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TRENDS AND PATTERNS IN CANCER MORTALITY IN NORTHERN IRELAND

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Abstract: Cancer is a major public health issue in Northern Ireland with one in three of the population developing some form of the disease by the time they reach 75 years. However in many ways cancer is a misunderstood disease with the common perception that it is unavoidable and almost always fatal. In this paper we give an overview of the cancer burden in Northern Ireland, focusing on the many aspects of cancer mortality including the distribution by cancer type, trends over time and variations by geographic area and socio-economic factors. Cancer mortality patterns are put into context alongside incidence levels and survival, and differences with the situation in the UK and Republic of Ireland are highlighted.

Keywords: Cancer, mortality, incidence, survival, trends, Northern Ireland
JEL Classifications: I18, J11, N34

1. INTRODUCTION

Cancer is a major public health issue in Northern Ireland with one in three of the population developing some form of cancer by the time they reach 75 years of age.[1] In addition, cancer is responsible for approximately one quarter of all deaths occurring in Northern Ireland causing more deaths than any of ischaemic heart disease, stroke or other diseases of the circulatory or respiratory systems. Indeed, since 2000, cancer has accounted for the largest proportion of deaths in Northern Ireland from any of these causes.[2]

The disease is a considerable burden on the individuals who develop it, the families and friends of cancer patients and on the health services that treat and care for such patients. However, in many ways cancer is a misunderstood disease with the common perception that it is unavoidable and almost always fatal; both misconceptions adding to the stress those with a connection to the disease must feel.

However many cancers are preventable and a large reduction in the number of cancers diagnosed could be attained if the population adopted healthier lifestyles, for example by reducing smoking and eating a healthier diet. Despite the best efforts of prevention initiatives, the message with regard to healthy lifestyles and its protective effect against cancer is not sufficiently penetrating the public consciousness and cancers related to risk factors such as tobacco, diet, alcohol and sun exposure are on the rise. Since other hereditary and environmental factors play a part, it is clear that the task of reducing the number of diagnoses of cancer as a result of prevention through education and environmental and social change is extremely challenging.

Fortunately continuous developments in available screening, diagnostic methods and treatments are improving the prospects of those who develop cancer. Recent studies have shown that at the beginning of the 21st century approximately half of the people diagnosed with cancer in Europe survive at least five years from diagnosis and that in the previous decade alone there were considerable improvements in survival for many forms of cancer.[3] While these conclusions are undoubtedly positive, comparisons of survival estimates between countries indicate that further improvements are achievable.

Reducing the burden of cancer involves the public, medical researchers, charities, health service professionals and health policy makers. Monitoring the outcomes of such an integrated cancer control programme within a population wide context is thus essential. This requires collection of data for the purpose of providing accurate, timely information

on cancer in Northern Ireland for research, education and the planning and monitoring of services. For example information is required for:

- Monitoring of targets/performance;
- Regional and international comparisons;
- Relationships between cancer and lifestyle factors or other health conditions.

This data is provided by the Northern Ireland Cancer Registry (NICR) which was established in 1994 and collects comprehensive information on all new cases of cancer occurring within the resident population of Northern Ireland. While performing a range of cancer intelligence functions, at its core it provides detailed information on four key measures of cancer burden:

- **Incidence** – the number of cases of cancer within the population;
- **Mortality** – the number of deaths from cancer within the population;
- **Prevalence** – the number of people living within the population who have had a diagnosis of cancer;
- **Survival** – the proportion of cancer patients still alive after a given length of time.

2. DATA COLLECTION

The Northern Ireland Cancer Registry (NICR) uses an automated computer system with multiple information sources to collate information on new diagnoses of cancer, with information collected for new cases from 1993 onwards. The two main sources for registration are Hospital Discharge records from the Patient Administration System (PAS), and histopathology reports.

From PAS, the registry obtains demographic information such as age and area of residence on individual patients along with basic information on their cancer. This information is further supplemented by, and cross referenced with electronic downloads from histopathology and cytopathology laboratories, the Health and Social Care Business Services Organisation (BSO) (formally the Central Services Agency), radiology systems and death certificate notifications supplied by the General Register Office (GRO). In the event that information comes from a single source manual verification is completed by a small team of trained Tumour Verification Officers (TVOs) who confidentially examine patient hospital records.

