0.533]	0.197 [-0.271,0.664]	0.849 [0.328,1.371]
55–64	0.291 [-0.043,0.625]	0.207 [-0.232,0.645]	1.490 [1.039,1.942]
65–74	0.834 [0.418,1.250]	0.407 [-0.198,1.012]	1.704 [1.034,2.375]
75+	1.266 [0.804,1.727]	0.553 [-0.117,1.224]	2.265 [1.285,3.245]
Sex			
Male (reference)			
Female		0.044 [-0.082,0.171]	-0.020 [-0.315,0.275]
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	0.102 [-0.081,0.284]	0.156 [-0.006,0.318]	-0.015 [-0.371,0.340]
Deciles 8-10	0.161 [-0.026,0.348]	0.180 [0.013,0.347]	-0.045 [-0.420,0.330]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	-0.186 [-0.568,0.196]	0.148 [-0.359,0.655]	0.559 [-0.277,1.395]
65-74 and 2nd year after diagnosis	-0.028 [-0.433,0.377]	0.223 [-0.320,0.765]	0.743 [-0.159,1.644]
75+ and 1st year after diagnosis	0.229 [-0.187,0.645]	0.391 [-0.186,0.968]	1.182 [0.122,2.241]
75+ and 2nd year after diagnosis	0.255 [-0.191,0.701]	0.407 [-0.194,1.008]	0.422 [-0.912,1.755]
Constant	-2.670 [-3.066,-2.273]	-0.265 [-0.733,0.203]	-3.401 [-4.007,-2.794]
Person-time (years)	23,414	15,136	30,277
Number of cases	4670	1298	1092
AIC	9,506	7,098	3,106
BIC	9,643	7,235	3,256
Log-likelihood	-4,736	-3,531	-1,535
Deviance/DF	0.28	0.33	0.08
Pearson/DF	3.14	8.92	4.60
Over dispersion parameter	0.16	-0.04	-0.20
Ho: a=0	0.03	0.55	0.02
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	1.33	0.92	1.75
Knot at percentile 50	2.75	2.25	3.75
Knot at percentile 75	4.25	4.08	6.25
Knot at end	6	7	10

[1] 15–44 for bone and connective issue, brain, hogdkins, leukaemia, melanoma, non-hodgkins, ovarian, testicular, thyroid and other sites

[2] 45+ for bone and connective tissue, testicular and thyroid

[3] 0-4 (reference), 5-9 and 10-14 age groups for childhood

	Kidney Poission	Laryngeal Poisson	Luekaemia Negative Binomial
Years after diagnosis (Basis functions)			
γ1	-1.314 [-1.455,-1.173]	-0.043 [-0.428,0.341]	-1.567 [-1.691,-1.443]
γ2	-0.166 [-0.213,-0.118]	0.088 [-0.024,0.200]	-0.221 [-0.260,-0.182]
γ3	0.122 [0.069,0.175]	-0.079 [-0.188,0.029]	0.159 [0.116,0.202]
γ4	-0.041 [-0.072,-0.009]	0.026 [-0.028,0.081]	-0.047 [-0.072,-0.022]
Year of diagnosis			
(centered in 2006)	-0.023 [-0.033,-0.013]	0.014 [-0.012,0.039]	-0.043 [-0.053,-0.034]
Ethnicity			
Non-Māori (reference)			
Māori	0.449 [0.295,0.603]	0.415 [0.090,0.740]	0.313 [0.181,0.445]
Age			
25–44 (reference) [1]			
45–54 [2]	0.148 [-0.070,0.365]	0.808 [-0.169,1.785]	0.086 [-0.080,0.252]
55–64	0.385 [0.181,0.588]	0.945 [0.002,1.889]	0.314 [0.167,0.461]
65–74	0.529 [0.247,0.810]	1.306 [0.328,2.284]	0.819 [0.622,1.015]
75+	0.749 [0.413,1.086]	1.469 [0.424,2.514]	1.170 [0.963,1.376]
Sex			
Male (reference)			
Female	-0.059 [-0.147,0.029]	0.157 [-0.120,0.434]	-0.022 [-0.096,0.052]
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	0.056 [-0.051,0.163]	0.134 [-0.159,0.427]	-0.032 [-0.125,0.060]
Deciles 8-10	0.066 [-0.049,0.181]	0.051 [-0.250,0.352]	0.060 [-0.037,0.157]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	0.114 [-0.146,0.374]	-0.191 [-0.737,0.355]	-0.165 [-0.371,0.041]
65-74 and 2nd year after diagnosis	0.096 [-0.212,0.404]	-0.089 [-0.608,0.429]	-0.281 [-0.549,-0.013]
75+ and 1st year after diagnosis	0.385 [0.071,0.700]	0.445 [-0.189,1.080]	-0.116 [-0.326,0.094]
75+ and 2nd year after diagnosis	0.255 [-0.110,0.620]	0.428 [-0.202,1.058]	-0.386 [-0.665,-0.107]
Constant	-1.276 [-1.504,-1.048]	-3.159 [-4.195,-2.122]	-1.050 [-1.219,-0.881]
Person-time (years)	55,219	27,749	58,462
Number of cases	5655	1156	7833
AIC	19,164	5,832	25,949
BIC	19,325	5,980	26,111
Log-likelihood	-9,564	-2,898	-12,957
Deviance/DF	0.24	0.16	0.28
Pearson/DF	3.27	2.43	3.90
Over dispersion parameter	0.05	0.14	0.29
Ho: a=0	0.23	0.52	0.00
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	1.83	1.75	1.83
Knot at percentile 50	3.83	3.67	3.83
Knot at percentile 75	6.42	6.25	6.33
Knot at end	10	10	10

[1] 15–44 for bone and connective issue, brain, hogdkins, leukaemia, melanoma, non-hodgkins, ovarian, testicular, thyroid and other sites

[2] 45+ for bone and connective tissue, testicular and thyroid

[3] 0-4 (reference), 5-9 and 10-14 age groups for childhood

	Lip, mouth and pharynx	Liver	Lung, trachea and bronchus
	Poisson	Poisson	Negative Binomial
Years after diagnosis (Basis functions)			
$\gamma1$	-0.124 [-0.295,0.047]	-2.205 [-2.438,-1.972]	-1.018 [-1.085,-0.951]
$\gamma2$	0.080 [0.028,0.133]	-0.793 [-1.029,-0.557]	-0.187 [-0.252,-0.122]
$\gamma3$	-0.078 [-0.133,-0.022]	0.519 [0.305,0.733]	0.179 [0.092,0.265]
$\gamma4$	0.027 [-0.004,0.058]	-0.186 [-0.301,-0.072]	-0.106 [-0.174,-0.038]
Year of diagnosis			
(centered in 2006)	-0.021 [-0.033,-0.008]	-0.022 [-0.033,-0.012]	0.001 [-0.002,0.005]
Ethnicity			
Non-Māori (reference)			
Māori	0.356 [0.177,0.535]	0.269 [0.151,0.387]	0.195 [0.155,0.236]
Age			
25–44 (reference) [1]			
45–54 [2]	0.570 [0.311,0.828]	0.201 [-0.009,0.411]	0.233 [0.122,0.344]
55–64	0.977 [0.733,1.221]	0.198 [-0.002,0.397]	0.293 [0.188,0.397]
65–74	1.109 [0.802,1.416]	0.748 [0.337,1.158]	0.360 [0.210,0.510]
75+	1.008 [0.582,1.434]	0.940 [0.382,1.498]	0.708 [0.547,0.869]
Sex			
Male (reference)			
Female	-0.345 [-0.461,-0.229]	-0.025 [-0.121,0.072]	-0.088 [-0.118,-0.058]
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	0.114 [-0.025,0.253]	0.018 [-0.107,0.144]	0.055 [0.014,0.096]
Deciles 8-10	0.081 [-0.064,0.226]	0.037 [-0.088,0.162]	0.102 [0.060,0.144]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	0.525 [0.239,0.810]	-0.352 [-0.751,0.047]	0.076 [-0.047,0.199]
65-74 and 2nd year after diagnosis	0.149 [-0.163,0.461]	-0.264 [-0.719,0.190]	0.119 [-0.010,0.247]
75+ and 1st year after diagnosis	1.016 [0.607,1.425]	-0.332 [-0.880,0.217]	-0.063 [-0.199,0.073]
75+ and 2nd year after diagnosis	0.247 [-0.218,0.712]	0.160 [-0.435,0.756]	-0.057 [-0.203,0.088]
Constant	-2.713 [-3.012,-2.413]	0.683 [0.457,0.908]	0.178 [0.066,0.291]
Person-time (years)	51,700	19,598	42,809
Number of cases	3624	2358	23970
AIC	14,734	10,875	46,632
BIC	14,893	11,017	46,788
Log-likelihood	-7,349	-5,419	-23,298
Deviance/DF	0.21	0.38	0.55
Pearson/DF	3.50	4.82	4.83
Over dispersion parameter	-0.08	0.11	0.03
Ho: a=0	0.21	0.22	0.00
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	1.83	0.92	1.17
Knot at percentile 50	3.83	2.25	2.5
Knot at percentile 75	6.33	4.08	4.08
Knot at end	10	7	6

[1] 15–44 for bone and connective issue, brain, hogdkins, leukaemia, melanoma, non-hodgkins, ovarian, testicular, thyroid and other cancer sites

[2] 45+ for bone and connective tissue, testicular and thyroid

[3] 0-4 (reference), 5-9 and 10-14 age groups for childhood

	Melanoma Poisson	Myeloma Negative Binomial	Non-Hodgkin's Negative Binomial
Years after diagnosis (Basis functions)			
γ1	-0.297 [-0.534,-0.060]	-0.878 [-1.058,-0.697]	-1.087 [-1.198,-0.976]
γ2	-0.051 [-0.184,0.081]	-0.167 [-0.225,-0.109]	-0.108 [-0.142,-0.073]
γ3	0.073 [-0.084,0.230]	0.104 [0.052,0.157]	0.069 [0.029,0.108]
γ4	-0.061 [-0.169,0.047]	-0.017 [-0.041,0.007]	-0.016 [-0.039,0.008]
Year of diagnosis			
(centered in 2006)	0.000 [-0.011,0.012]	-0.039 [-0.050,-0.028]	-0.044 [-0.052,-0.035]
Ethnicity			
Non-Māori (reference)			
Māori	0.857 [0.552,1.163]	0.376 [0.214,0.538]	0.538 [0.410,0.666]
Age			
25–44 (reference) [1]			
45–54 [2]	0.191 [0.027,0.355]	0.460 [0.106,0.814]	0.178 [0.017,0.338]
55–64	0.400 [0.240,0.560]	0.819 [0.482,1.157]	0.508 [0.363,0.652]
65–74	0.723 [0.506,0.939]	1.218 [0.866,1.570]	1.052 [0.867,1.238]
75+	1.543 [1.342,1.744]	1.606 [1.247,1.965]	1.253 [1.032,1.473]
Sex			
Male (reference)			
Female	-0.639 [-0.744,-0.534]	-0.067 [-0.157,0.023]	-0.063 [-0.131,0.005]
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	0.185 [0.067,0.304]	0.036 [-0.073,0.146]	0.016 [-0.069,0.101]
Deciles 8-10	0.272 [0.142,0.403]	-0.036 [-0.153,0.082]	0.071 [-0.020,0.163]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	0.028 [-0.248,0.303]	-0.167 [-0.409,0.075]	-0.207 [-0.397,-0.017]
65-74 and 2nd year after diagnosis	-0.049 [-0.350,0.251]	0.065 [-0.196,0.326]	-0.229 [-0.455,-0.002]
75+ and 1st year after diagnosis	-0.503 [-0.780,-0.226]	0.043 [-0.192,0.278]	0.296 [0.078,0.513]
75+ and 2nd year after diagnosis	-0.192 [-0.464,0.080]	0.165 [-0.086,0.417]	-0.073 [-0.335,0.189]
Constant	-3.747 [-3.982,-3.512]	-1.944 [-2.317,-1.570]	-1.729 [-1.897,-1.561]
Person-time (years)	41,991	41,680	59,841
Number of cases	26258	3439	8802
AIC	27,474	17,016	26,493
BIC	27,630	17,172	26,655
Log-likelihood	-13,719	-8,490	-13,228
Deviance/DF	0.42	0.29	0.30
Pearson/DF	1.42	5.30	5.10
Over dispersion parameter	0.00	0.10	0.06
Ho: a=0	0.88	.016798	0.02
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	1.42	1.58	1.92
Knot at percentile 50	2.75	3.42	3.92
Knot at percentile 75	4.33	5.83	6.42
Knot at end	6	10	10