With regard to death certificate information received from the GRO, in the event that there is no further information on a case notified by death only the record is included in the registry but flagged as a death certificate only (DCO) case. A measure of data quality in a registry is the proportion of records that are DCOs. The target is 2.0% while a very low level, close to 0%, indicates that the registry is missing some deaths. During 2003-2007, 1.5% of cases registered by the NICR (excluding the rarely fatal non-melanoma skin cancer) were DCO cases. Naturally, cancers with a poor survival such as lung, pancreas and liver had a higher proportion of DCO cases.

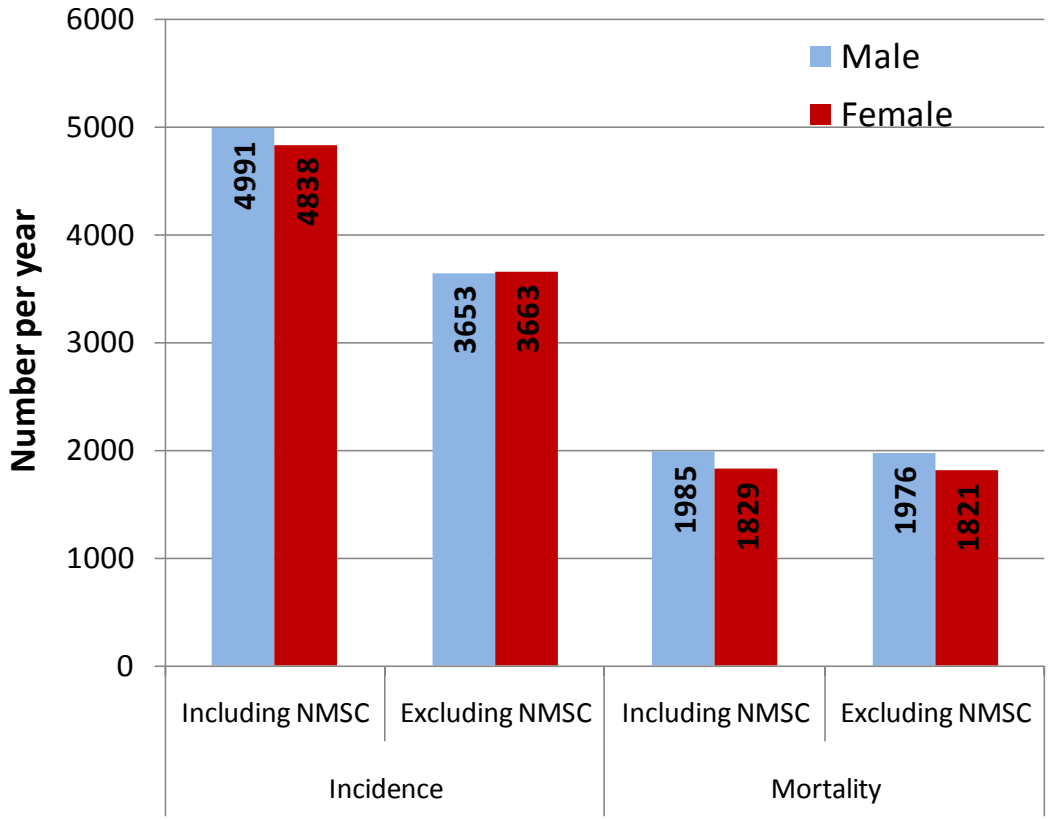
In addition to identification of some cases GRO data also performs an important function in cancer registration work by providing follow up of cancer patients. This is conducted passively by linking cancer incidence data to death certificate information, thereby providing the patient's vital status, i.e. whether they are alive or dead at a given point in time. This provides a crucial end point for survival analysis and an indication of prevalence within the population.

Cancer mortality data is also extracted from GRO death registrations. However, unlike cancer incidence data, which is based upon the primary cancer a patient is diagnosed with, GRO mortality data is based upon the actual cause of death. In most cases, if the death is from cancer, this is the same as the cancer identified at diagnosis. In some cases, however, the cause of death can sometimes be from the spread of the cancer to another organ from its original site as would be the case if lung cancer was the diagnosed disease but death was caused because the cancer had spread to the brain or liver. Despite this difference, NICR publications that include information on cancer mortality use the GRO assignment of cause of death in order to retain consistency with official Government statistics. The NICR does however use the date on which the death occurred rather than the date of death registration as the basis of any analysis, as this is more relevant in the context of cancer registration and patient survival. The different base therefore results in small discrepancies with official GRO statistics.