[1] 15–44 for bone and connective issue, brain, hogdkins, leukaemia, melanoma, non-hodgkins, ovarian, testicular, thyroid and other cancer sites

[2] 45+ for bone and connective tissue, testicular and thyroid

[3] 0-4 (reference), 5-9 and 10-14 age groups for childhood

	Oesophageal	Other[3]	Ovary
	Poisson	Negative Binomial	Negative Binomial
Years after diagnosis (Basis functions)			
$\gamma 1$	-0.213 [-0.409,-0.017]	-2.097 [-2.179,-2.015]	-0.560 [-0.689,-0.430]
$\gamma 2$	0.364 [0.115,0.613]	-0.315 [-0.348,-0.282]	-0.061 [-0.100,-0.023]
$\gamma 3$	-0.276 [-0.523,-0.029]	0.256 [0.212,0.300]	0.064 [0.017,0.110]
$\gamma 4$	0.094 [-0.047,0.235]	-0.100 [-0.132,-0.069]	-0.035 [-0.066,-0.004]
Year of diagnosis			
(centered in 2006)	-0.010 [-0.018,-0.001]	-0.022 [-0.027,-0.016]	0.004 [-0.007,0.014]
Ethnicity			
Non-Māori (reference)			
Māori	0.389 [0.246,0.531]	0.421 [0.344,0.497]	0.188 [0.029,0.346]
Age			
25–44 (reference) [1]			
45–54 [2]	-0.022 [-0.342,0.298]	0.409 [0.324,0.493]	0.796 [0.606,0.985]
55–64	0.136 [-0.160,0.432]	0.741 [0.569,0.912]	1.213 [1.034,1.392]
65–74	0.487 [0.086,0.887]	0.790 [0.586,0.995]	1.454 [1.214,1.694]
75+	0.835 [0.418,1.253]		1.348 [1.030,1.666]
Sex			
Male (reference)			
Female	-0.143 [-0.224,-0.062]	-0.030 [-0.074,0.014]	
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	0.041 [-0.057,0.139]	-0.013 [-0.070,0.044]	0.159 [0.054,0.263]
Deciles 8-10	0.093 [-0.010,0.197]	0.100 [0.041,0.159]	0.090 [-0.022,0.202]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	-0.076 [-0.393,0.240]	-0.163 [-0.337,0.011]	0.089 [-0.153,0.332]
65-74 and 2nd year after diagnosis	-0.269 [-0.605,0.067]	0.170 [-0.030,0.370]	0.288 [0.030,0.545]
75+ and 1st year after diagnosis	-0.078 [-0.412,0.257]	0.065 [-0.141,0.270]	1.063 [0.752,1.375]
75+ and 2nd year after diagnosis	-0.235 [-0.582,0.113]	0.267 [0.036,0.497]	0.414 [0.053,0.775]
Constant	-0.273 [-0.584,0.038]	-0.002 [-0.097,0.094]	-2.138 [-2.356,-1.920]
Person-time (years)	18,584	49,693	31,384
Number of cases	3338	15849	4129
AIC	13,414	35,437	14,204
BIC	13,555	35,587	14,346
Log-likelihood	-6,689	-17,701	-7,085
Deviance/DF	0.46	0.41	0.30
Pearson/DF	3.44	2.30	1.74
Over dispersion parameter	0.02	0.07	0.07
Ho: a=0	0.61	0.00	0.01
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	0.92	1.83	1.92
Knot at percentile 50	2	3.92	4
Knot at percentile 75	3.67	6.5	6.58
Knot at end	6	10	10

[1] 15–44 for bone and connective issue, brain, hogdkins, leukaemia, melanoma, non-hodgkins, ovarian, testicular, thyroid and other cancer sites

[2] 45+ for bone and connective tissue, testicular and thyroid

[3] 0-4 (reference), 5-9 and 10-14 age groups for childhood

	Pancreatic	Prostate	Stomach
	Poisson	Negative Binomial	Poisson
Years after diagnosis (Basis functions)			
$\gamma 1$	-1.110 [-1.296,-0.924]	-0.469 [-0.612,-0.325]	-1.125 [-1.268,-0.982]
$\gamma 2$	0.020 [-0.419,0.460]	-0.069 [-0.104,-0.035]	-0.150 [-0.287,-0.013]
$\gamma 3$	-0.089 [-0.534,0.355]	0.058 [0.020,0.095]	0.130 [-0.049,0.308]
$\gamma 4$	0.052 [-0.201,0.305]	-0.020 [-0.041,0.000]	-0.087 [-0.223,0.049]
Year of diagnosis			
(centered in 2006)	-0.001 [-0.008,0.006]	-0.054 [-0.064,-0.044]	-0.009 [-0.016,-0.001]
Ethnicity			
Non-Māori (reference)			
Māori	0.105 [0.000,0.209]	0.699 [0.561,0.837]	0.193 [0.101,0.284]
Age			
25–44 (reference) [1]			
45–54 [2]	0.308 [0.100,0.517]	-0.079 [-0.848,0.689]	-0.026 [-0.185,0.134]
55–64	0.382 [0.189,0.576]	-0.021 [-0.772,0.731]	0.091 [-0.056,0.238]
65–74	0.466 [0.029,0.903]	0.325 [-0.429,1.080]	0.130 [-0.141,0.401]
75+	0.536 [0.049,1.023]	1.260 [0.506,2.014]	0.204 [-0.111,0.520]
Sex			
Male (reference)			
Female	-0.004 [-0.063,0.056]		-0.025 [-0.090,0.040]
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	0.058 [-0.018,0.134]	0.121 [0.028,0.215]	0.041 [-0.042,0.124]
Deciles 8-10	0.105 [0.024,0.186]	0.200 [0.099,0.300]	0.041 [-0.046,0.127]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	0.141 [-0.273,0.555]	0.097 [-0.129,0.323]	0.049 [-0.214,0.312]
65-74 and 2nd year after diagnosis	0.186 [-0.263,0.636]	0.166 [-0.057,0.389]	-0.098 [-0.386,0.191]
75+ and 1st year after diagnosis	0.330 [-0.136,0.796]	0.571 [0.371,0.770]	0.343 [0.037,0.649]
75+ and 2nd year after diagnosis	0.148 [-0.357,0.654]	0.259 [0.062,0.457]	0.104 [-0.227,0.435]
Constant	0.432 [0.229,0.635]	-3.983 [-4.749,-3.217]	0.086 [-0.077,0.250]
Person-time (years)	18,170	35,475	36,032
Number of cases	4971	38219	5539
AIC	15,445	39,803	20,245
BIC	15,586	39,947	20,398
Log-likelihood	-7,704	-19,885	-10,105
Deviance/DF	0.50	0.53	0.36
Pearson/DF	15.64	1.38	5.68
Over dispersion parameter	-0.01	0.06	0.00
Ho: a=0	0.73	0.00	0.98
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	.75	2	1.17
Knot at percentile 50	1.67	4	2.5
Knot at percentile 75	3.08	6.5	4.08
Knot at end	5	10	6

[1] 15–44 for bone and connective issue, brain, hogdkins, leukaemia, melanoma, non-hodgkins, ovarian, testicular, thyroid and other cancer sites

[2] 45+ for bone and connective tissue, testicular and thyroid

[3] 0-4 (reference), 5-9 and 10-14 age groups for childhood

	Testis Negative Binomial	Thyroid Poisson
Years after diagnosis (Basis functions)		
$\gamma 1$	-0.805 [-1.804,0.194]	-2.798 [-3.478,-2.118]
$\gamma 2$	-0.084 [-1.239,1.071]	-1.309 [-2.114,-0.504]
$\gamma 3$	-0.068 [-2.217,2.081]	1.599 [0.269,2.929]
$\gamma 4$	0.275 [-1.949,2.499]	-1.129 [-2.295,0.038]
Year of diagnosis		
(centered in 2006)	0.018 [-0.038,0.074]	-0.027 [-0.061,0.008]
Ethnicity		
Non-Māori (reference)		
Māori	1.066 [0.544,1.587]	0.166 [-0.286,0.618]
Age		
25–44 (reference) [1]		
45–54 [2]	0.593 [0.015,1.172]	2.345 [1.743,2.947]
55–64		
65–74		
75+		
Sex		
Male (reference)		
Female		-0.425 [-0.727,-0.122]
Deprivation		
Deciles 1-3 (reference)		
Deciles 4-7	0.334 [-0.346,1.014]	0.188 [-0.174,0.549]
Deciles 8-10	0.178 [-0.536,0.892]	-0.125 [-0.530,0.280]
Interactions		
Other (reference)		
65-74 and 1st year after diagnosis		
65-74 and 2nd year after diagnosis		
75+ and 1st year after diagnosis		
75+ and 2nd year after diagnosis		
Constant	-3.908 [-4.736,-3.080]	-3.264 [-3.991,-2.537]
Person-time (years)	8,645	16,775
Number of cases	2035	2442
AIC	1,122	2,504
BIC	1,192	2,589
Log-likelihood	-551	-1,241
Deviance/DF	0.10	0.11
Pearson/DF	2.83	1.17
Over dispersion parameter	-0.87	0.40
Ho: a=0	0.00	0.09
Knot positions for years after diagnosis		
Knot at start	0.08	0.08
Knot at percentile 25	1.25	1.25
Knot at percentile 50	2.42	2.42
Knot at percentile 75	3.67	3.67
Knot at end	5	5

[1] 15–44 for bone and connective issue, brain, hogdkins, leukaemia, melanoma, non-hodgkins, ovarian, testicular, thyroid and other cancer sites

[2] 45+ for bone and connective tissue, testicular and thyroid

[3] 0-4 (reference), 5-9 and 10-14 age groups for childhood

5.2.2 Predictions over 2006-2026 for baseline models

This section shows the excess mortality rate (EMR) predictions by time since diagnosis for one stratum in selected cancer sites and. The sites are breast, colorectal, colon, rectal, lung, prostate and cervical and the stratum is 55-64 years old non-Māori women (men in the case of prostate) from deprivation deciles 1-3 diagnosed in 2006.