3. CANCER INCIDENCE AND MORTALITY

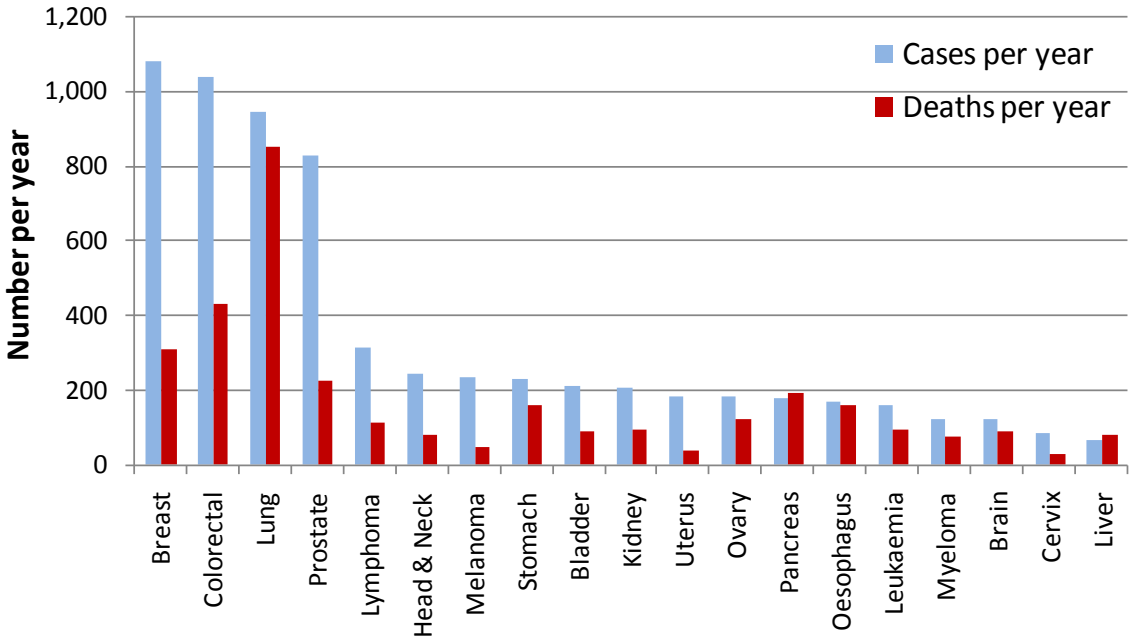
On average 1.74 million people were resident in Northern Ireland each year during 2003-2007. Within that population there was an average of 4,991 male and 4,838 female cases of cancer diagnosed each year. This includes non-melanoma skin cancer (NMSC) which is easily treated and is rarely fatal. In addition, due to difficulties in registration of this disease in other countries, it is frequently excluded from cancer totals. Excluding this form of cancer there were 3,653 male and 3,663 female cases of cancer diagnosed in Northern Ireland each year. In contrast there were 1,985 male and 1,829 female cancer deaths per year during 2004-2008. Only a handful of these (9 male and 8 female) were a result of non-melanoma skin cancer. (Fig. 1)

Figure 1: Cancer incidence (2003-2007) and mortality (2004-2008)



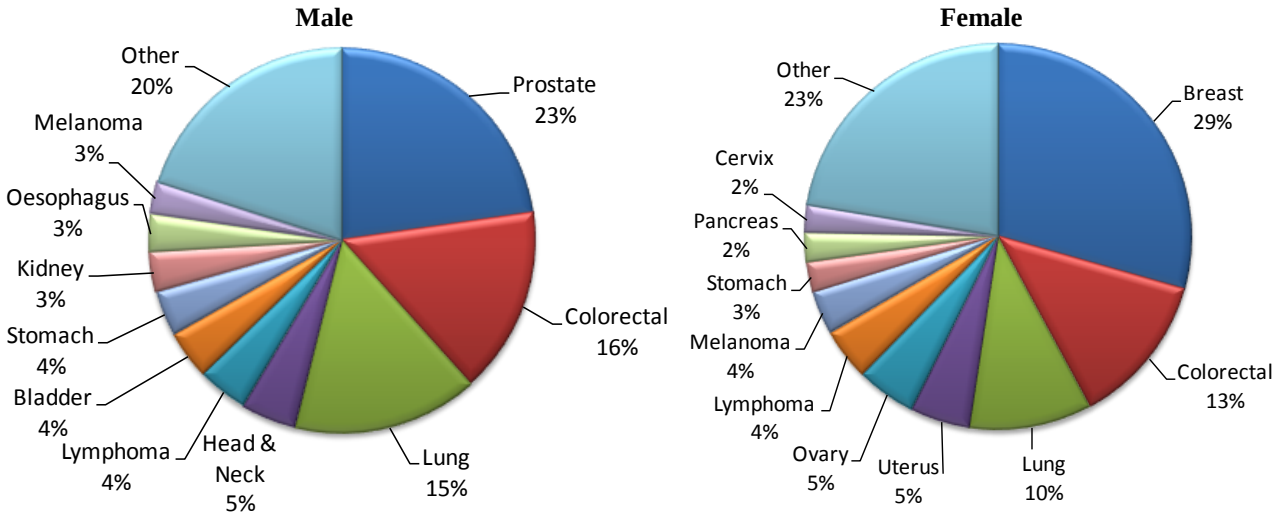
Some forms of cancer are more common than others, while some are more easily and successfully treated resulting in survival varying considerably by cancer site. Consequently, the number of cancer deaths also varies quite considerably by type, with the number of deaths not correlating well with incidence figures with the exception of cancers with poor survival (e.g. lung and pancreas). Breast cancer was the most common cancer during 2003-2007, making up 14.8% of all cancers (excluding NMSC). The next most common cancers were colorectal cancer (14.2%), lung cancer (12.9%) and prostate cancer (11.3%). In contrast, lung cancer was the biggest cause of cancer death during 2004-2008, making up 22.4% of all cancer deaths (853 deaths per year). The next most common cancers causing fatality were colorectal cancer (11.4%), breast cancer (8.1%) and prostate cancer (5.9%). (Fig. 2)

Figure 2: Cases (2003-2007) and deaths (2004-2008) from cancer per year by sex and cancer site



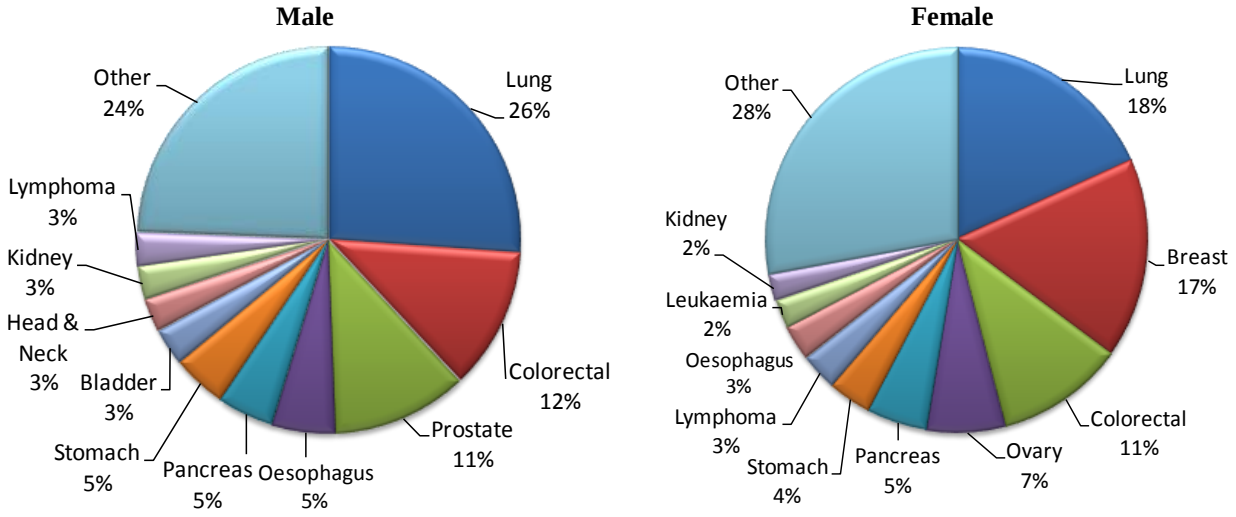
Given that some cancers are gender specific and that males and females have different lifestyles (e.g. historically more men smoked than women), the distribution of cancer type differs by sex. The most commonly diagnosed cancers (excluding NMSC) during 2003-2007 among males were prostate cancer, colorectal cancer and lung cancer. Among females they were breast cancer, which made up 29% of all cases, followed by colorectal cancer and lung cancer. Most cancers were more common among males than females except for cancer of the gallbladder, pancreatic cancer and lymphoma which had similar levels between the two sexes, and breast cancer, melanoma and thyroid cancer, which were higher among females than males. (Fig. 3)