For instance in the case of breast cancer, Figure 3, the predicted excess mortality rates are increasing in the first years after diagnosis and then start to decrease, reaching very low levels after 20 years since diagnosis. This shape, initial increase in excess mortality and monotonic decrease but not completely to zero, is characteristic of breast cancer (Lambert and Royston 2009) and is consistent with previous findings for New Zealand. The Burden of Cancer report found a similar pattern ((Blakely, Costilla et al. 2010) Appendix A), however analysing data from an earlier period, e.g. 2002-2006, and using a categorical time scale, e.g. dummies for each year of follow-up. In this Burden of Cancer study the excess mortality rates increased in the first years after diagnosis, e.g. excess mortality rate ratio of 1.45 up to 4 years after diagnosis, and then decreased monotonically, excess mortality rate ratio of 0.73 after 10 years after diagnosis.

Figure 3: Baseline model (model 1) predictions for 55-64 years old, 1-3 deprivation deciles, Non-Māori female patients diagnosed with breast cancer in 2006
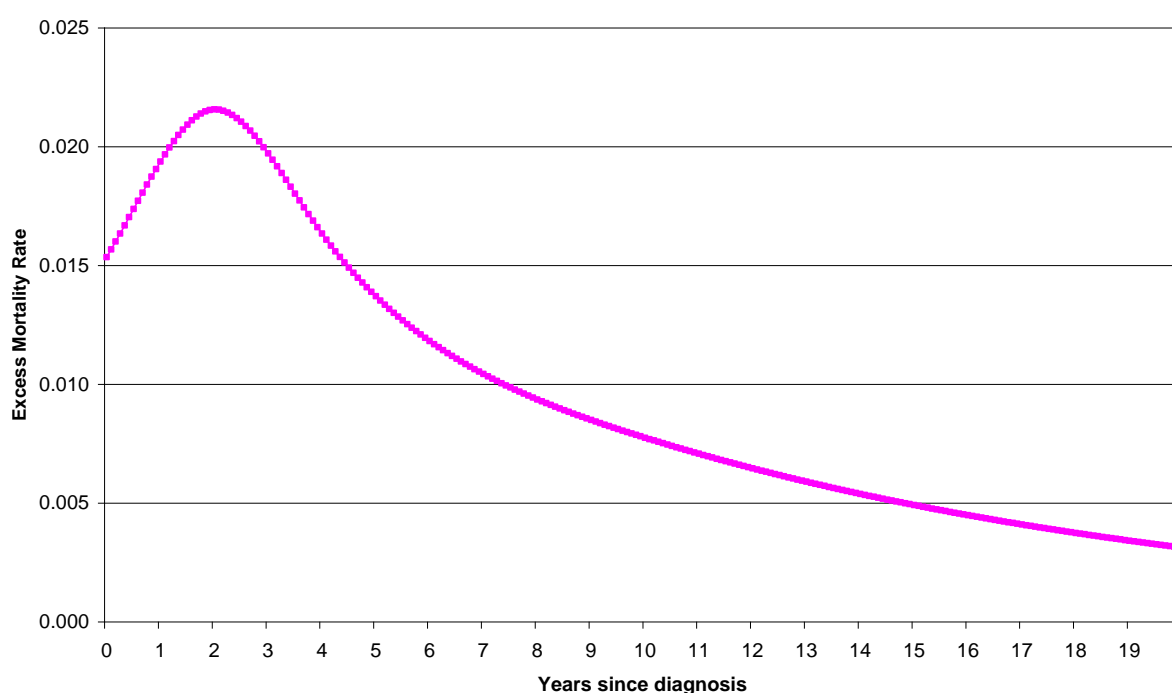
Figure 4 to Figure 9 show the cubic spline estimated excess mortality rate by time since diagnosis for other cancers, but the same sociodemographic. There are important differences between the cancers (and figures) in both the actual excess mortality rate on the y-axis (high for lung cancer, low for prostate) and shape of the curves (delayed peak for breast, highest initially for other cancers – although this varies by stage). These outputs will be used in the ABC-CBA modelling to estimate time dependent transition probabilities (i.e. Markov macrosimulation models), or converted to cumulative probability curves for discrete event simulation.