Figure 3: Top ten most common cancers in Northern Ireland by sex: 2003-2007



Among males the most common causes of cancer death during 2004-2008 were lung, colorectal, prostate, oesophageal and pancreatic cancer, while among females they were lung, breast, colorectal, ovarian and pancreatic cancer. Among males the number of lung cancer deaths was more than double that of colorectal cancer while the number of lung cancer deaths among females exceeded those for breast cancer by an average of 27 deaths per year. Among the cancers present in both males and females the number of male deaths exceeded female deaths for the majority of the 20 most frequent causes of cancer death, the exceptions being breast cancer, lymphoma, pancreatic cancer, melanoma and cancer of the gallbladder. However, the most common female specific cancer (breast cancer) had more deaths each year than the most common male specific cancer (prostate cancer) (Fig. 4).

Figure 4: Top ten causes of death from cancer in Northern Ireland by sex, 2004-2008

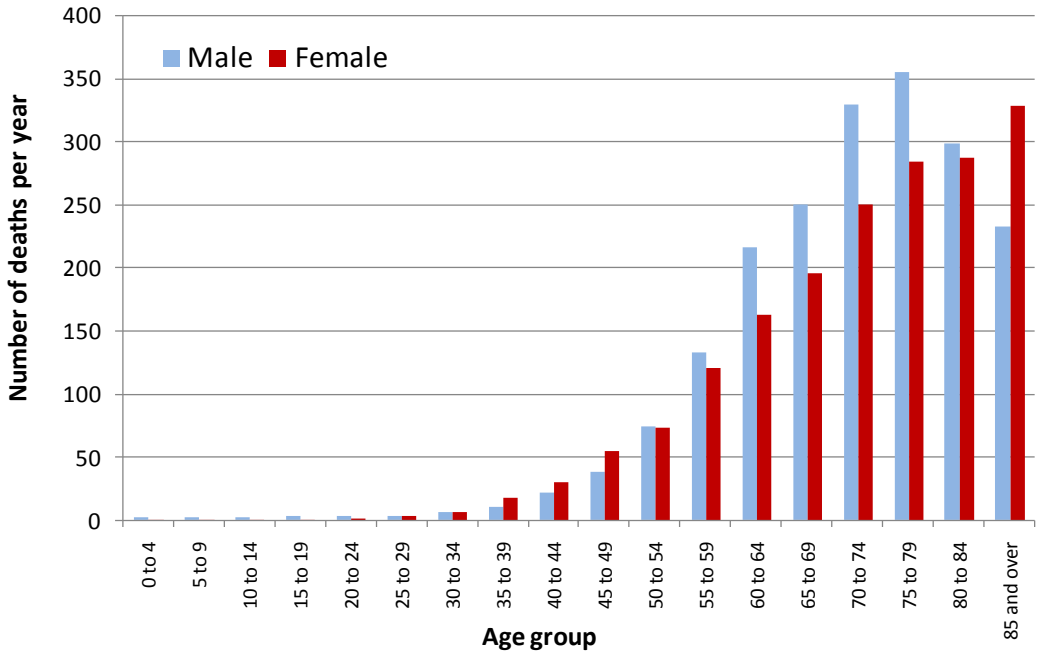


The breakdown of cancer deaths by site varies over time. Whilst among males lung cancer has been the most common cause of cancer death since the 1984-1988 period, with colorectal cancer and prostate cancer the second and third most common respectively, the proportion of cancer deaths which were attributable to lung cancer fell from 32.1% in 1984-1988 to 26.1% in 2004-2008. This reflects reductions in tobacco use among males in the preceding 10-30 years. Among females, breast cancer was the most common cause of cancer death in 1984-1988 followed by colorectal cancer then lung cancer. The change in order by 2004-2008 among females to one with lung cancer as the leading cause of death, followed by breast cancer, was caused by the number of breast cancer deaths remaining virtually static between 1984-1988 and 2004-2008, the number of colorectal cancer deaths falling and the number of lung cancer deaths increasing. The changes in lung cancer again reflect the increased number of women taking up smoking.