Figure 4: Baseline model (model 1) predictions for 55-64 years old, 1-3 deprivation deciles, Non-Māori female patients diagnosed with colorectal cancer in 2006
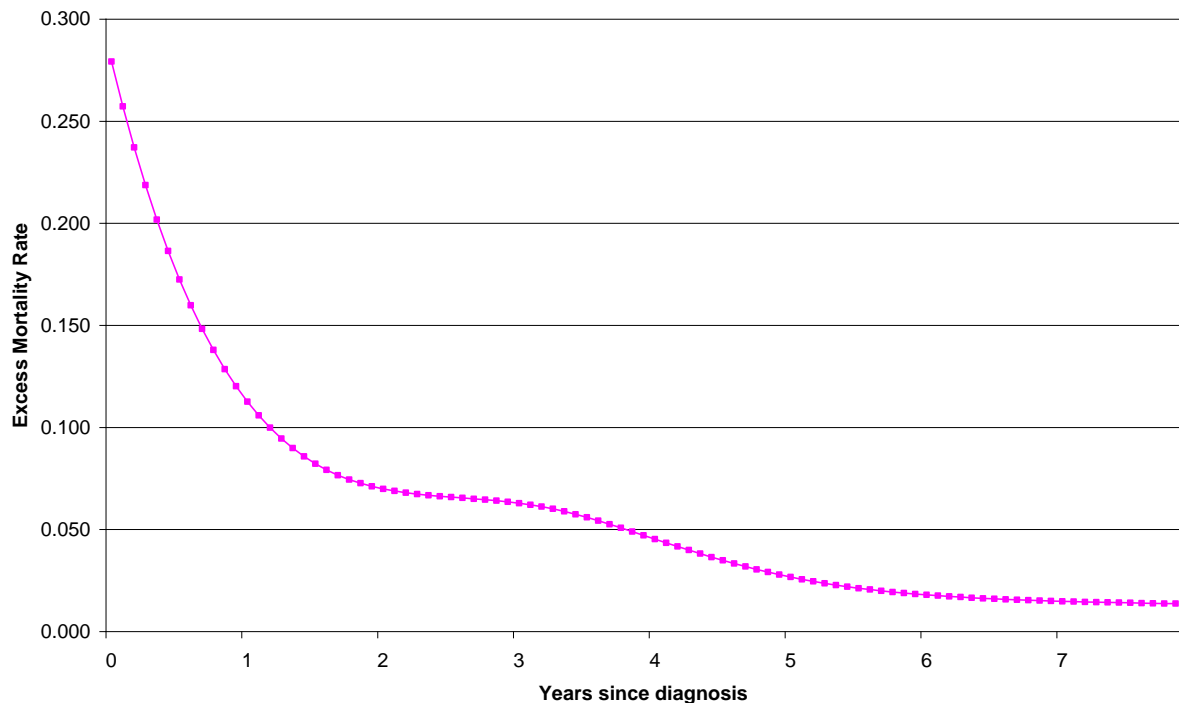
Figure 5: Baseline model (model 1) predictions for 55-64 years old, 1-3 deprivation deciles, Non-Māori female patients diagnosed with colon cancer in 2006
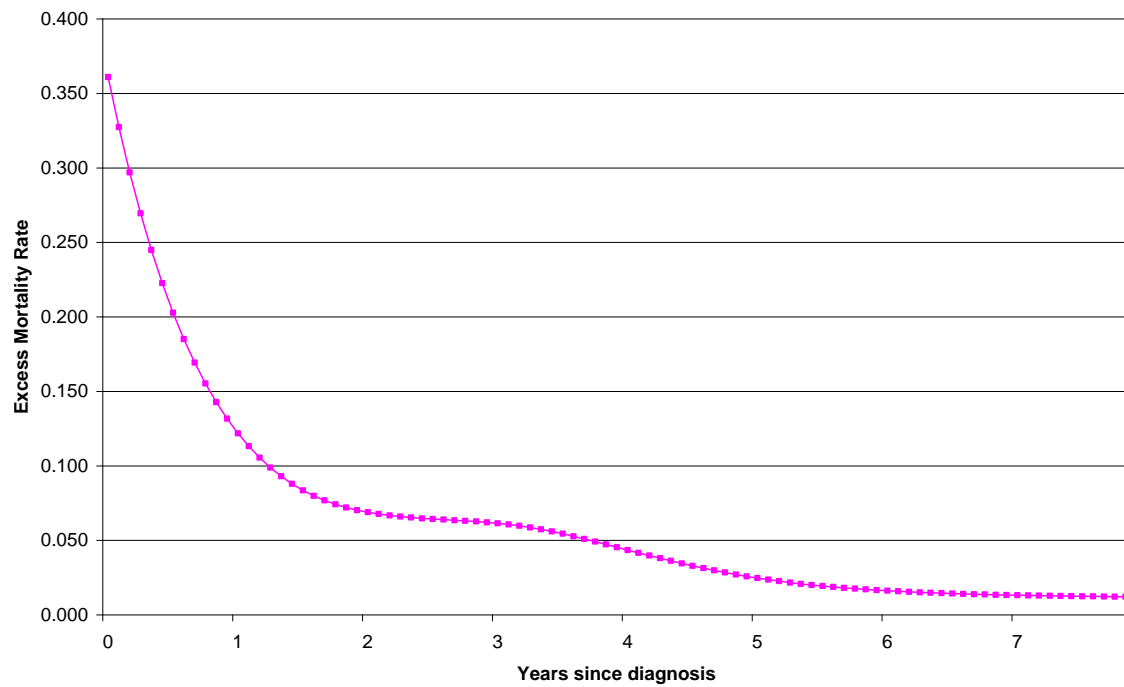
Figure 6: Baseline model (model 1) predictions for 55-64 years old, 1-3 deprivation deciles, Non-Māori female patients diagnosed with rectal cancer in 2006
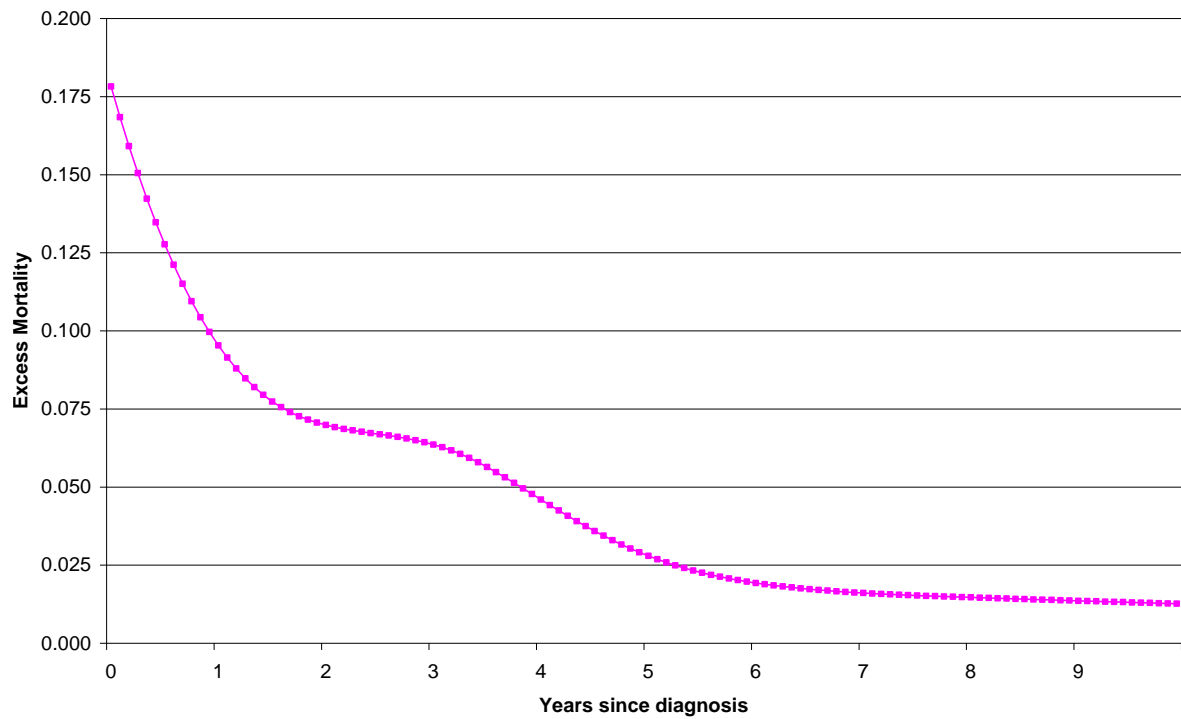
Figure 7: Baseline model (model 1) predictions for 55-64 years old, 1-3 deprivation deciles, Non-Māori female patients diagnosed with lung cancer in 2006
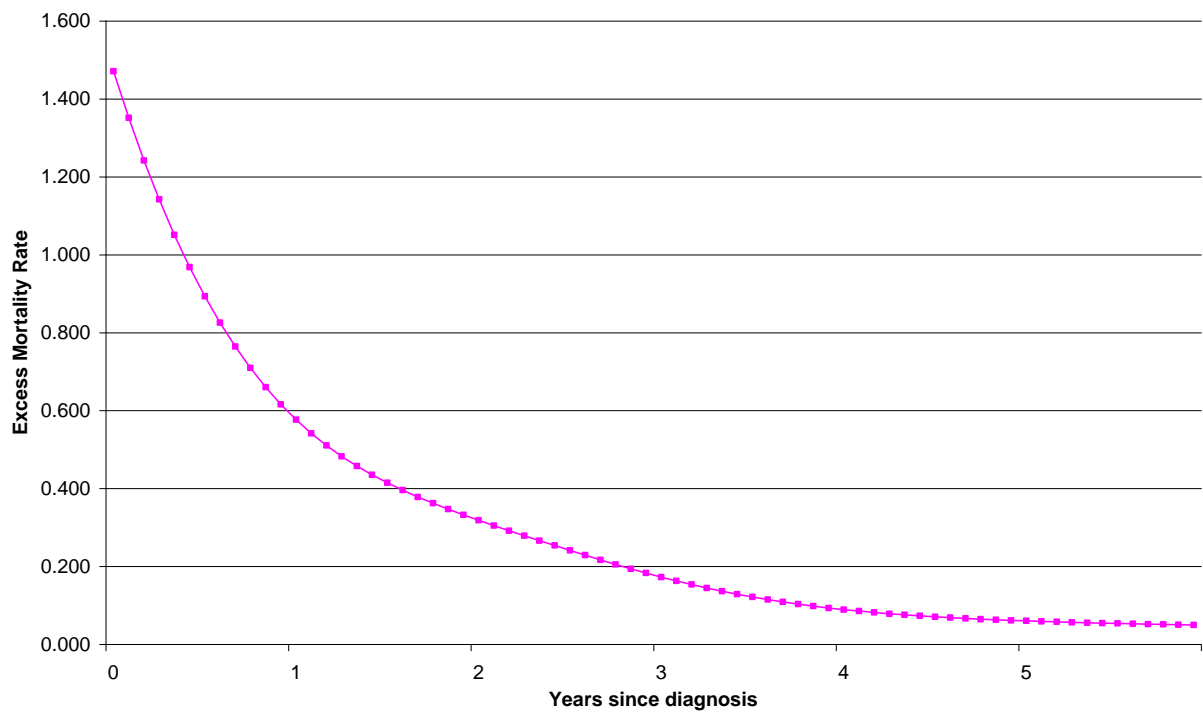
Figure 8: Baseline model (model 1) predictions for 55-64 years old, 1-3 deprivation deciles, Non-Māori male patients diagnosed with prostate cancer in 2006
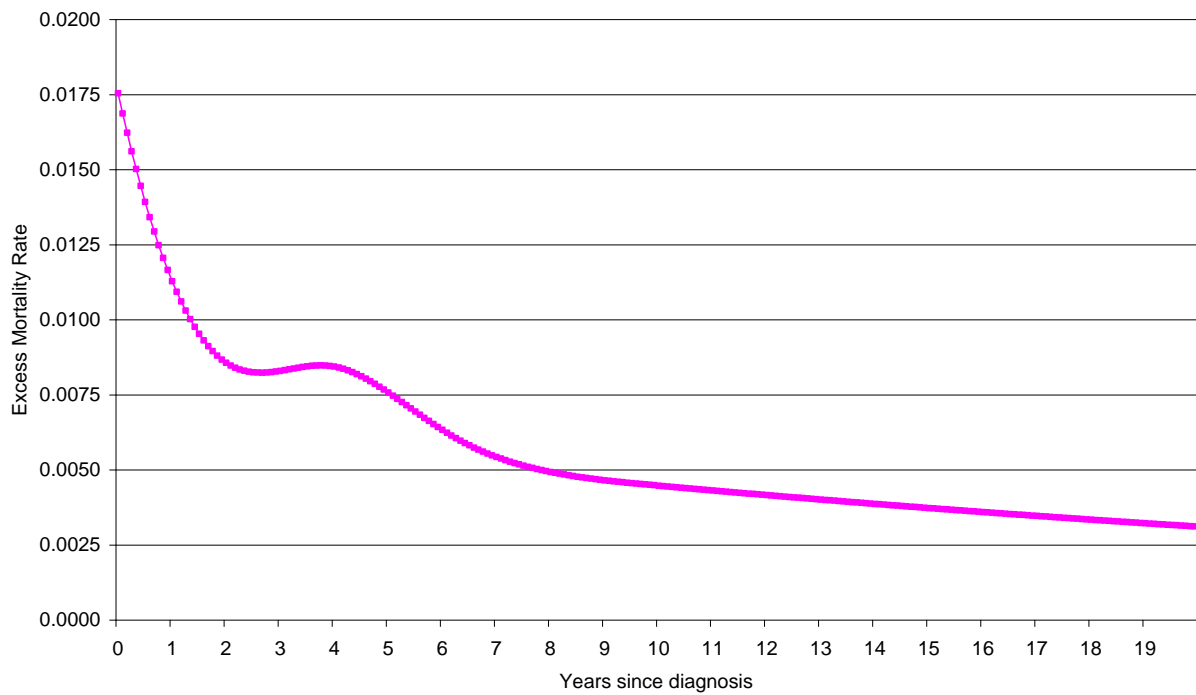
Figure 9: Baseline model (model 1) predictions for 55-64 years old, 1-3 deprivation deciles, Non-Māori females patients diagnosed with cervical cancer in 2006
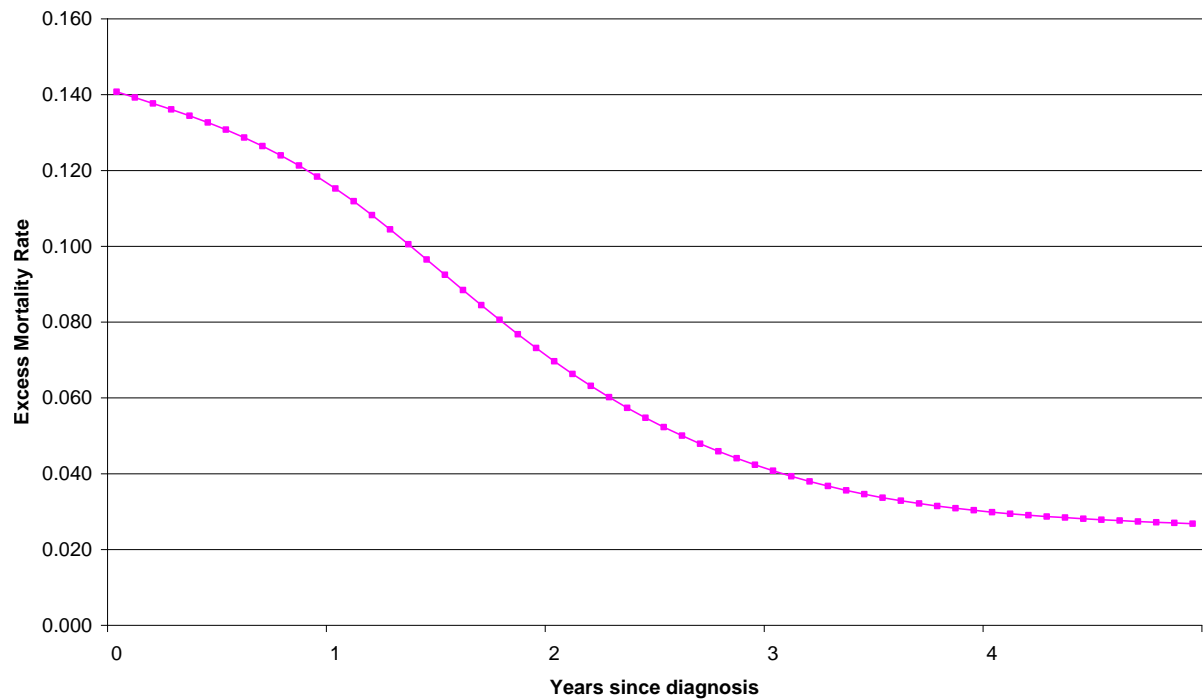
5.2.3 Models with non-missing observations on stage at diagnosis (model 2)

As detailed in the methods section, this second set of models (model 2) includes all model 1 data with non-missing data on stage at diagnosis for six selected cancer sites: breast, colorectal, colon, rectal, lung, and cervical.

Table 31: Regressions with non-missing observations of stage at diagnosis (model 2) for selected cancer sites

	Breast	Cervical	Colorectal
Type of Regression	Poisson	Negative Binomial	Negative Binomial
Years after diagnosis (Basis functions)			
$\gamma 1$	0.245 [0.138,0.352]	-0.974 [-1.529,-0.419]	-0.982 [-1.058,-0.906]
$\gamma 2$	0.042 [0.019,0.066]	-0.087 [-0.611,0.437]	-0.188 [-0.221,-0.154]
$\gamma 3$	-0.023 [-0.048,0.002]	-0.098 [-0.814,0.617]	0.171 [0.129,0.213]
$\gamma 4$	0.001 [-0.013,0.016]	0.180 [-0.400,0.761]	-0.073 [-0.102,-0.044]
Year of diagnosis			
(centered in 2006)	-0.069 [-0.077,-0.060]	0.032 [0.003,0.061]	-0.020 [-0.025,-0.015]
Ethnicity			
Non-Māori (reference)			
Māori	0.410 [0.315,0.505]	0.810 [0.542,1.078]	0.465 [0.378,0.553]
Age			
25–44 (reference) [1]			
45–54 [2]	-0.334 [-0.421,-0.247]	0.890 [0.559,1.222]	0.081 [-0.034,0.195]
55–64	-0.355 [-0.448,-0.262]	1.261 [0.912,1.610]	0.046 [-0.060,0.151]
65–74	-0.207 [-0.338,-0.076]	1.648 [0.877,2.418]	0.055 [-0.072,0.181]
75+	-0.099 [-0.300,0.102]	1.540 [-0.389,3.470]	-0.148 [-0.309,0.012]
Sex			
Male (reference)			
Female			-0.069 [-0.110,-0.028]
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	0.138 [0.058,0.219]	0.222 [-0.119,0.563]	0.047 [-0.003,0.098]
Deciles 8-10	0.176 [0.088,0.263]	0.323 [-0.017,0.663]	0.090 [0.035,0.144]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	0.209 [-0.016,0.434]	0.274 [-0.578,1.127]	0.064 [-0.044,0.172]
65-74 and 2nd year after diagnosis	0.046 [-0.172,0.263]	0.298 [-0.689,1.284]	0.139 [0.019,0.259]
75+ and 1st year after diagnosis	0.909 [0.653,1.166]	1.314 [-0.658,3.286]	0.544 [0.398,0.691]
75+ and 2nd year after diagnosis	-0.011 [-0.352,0.329]	1.474 [-0.572,3.520]	0.304 [0.137,0.470]
Constant	-3.923 [-4.080,-3.766]	-2.937 [-3.410,-2.464]	-1.277 [-1.398,-1.157]
Person-time (years)	41,162.00	15,988.00	60,541.00
Number of cases	27924	1729	33265
AIC	36,336.21	3,175.95	57,307.91
BIC	36,482.84	3,306.50	57,470.11
Log-likelihood	-18,151.10	-1,570.97	-28,635.96
Deviance/DF	0.55	0.16	0.50

Type of Regression	Breast Poisson	Cervical Negative Binomial	Colorectal Negative Binomial
Pearson/DF	2.29	1.75	1.65
Over dispersion parameter	0.04	-0.54	0.13
Ho: a=0	0.08	0.00	0.00
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	2	1.17	1.67
Knot at percentile 50	4.08	2.33	3.33
Knot at percentile 75	6.58	3.63	5.42
Knot at end	10	5	8

Type of Regression	Colon Negative Binomial	Rectal Poisson	Lung, trachea and bronchus Poisson
Years after diagnosis (Basis functions)			
$\gamma 1$	-1.117 [-1.208,-1.026]	-0.715 [-0.848,-0.582]	-1.430 [-1.521,-1.339]
$\gamma 2$	-0.205 [-0.248,-0.162]	-0.152 [-0.205,-0.099]	-0.249 [-0.348,-0.150]
$\gamma 3$	0.181 [0.125,0.237]	0.147 [0.086,0.208]	0.158 [0.034,0.281]
$\gamma 4$	-0.073 [-0.113,-0.033]	-0.071 [-0.112,-0.030]	-0.065 [-0.161,0.030]
Year of diagnosis			
(centered in 2006)	-0.019 [-0.025,-0.013]	-0.026 [-0.035,-0.018]	-0.005 [-0.009,-0.001]
Ethnicity			
Non-Māori (reference)			
Māori	0.458 [0.348,0.568]	0.497 [0.355,0.639]	0.233 [0.178,0.287]
Age			
25–44 (reference) [1]			
45–54 [2]	0.190 [0.045,0.336]	-0.107 [-0.291,0.077]	0.186 [0.055,0.317]
55–64	0.153 [0.019,0.287]	-0.159 [-0.329,0.012]	0.246 [0.122,0.370]
65–74	0.097 [-0.066,0.261]	-0.016 [-0.212,0.181]	0.201 [-0.012,0.414]
75+	-0.165 [-0.377,0.046]	-0.059 [-0.296,0.177]	0.376 [0.096,0.656]
Sex			
Male (reference)			
Female	-0.081 [-0.130,-0.031]	-0.079 [-0.150,-0.009]	-0.076 [-0.115,-0.037]
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	0.066 [0.005,0.126]	0.008 [-0.079,0.095]	0.098 [0.045,0.151]
Deciles 8-10	0.067 [0.001,0.133]	0.148 [0.055,0.241]	0.159 [0.104,0.213]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	0.063 [-0.074,0.199]	0.044 [-0.130,0.217]	0.251 [0.063,0.439]
65-74 and 2nd year after diagnosis	0.191 [0.041,0.342]	0.036 [-0.155,0.228]	0.070 [-0.136,0.276]
75+ and 1st year after diagnosis	0.567 [0.377,0.757]	0.435 [0.218,0.653]	0.424 [0.162,0.686]
75+ and 2nd year after diagnosis	0.350 [0.136,0.563]	0.205 [-0.047,0.458]	0.091 [-0.202,0.385]
Constant	-1.155 [-1.305,-1.006]	-1.550 [-1.752,-1.348]	0.421 [0.288,0.555]
Person-time (years)	55,190.00	49,787.00	36,374.00
Number of cases	22789	10476	12719
AIC	44,827.58	29,277.11	30,224.88

	Colon	Rectal	Lung, trachea and bronchus
Type of Regression	Negative Binomial	Poisson	Poisson
BIC	44,988.11	29,435.79	30,377.91
Log-likelihood	-22,395.79	-14,620.55	-15,094.44
Deviance/DF	0.45	0.39	0.46
Pearson/DF	1.80	2.12	2.77
Over dispersion parameter	0.16	0.00	0.01
Ho: a=0	0.00	0.97	0.15
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	1.67	1.58	1.08
Knot at percentile 50	3.33	3.33	2.42
Knot at percentile 75	5.42	5.42	4.08
Knot at end	8	8	6

5.2.4 Models including stage or severity (model 3)

This section presents models that use the same observations as the ones in the previous section (model 2) but include stage at diagnosis as covariate. As would be expected based on the literature reviewed earlier in this Report, there are very strong effects of stage on the excess mortality. For example, for breast cancer coefficient of 3.612 for distant corresponds to an excess mortality rate ratio of 37 compared to local. Whilst it is useful to have the stage as a main effect in the model, it is making the assumption that the shape of the curve does not vary between stages – just that it shifts up and down with stage. This is likely to often be an incorrect assumption, as more advanced stage cancer will tend to have the highest excess mortality initially, whereas local cancer may have a delayed peak. To overcome this, one could include interaction terms of the cubic splines with the stage, but that would make for an extremely complex model. Thus, we present analyses by stage in the following section.

Table 32: Regressions including stage at diagnosis with non-missing observations (model 3) for selected cancer sites

	Breast	Cervical	Colorectal
Type of regression	Poisson	Negative Binomial	Negative Binomial
Years after diagnosis (Basis functions)			
$\gamma1$	0.252 [0.143,0.361]	-0.300 [-0.885,0.285]	-0.612 [-0.691,-0.533]
$\gamma2$	0.026 [-0.001,0.052]	0.054 [-0.506,0.615]	-0.146 [-0.181,-0.111]
$\gamma3$	-0.004 [-0.029,0.022]	-0.135 [-0.840,0.571]	0.138 [0.097,0.180]
$\gamma4$	-0.007 [-0.020,0.007]	0.129 [-0.406,0.665]	-0.062 [-0.091,-0.033]
Year of diagnosis			
(centered in 2006)	-0.040 [-0.048,-0.032]	-0.015 [-0.044,0.015]	-0.021 [-0.026,-0.016]
Ethnicity			
Non-Māori (reference)			
Māori	0.372 [0.280,0.464]	0.682 [0.406,0.958]	0.300 [0.212,0.389]
Age			
25–44 (reference) [1]			
45–54 [2]	-0.212 [-0.299,-0.124]	0.292 [-0.045,0.630]	0.193 [0.078,0.307]
55–64	-0.191 [-0.284,-0.099]	0.428 [0.077,0.779]	0.233 [0.127,0.339]
65–74	-0.065 [-0.195,0.065]	-0.036 [-1.118,1.047]	0.265 [0.137,0.394]
75+	-0.226 [-0.420,-0.032]	0.313 [-1.098,1.724]	0.055 [-0.105,0.215]
Sex			
Male (reference)			
Female			-0.065 [-0.105,-0.025]
Stage			
Stage at diagnosis - Regional	1.542 [1.449,1.636]	3.163 [2.448,3.877]	1.378 [1.285,1.471]
Stage at diagnosis – Distant	3.612 [3.506,3.718]	5.086 [4.382,5.790]	3.177 [3.085,3.269]
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	0.077 [-0.001,0.156]	0.216 [-0.130,0.561]	0.041 [-0.008,0.091]
Deciles 8-10	0.083 [-0.001,0.168]	0.195 [-0.151,0.541]	0.077 [0.023,0.130]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	0.290 [0.089,0.490]	0.675 [-0.463,1.812]	0.148 [0.039,0.257]
65-74 and 2nd year after diagnosis	0.051 [-0.164,0.266]	0.818 [-0.425,2.062]	0.200 [0.080,0.319]
75+ and 1st year after diagnosis	0.994 [0.761,1.226]	0.806 [-0.659,2.270]	0.732 [0.587,0.877]
75+ and 2nd year after diagnosis	0.043 [-0.262,0.347]	0.935 [-0.641,2.510]	0.530 [0.369,0.690]
Constant	-5.034 [-5.202,-4.867]	-5.829 [-6.651,-5.007]	-3.478 [-3.628,-3.328]
Person-time (years)	94,936	25,532	137,157
Number of cases	27924	1729	33265
AIC	49,003	3,425	82,175
BIC	49,183	3,580	82,372
Log-likelihood	-24,483	-1,694	-41,067
Deviance/DF	0.35	0.11	0.37
Pearson/DF	2.68	4.37	2.45
Over dispersion parameter	0.12	-0.32	0.12
Ho: a=0	0.01	0.00	0.00
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	1.83	1.04	1.5
Knot at percentile 50	3.83	2.25	3.25
Knot at percentile 75	6.42	3.5	5.33
Knot at end	10	5	8

Type of regression	Colon Negative Binomial	Rectal Poisson	Lung, trachea and bronchus Poisson
Years after diagnosis (Basis functions)			
γ1	-0.722 [-0.817,-0.628]	-0.368 [-0.507,-0.230]	-0.875 [-0.975,-0.775]
γ2	-0.155 [-0.199,-0.111]	-0.123 [-0.182,-0.064]	-0.156 [-0.280,-0.032]
γ3	0.139 [0.084,0.194]	0.130 [0.065,0.194]	0.117 [-0.016,0.251]
γ4	-0.058 [-0.098,-0.018]	-0.061 [-0.101,-0.021]	-0.054 [-0.144,0.036]
Year of diagnosis			
(centered in 2006)	-0.018 [-0.024,-0.012]	-0.027 [-0.035,-0.019]	-0.016 [-0.020,-0.012]
Ethnicity			
Non-Māori (reference)			
Māori	0.271 [0.161,0.382]	0.366 [0.223,0.509]	0.163 [0.108,0.218]
Age			
25–44 (reference) [1]			
45–54 [2]	0.223 [0.078,0.368]	0.122 [-0.063,0.307]	0.188 [0.056,0.319]
55–64	0.304 [0.171,0.437]	0.087 [-0.086,0.259]	0.281 [0.158,0.405]
65–74	0.294 [0.129,0.459]	0.243 [0.043,0.443]	0.257 [0.032,0.481]
75+	0.056 [-0.151,0.263]	0.153 [-0.088,0.394]	0.400 [0.104,0.697]
Sex			
Male (reference)			
Female	-0.055 [-0.103,-0.007]	-0.085 [-0.155,-0.015]	-0.080 [-0.119,-0.041]
Stage			
Stage at diagnosis - Regional	1.450 [1.324,1.575]	1.276 [1.142,1.410]	1.141 [1.037,1.245]
Stage at diagnosis – Distant	3.293 [3.169,3.417]	2.982 [2.849,3.115]	2.126 [2.030,2.222]
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	0.066 [0.006,0.125]	-0.018 [-0.104,0.069]	0.054 [0.000,0.107]
Deciles 8-10	0.057 [-0.007,0.122]	0.123 [0.030,0.215]	0.093 [0.038,0.148]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	0.146 [0.007,0.284]	0.119 [-0.057,0.294]	0.271 [0.069,0.472]
65-74 and 2nd year after diagnosis	0.254 [0.103,0.404]	0.065 [-0.128,0.257]	0.108 [-0.111,0.327]
75+ and 1st year after diagnosis	0.737 [0.551,0.922]	0.600 [0.378,0.822]	0.370 [0.090,0.650]
75+ and 2nd year after diagnosis	0.564 [0.362,0.767]	0.395 [0.144,0.645]	0.043 [-0.267,0.353]
Constant	-3.484 [-3.675,-3.292]	-3.545 [-3.785,-3.304]	-1.513 [-1.677,-1.350]
Person-time (years)	120,702	102,343	68,142
Number of cases	22789	10476	12719
AIC	62,177	38,253	39,728
BIC	62,371	38,444	39,911
Log-likelihood	-31,069	-19,107	-19,844
Deviance/DF	0.33	0.27	0.37
Pearson/DF	2.09	5.78	5.30
Over dispersion parameter	0.13	-0.02	0.02
Ho: a=0	0.00	0.63	0.26
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	1.5	1.5	0.92
Knot at percentile 50	3.25	3.17	2.17
Knot at percentile 75	5.33	5.25	3.83
Knot at end	8	8	6

### 5.2.5 Models by stage or severity

As detailed in the methods section, this set of models (model 4) show the regressions by stage at diagnosis (local, regional, distant) for six selected cancer sites: breast, colorectal, colon, rectal, lung and cervical (Table 33 to Table 38). Results for prostate cancer are explicitly not

included due to the considerable amount of observations with missing stage (around three quarters). Additionally, in the case of cervical cancer only Poisson models with 2 interior knots (percentiles 33 and 67) are presented for regional and distant stages since Negative Binomial models failed to converge due to the low mortality (literally zero for patients diagnosed with local stage) of this cancer site.

As an example, Figure 10 below shows the breast cancer excess mortality rate by time since diagnosis, by stage, on both a unit scale and the log scale. It can be clearly seen that in the first few years post diagnosis, the shape of the curve differs by stage. Figure 11 shows how these smoothed excess mortality rate functions translate into predicted relative survival curves.

Figure 10: Predicted Excess Mortality Rates by Stage at Diagnosis for 55-64 years old, 1-3 deprivation deciles, Non-Māori female patients diagnosed with breast cancer in 2006

a) Unit excess mortality rate scale
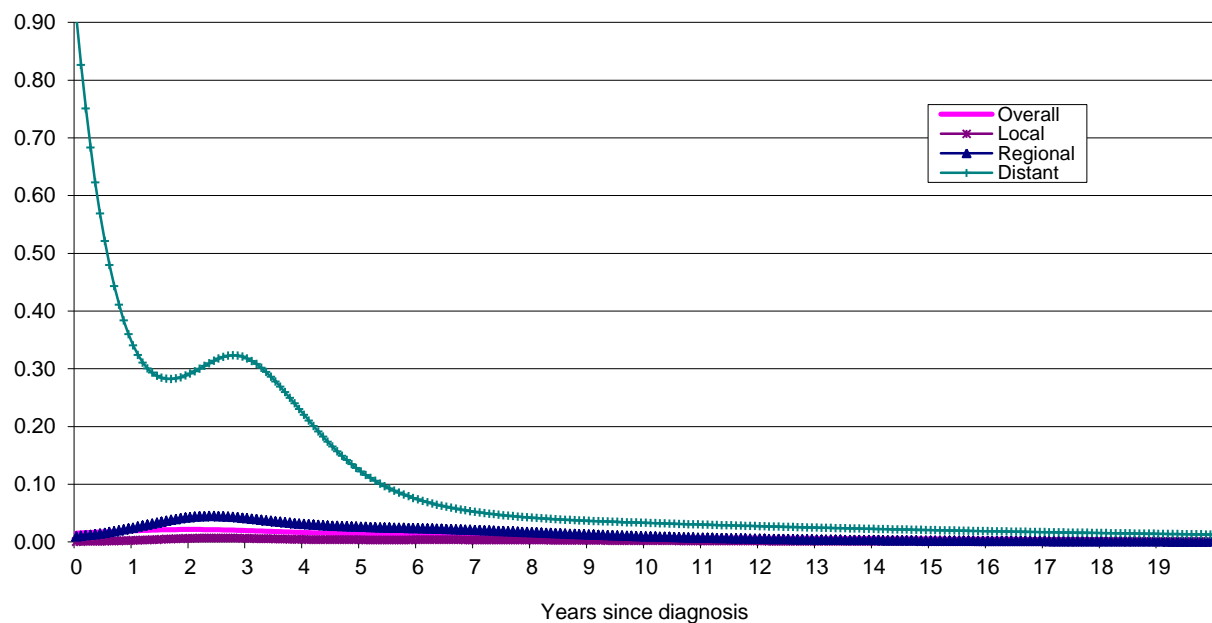
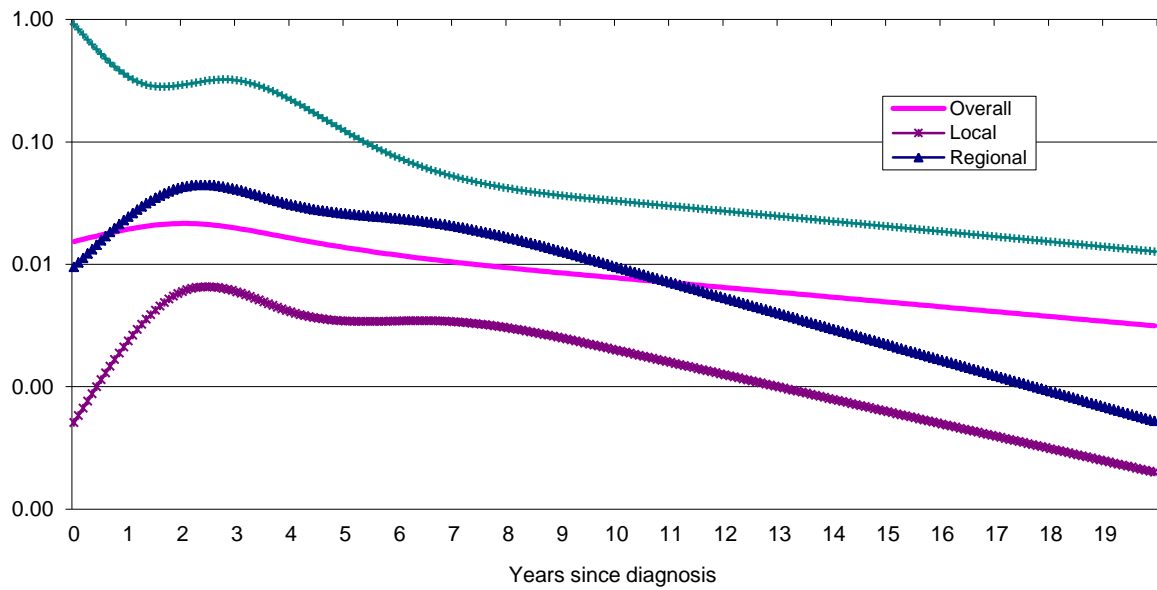**a) Log excess mortality rate scale**

Figure 11: Predicted (Cumulative) Relative Survival by Stage at Diagnosis for 55-64 years old, 1-3 deprivation deciles, Non-Māori female patients diagnosed with breast cancer in 2006
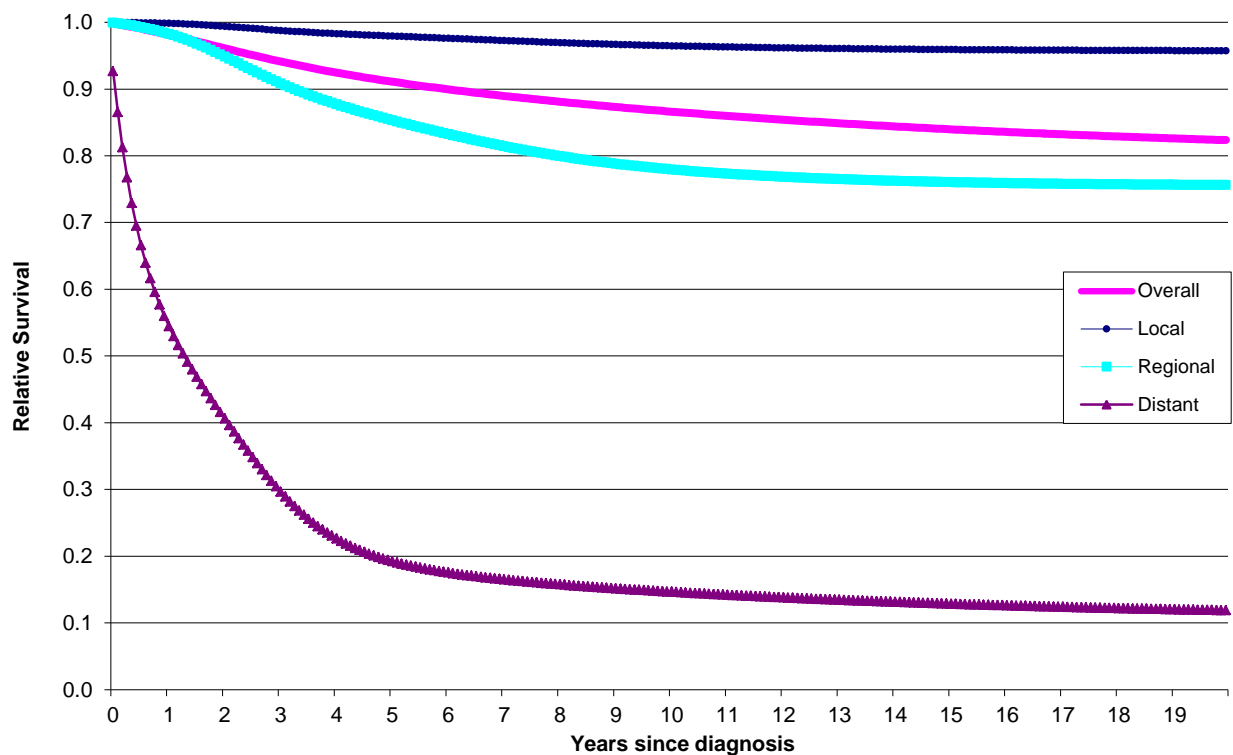
Table 33: Regressions by stage at diagnosis (model 4) for colorectal cancer

Type of Regression	Local Poisson	Regional Negative Binomial	Distant Poisson
Years after diagnosis (Basis functions)			
γ1	-1.449 [-1.823,-1.074]	-0.132 [-0.266,0.001]	-0.746 [-0.853,-0.639]
γ2	-0.461 [-0.590,-0.332]	-0.052 [-0.101,-0.004]	-0.147 [-0.217,-0.077]
γ3	0.442 [0.305,0.579]	0.074 [0.019,0.128]	0.130 [0.055,0.205]
γ4	-0.198 [-0.279,-0.117]	-0.040 [-0.077,-0.004]	-0.059 [-0.107,-0.011]
Year of diagnosis			
(centered in 2006)	-0.089 [-0.110,-0.067]	-0.045 [-0.053,-0.037]	0.000 [-0.006,0.006]
Ethnicity			
Non-Māori (reference)			
Māori	0.777 [0.432,1.121]	0.376 [0.231,0.521]	0.201 [0.089,0.313]
Age			
25–44 (reference) [1]			
45–54 [2]	0.487 [-0.082,1.057]	0.105 [-0.076,0.287]	0.221 [0.069,0.372]
55–64	0.535 [-0.011,1.080]	0.112 [-0.054,0.277]	0.279 [0.139,0.418]
65–74	0.836 [0.277,1.396]	0.111 [-0.070,0.293]	0.332 [0.121,0.543]
75+	0.510 [-0.165,1.185]	0.056 [-0.150,0.262]	0.040 [-0.237,0.317]
Sex			
Male (reference)			
Female	-0.182 [-0.344,-0.021]	-0.105 [-0.167,-0.042]	-0.019 [-0.069,0.032]
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	-0.067 [-0.264,0.130]	0.042 [-0.035,0.119]	0.045 [-0.019,0.109]
Deciles 8-10	0.078 [-0.132,0.288]	0.090 [0.007,0.174]	0.055 [-0.014,0.124]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	-0.055 [-0.454,0.344]	0.182 [0.019,0.345]	0.154 [-0.035,0.343]
65-74 and 2nd year after diagnosis	0.492 [0.023,0.962]	0.219 [0.061,0.376]	0.162 [-0.042,0.365]
75+ and 1st year after diagnosis	0.955 [0.429,1.482]	0.677 [0.491,0.863]	0.788 [0.528,1.048]
75+ and 2nd year after diagnosis	0.367 [-0.506,1.240]	0.424 [0.231,0.617]	0.583 [0.303,0.863]
Constant	-3.926 [-4.553,-3.300]	-2.587 [-2.795,-2.378]	-0.093 [-0.246,0.060]
Person-time (years)	50,474	53,379	33,304
Number of cases	10341	15798	7126
AIC	20,062	37,067	24,435
BIC	20,221	37,227	24,586
Log-likelihood	-10,013	-18,515	-12,199
Deviance/DF	0.28	0.42	0.44
Pearson/DF	1.67	2.00	5.19
Over dispersion parameter	0.32	0.17	0.03
Ho: a=0	0.20	0.00	0.27
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	1.67	1.58	1.25
Knot at percentile 50	3.42	3.33	2.83
Knot at percentile 75	5.42	5.42	5
Knot at end	8	8	8

Table 34: Regressions by stage at diagnosis (model 4) for colon cancer

Type of Regression	Local Negative Binomial	Regional Negative Binomial	Distant Poisson
Years after diagnosis (Basis functions)			
γ1	-1.568 [-2.086,-1.050]	-0.305 [-0.463,-0.147]	-0.896 [-1.027,-0.765]
γ2	-0.523 [-0.709,-0.337]	-0.053 [-0.113,0.008]	-0.214 [-0.308,-0.120]
γ3	0.530 [0.326,0.734]	0.051 [-0.021,0.123]	0.170 [0.076,0.264]
γ4	-0.267 [-0.394,-0.140]	-0.015 [-0.066,0.036]	-0.066 [-0.120,-0.012]
Year of diagnosis			
(centered in 2006)	-0.074 [-0.103,-0.044]	-0.036 [-0.046,-0.026]	-0.003 [-0.010,0.004]
Ethnicity			
Non-Māori (reference)			
Māori	0.695 [0.172,1.217]	0.405 [0.222,0.587]	0.175 [0.037,0.313]
Age			
25–44 (reference) [1]			
45–54 [2]	1.199 [0.225,2.173]	0.226 [-0.012,0.464]	0.179 [-0.006,0.364]
55–64	1.066 [0.111,2.021]	0.246 [0.029,0.464]	0.286 [0.116,0.456]
65–74	1.334 [0.362,2.306]	0.213 [-0.027,0.452]	0.253 [-0.011,0.517]
75+	1.024 [-0.101,2.149]	0.094 [-0.180,0.367]	-0.001 [-0.342,0.340]
Sex			
Male (reference)			
Female	-0.223 [-0.450,0.003]	-0.085 [-0.162,-0.009]	-0.019 [-0.079,0.040]
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	-0.081 [-0.355,0.193]	0.064 [-0.029,0.158]	0.080 [0.005,0.155]
Deciles 8-10	0.033 [-0.260,0.326]	0.074 [-0.028,0.176]	0.047 [-0.035,0.129]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	0.106 [-0.444,0.656]	0.084 [-0.115,0.283]	0.234 [-0.002,0.470]
65-74 and 2nd year after diagnosis	0.509 [-0.168,1.187]	0.216 [0.020,0.412]	0.293 [0.042,0.545]
75+ and 1st year after diagnosis	0.882 [0.116,1.648]	0.634 [0.401,0.867]	0.820 [0.501,1.139]
75+ and 2nd year after diagnosis	0.187 [-1.205,1.580]	0.396 [0.149,0.642]	0.670 [0.330,1.011]
Constant	-4.293 [-5.335,-3.252]	-2.411 [-2.671,-2.151]	-0.004 [-0.188,0.181]
Person-time (years)	44,159	48,266	28,277
Number of cases	6474	11183	5132
AIC	14,085	28,584	19,201
BIC	14,241	28,742	19,349
Log-likelihood	-7,024	-14,274	-9,582
Deviance/DF	0.21	0.37	0.42
Pearson/DF	1.67	1.84	2.92
Over dispersion parameter	0.49	0.22	0.04
Ho: a=0	0.00	0.00	0.11
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	1.67	1.58	1.17
Knot at percentile 50	3.42	3.33	2.67
Knot at percentile 75	5.5	5.42	4.83
Knot at end	8	8	8

Table 35: Regressions by stage at diagnosis (model 4) for rectal cancer

Type of Regression	Local Poisson	Regional Poisson	Distant Poisson
Years after diagnosis (Basis functions)			
γ1	-1.150 [-1.680,-0.620]	0.351 [0.106,0.595]	-0.480 [-0.721,-0.239]
γ2	-0.357 [-0.532,-0.182]	-0.002 [-0.082,0.078]	-0.140 [-0.347,0.067]
γ3	0.324 [0.142,0.506]	0.064 [-0.023,0.151]	0.115 [-0.043,0.273]
γ4	-0.128 [-0.233,-0.022]	-0.057 [-0.111,-0.004]	-0.039 [-0.104,0.025]
Year of diagnosis			
(centered in 2006)	-0.110 [-0.143,-0.077]	-0.065 [-0.079,-0.051]	0.006 [-0.005,0.018]
Ethnicity			
Non-Māori (reference)			
Māori	0.854 [0.404,1.304]	0.328 [0.093,0.563]	0.289 [0.097,0.481]
Age			
25–44 (reference) [1]			
45–54 [2]	-0.248 [-0.952,0.456]	-0.084 [-0.363,0.195]	0.315 [0.051,0.578]
55–64	0.007 [-0.645,0.659]	-0.089 [-0.346,0.167]	0.244 [-0.003,0.491]
65–74	0.367 [-0.302,1.035]	0.035 [-0.240,0.309]	0.435 [0.081,0.789]
75+	0.041 [-0.817,0.899]	0.165 [-0.138,0.468]	0.121 [-0.345,0.587]
Sex			
Male (reference)			
Female	-0.069 [-0.305,0.167]	-0.104 [-0.212,0.003]	-0.059 [-0.158,0.040]
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	-0.036 [-0.325,0.253]	-0.016 [-0.147,0.114]	-0.036 [-0.159,0.088]
Deciles 8-10	0.111 [-0.197,0.420]	0.125 [-0.016,0.266]	0.086 [-0.045,0.217]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	-0.254 [-0.860,0.351]	0.350 [0.063,0.636]	0.055 [-0.265,0.374]
65-74 and 2nd year after diagnosis	0.378 [-0.262,1.018]	0.153 [-0.104,0.410]	-0.096 [-0.436,0.244]
75+ and 1st year after diagnosis	1.078 [0.327,1.830]	0.619 [0.306,0.933]	0.702 [0.260,1.143]
75+ and 2nd year after diagnosis	0.577 [-0.494,1.647]	0.396 [0.101,0.692]	0.350 [-0.132,0.832]
Constant	-3.759 [-4.558,-2.961]	-3.172 [-3.538,-2.807]	-0.296 [-0.574,-0.018]
Person-time (years)	41,317	42,136	18,890
Number of cases	3867	4615	1994
AIC	10,008	16,904	11,013
BIC	10,163	17,060	11,154
Log-likelihood	-4,986	-8,434	-5,488
Deviance/DF	0.18	0.29	0.40
Pearson/DF	1.82	8.58	9.00
Over dispersion parameter	-0.03	-0.09	-.0340928
Ho: a=0	0.81	0.13	0.64
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	1.67	1.67	0.92
Knot at percentile 50	3.42	3.33	2.17
Knot at percentile 75	5.42	5.42	4.25
Knot at end	8.00	8	8

Table 36: Regressions by stage at diagnosis (model 4) for lung cancer

Type of Regression	Local Poisson	Regional Poisson	Distant Poisson
Years after diagnosis (Basis functions)			
γ1	-0.135 [-0.582,0.313]	-0.422 [-0.689,-0.155]	-0.895 [-1.041,-0.748]
γ2	-0.010 [-0.273,0.254]	-0.064 [-0.297,0.169]	-0.126 [-0.374,0.121]
γ3	0.097 [-0.200,0.394]	0.031 [-0.186,0.248]	0.153 [-0.065,0.371]
γ4	-0.088 [-0.239,0.063]	0.009 [-0.088,0.105]	-0.078 [-0.177,0.020]
Year of diagnosis			
(centered in 2006)	-0.172 [-0.196,-0.147]	-0.059 [-0.070,-0.048]	-0.001 [-0.006,0.004]
Ethnicity			
Non-Māori (reference)			
Māori	0.452 [0.182,0.722]	0.321 [0.180,0.463]	0.117 [0.056,0.178]
Age			
25–44 (reference) [1]			
45–54 [2]	0.400 [-0.294,1.094]	0.286 [-0.033,0.605]	0.149 [0.002,0.296]
55–64	0.575 [-0.067,1.217]	0.288 [-0.017,0.593]	0.258 [0.119,0.396]
65–74	0.921 [0.237,1.605]	-0.059 [-0.462,0.344]	0.272 [-0.101,0.645]
75+	0.663 [-0.182,1.508]	0.560 [0.107,1.013]	0.435 [-0.060,0.929]
Sex			
Male (reference)			
Female	-0.352 [-0.541,-0.164]	-0.072 [-0.173,0.029]	-0.068 [-0.111,-0.025]
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	0.112 [-0.122,0.345]	0.188 [0.055,0.322]	0.022 [-0.037,0.082]
Deciles 8-10	0.052 [-0.195,0.299]	0.321 [0.182,0.460]	0.063 [0.002,0.124]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	0.054 [-0.381,0.490]	0.555 [0.233,0.878]	0.239 [-0.118,0.595]
65-74 and 2nd year after diagnosis	-0.016 [-0.457,0.424]	0.491 [0.152,0.829]	-0.091 [-0.475,0.293]
75+ and 1st year after diagnosis	0.594 [-0.087,1.274]	0.301 [-0.089,0.692]	0.283 [-0.199,0.766]
75+ and 2nd year after diagnosis	0.303 [-0.441,1.047]	-0.022 [-0.465,0.421]	-0.056 [-0.572,0.460]
Constant	-3.556 [-4.296,-2.815]	-1.128 [-1.476,-0.781]	0.771 [0.621,0.920]
Person-time (years)	25,295	22,264	20,583
Number of cases	1477	2165	9077
AIC	5,968	11,479	21,676
BIC	6,114	11,623	21,819
Log-likelihood	-2,966	-5,721	-10,820
Deviance/DF	0.18	0.37	0.56
Pearson/DF	5.31	3.36	7.44
Over dispersion parameter	0.28	0.07	0.01
Ho: a=0	0.25	0.53	0.18
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	1.25	0.92	0.67
Knot at percentile 50	2.58	2.08	1.75
Knot at percentile 75	4.08	3.75	3.5
Knot at end	6	6	6

Table 37: Regressions by stage at diagnosis (model 4) for breast cancer

Type of Regression	Local Poisson	Regional Poisson	Distant Poisson
Years after diagnosis (Basis functions)			
γ1	1.640 [1.218,2.063]	1.015 [0.850,1.181]	-1.158 [-1.392,-0.925]
γ2	0.224 [0.153,0.295]	0.145 [0.112,0.178]	-0.370 [-0.485,-0.254]
γ3	-0.154 [-0.218,-0.090]	-0.099 [-0.132,-0.067]	0.252 [0.158,0.345]
γ4	0.038 [0.006,0.069]	0.024 [0.007,0.041]	-0.063 [-0.101,-0.025]
Year of diagnosis			
(centered in 2006)	-0.125 [-0.149,-0.101]	-0.048 [-0.058,-0.037]	0.002 [-0.010,0.015]
Ethnicity			
Non-Māori (reference)			
Māori	0.344 [0.086,0.602]	0.344 [0.228,0.460]	0.331 [0.149,0.513]
Age			
25–44 (reference) [1]			
45–54 [2]	-0.594 [-0.795,-0.392]	-0.229 [-0.338,-0.121]	0.221 [0.011,0.430]
55–64	-0.617 [-0.841,-0.394]	-0.128 [-0.244,-0.013]	0.135 [-0.075,0.344]
65–74	-0.650 [-0.993,-0.308]	0.079 [-0.067,0.224]	0.195 [-0.161,0.551]
75+	-0.926 [-1.775,-0.077]	0.119 [-0.083,0.320]	0.116 [-0.258,0.491]
Sex			
Male (reference)			
Female			0.000 [0.000,0.000]
Deprivation			
Deciles 1-3 (reference)			
Deciles 4-7	-0.029 [-0.228,0.169]	0.131 [0.030,0.231]	-0.023 [-0.175,0.129]
Deciles 8-10	0.001 [-0.219,0.222]	0.122 [0.013,0.231]	0.005 [-0.154,0.164]
Interactions			
Other (reference)			
65-74 and 1st year after diagnosis	-15.056 [-2517.996,2487.885]	0.066 [-0.320,0.453]	0.260 [-0.117,0.636]
65-74 and 2nd year after diagnosis	0.112 [-0.618,0.841]	0.157 [-0.091,0.406]	0.015 [-0.466,0.496]
75+ and 1st year after diagnosis	-13.689 [-2586.641,2559.263]	0.654 [0.265,1.042]	0.587 [0.207,0.967]
75+ and 2nd year after diagnosis	-12.805 [-2284.795,2259.185]	0.128 [-0.216,0.473]	-0.001 [-0.497,0.495]
Constant	-7.105 [-7.761,-6.450]	-4.615 [-4.864,-4.367]	-0.133 [-0.384,0.119]
Person-time (years)	39,169	38,739	17,028
Number of cases	15346	11124	1454
AIC	16,442	23,625	8,048
BIC	16,588	23,770	8,180
Log-likelihood	-8,204	-11,795	-4,007
Deviance/DF	0.30	0.42	0.34
Pearson/DF	3.45	1.26	3.48
Over dispersion parameter	-0.04	-0.01	0.01
Ho: a=0	0.56	0.81	0.90
Knot positions for years after diagnosis			
Knot at start	0.08	0.08	0.08
Knot at percentile 25	2	2	1.25
Knot at percentile 50	4.08	4	2.83
Knot at percentile 75	6.67	6.50	5.33
Knot at end	10	10	10

Table 38: Regressions by stage at diagnosis (model 4) for cervical cancer

Type of Regression	Regional Poisson	Distant Poisson
Years after diagnosis (Basis functions)		
γ1	0.919 [-0.766,2.605]	-0.642 [-4.246,2.961]
γ2	0.298 [-0.331,0.927]	0.028 [-3.287,3.343]
γ3	-0.197 [-0.713,0.319]	-0.041 [-1.499,1.418]
Year of diagnosis		
(centered in 2006)	0.002 [-0.100,0.105]	-0.025 [-0.193,0.143]
Ethnicity		
Non-Māori (reference)		
Māori	0.298 [-0.653,1.250]	0.735 [-0.839,2.309]
Age		
25–44 (reference) [1]		
45–54 [2]	0.093 [-0.876,1.063]	0.318 [-1.766,2.403]
55–64	0.340 [-0.706,1.387]	0.483 [-1.618,2.583]
65–74	-0.661 [-3.534,2.213]	0.521 [-6.809,7.852]
75+	-1.173 [-15.583,13.236]	1.049 [-5.954,8.052]
Sex		
Male (reference)		
Female		
Deprivation		
Deciles 1-3 (reference)		
Deciles 4-7	0.502 [-0.570,1.574]	0.032 [-1.987,2.051]
Deciles 8-10	0.408 [-0.714,1.530]	0.069 [-1.914,2.052]
Interactions		
Other (reference)		
65-74 and 1st year after diagnosis	-0.855 [-8.772,7.062]	0.193 [-7.295,7.681]
65-74 and 2nd year after diagnosis	0.775 [-2.713,4.264]	0.584 [-7.434,8.603]
75+ and 1st year after diagnosis	2.470 [-12.149,17.089]	0.019 [-7.235,7.273]
75+ and 2nd year after diagnosis	2.438 [-12.084,16.959]	0.302 [-7.546,8.150]
Constant	-3.641 [-5.541,-1.742]	-0.452 [-3.378,2.474]
Person-time (years)	8,332	2,808
Number of cases	302	218
AIC	1,180	1,640
BIC	1,293	1,735
Log-likelihood	-574	-804
Deviance/DF	0.11	0.44
Pearson/DF	3.15	21.25
Over dispersion parameter	-0.36	-0.27
Ho: a=0	0.02	0.03
Knot positions for years after diagnosis		
Knot at start	0.08	0.08
Knot at percentile 33	1.42	0.67
Knot at percentile 67	3.08	2.00
Knot at end	5	5

97

6 Conclusion

This Report both provides baseline excess mortality rates for cancers in New Zealand, and demonstrates how they can be calculated. Of note, it is likely that the baseline excess mortality rates will need to be re-estimated in some instances due to variations in the proposed intervention and comparator scenario, updated data, and such like. Regardless, the equations can then be used directly in economic decision software such as TreeAge, be it to specify time dependent transition probabilities, or transformed into cumulative distribution functions for time to event simulation with discrete event simulation.

References

1. Blakely, T., R. Costilla, et al. (2010). The Burden of Cancer: New Zealand 2006. Wellington, Ministry of Health.

2. Brenner, H. and B. Racher (2004). "Hybrid analysis for up-to-date long-term survival rates in cancer registries with delayed recording of incident cases." European Journal of Cancer 40(16): 2494-2501.

3. Bulow, S., H. Harling, et al. (2010). "Improved survival after rectal cancer in Denmark." Colorectal disease : the official journal of the Association of Coloproctology of Great Britain and Ireland 12(7 Online): e37-42.

4. Coleman, M. P., D. Forman, et al. (2011). "Cancer survival in Australia, Canada, Denmark, Norway, Sweden, and the UK, 1995-2007 (the International Cancer Benchmarking Partnership): an analysis of population-based cancer registry data." Lancet 377(9760): 127-138.

5. Coleman, M. P., B. Rachet, et al. (2004). "Trends and socioeconomic inequalities in cancer survival in England and Wales up to 2001." British Journal of Cancer 90(7): 1367-1373.

6. Cunningham, R., D. Sarfati, et al. (2008). "An audit of colon cancer data on the New Zealand Cancer Registry." New Zealand Medical Journal 121: 46-56.

7. Cunningham, R., D. Sarfati, et al. (2008). "An audit of colon cancer data on the New Zealand Cancer Registry." New Zealand Medical Journal 121(1279): 46-56.

8. Dickman, P., A. Sloggett, et al. (2004). "Regression models for relative survival." Statistics in Medicine 23: 51-64.

9. Durrleman, S. and R. Simon (1989). "Flexible regression models with cubic splines." Statistics in Medicine 8: 551-561.

10. Folkesson, J., G. Engholm, et al. (2009). "Rectal cancer survival in the Nordic countries and Scotland." International journal of cancer. Journal international du cancer 125(10): 2406-2412.

11. Kvizhinadze, G. and T. Blakely (2011). Projected NZ Life Tables. Burden of Disease Epidemiology, Equity and Cost-Effectiveness Programme, Technical Report No.4. . Wellington, Department of Public Health, University of Otago, Wellington.

12. Lambert, P. and P. Royston (2009). "Further development of flexible parametric models for survival analysis." The Stata Journal 9: 265-290.

13. Lemmens, V., L. van Steenbergen, et al. (2010). "Trends in colorectal cancer in the south of the Netherlands 1975-2007: rectal cancer survival levels with colon cancer survival." Acta oncologica 49(6): 784-796.

14. McKenzie, F., L. Ellison-Loschmann, et al. (2010). "Investigating reasons for socioeconomic inequalities in breast cancer survival in New Zealand." Cancer Epidemiology 34: 702-708.

15. Mitry, E., A.-M. Bouvier, et al. (2005). "Improvement in colorectal cancer survival: a population-based study." European Journal of Cancer 41(15): 2297-2303.

16. Monnet, E., J. Faivre, et al. (1999). "Influence of stage at diagnosis on survival differences for rectal cancer in three European populations." British Journal of Cancer 81(3): 463-468.

17. Rachet, B., C. Maringe, et al. (2009). "Population-based cancer survival trends in England and Wales up to 2007: an assessment of the NHS cancer plan for England.[see comment]." Lancet Oncology 10(4): 351-369.

18. Robson, B., G. Purdie, et al. (2005). Unequal Impact: Māori and Non-Māori Cancer Statistics 1996–2001. Wellington, Ministry of Health.

19. Royston, P. and P. Lambert (2009). Flexible Parametric Survival Analysis Using Stata: Beyond the Cox Model. College Station, Texas, Stata Press.

20. Shack, L. G., B. Rachet, et al. (2007). "Socioeconomic inequalities in cancer survival in Scotland 1986-2000." British journal of cancer 97(7): 999-1004.

21. Soeberg, M., T. Blakely, et al. (2012). Cancer Trends: Trends in Cancer Survival by Ethnic and Socioeconomic Group, New Zealand 1991-2004. Wellington, Ministry of Health.

22. van Steenbergen, L. N., M. A. Elferink, et al. (2010). "Improved survival of colon cancer due to improved treatment and detection: a nationwide population-based study in The Netherlands 1989-2006." Annals of oncology : official journal of the European Society for Medical Oncology / ESMO 21(11): 2206-2212.

23. Yu, X. Q., D. L. O'Connell, et al. (2006). "Trends in survival and excess risk of death after diagnosis of cancer in 1980-1996 in New South Wales, Australia.[erratum appears in Int J Cancer. 2006 Dec 15;119(12):2993]." International Journal of Cancer 119(4): 894-900.