4. Cancer and Age

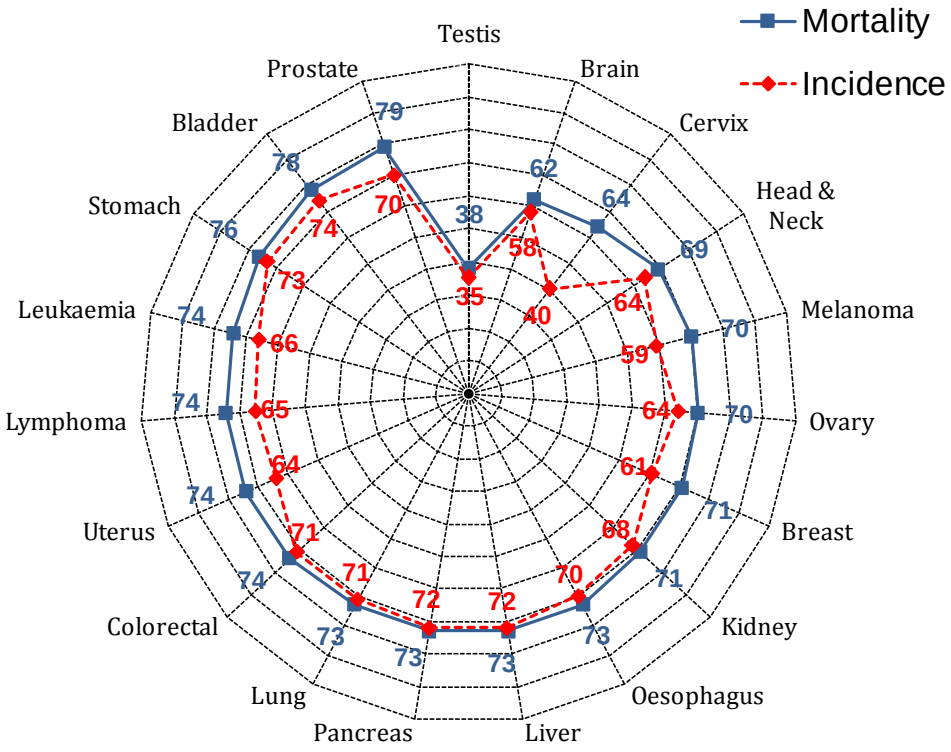
The single most important factor relating to the development of cancer is age with half of the patients dying from cancer in Northern Ireland during 2004-2008 aged over 74 years. The actual number of deaths was greatest among 75-79 year olds for males, contributing 17.9% of all male cancer deaths, and among females aged 85 and over, contributing 18.0% of all female cancer deaths. (Fig. 5)

Figure 5: Age distribution of cancer deaths by sex: 2004-2008



Age at death varied considerably by cancer site during 2004-2008. The median age ranged from 38 years for testicular cancer to 79 years for prostate cancer. Variation existed even for the main cancers with median age at death being 71 years for breast cancer, 73 for lung cancer, 74 for colorectal cancer and 79 for prostate cancer. Median age at death is naturally later than median age at diagnosis; with the difference larger for cancers with good survival (e.g. breast cancer). (Fig. 6)

Figure 6: Median age at diagnosis (2003-2007) and death (2004-2008)



There was only a small difference between males and females in the median age of death during 2004-2008 (Males: 73, Females: 74). For certain cancers however the difference was more marked. While for some cancers like non-melanoma skin and thyroid cancer this may be due to the small number of deaths annually, other differences are more significant. In particular, there was a difference of 8 years in the median age of death from oesophageal cancer between males and females, 6 years for colorectal and pancreatic cancers and 5 years for liver cancer and leukaemia. While for each of these cancers males died earlier than females, the median age of death from breast cancer was 8 years younger than for prostate cancer. (Tab. 1)

For all cancers combined the median age at death increased between 1984-1988 and 2004-2008 from 70 to 74 years old. The biggest changes occurred for lymphoma (9 year increase), breast cancer (7 year increase), cancer of the gallbladder (7 year increase), melanoma (5 year increase) and leukaemia (5 year increase). There was very little change (1 year or less) in median age at death for colorectal cancer, uterine cancer, pancreatic cancer and cancer of the head and neck. Those few cancers which experienced a decrease in the median age at death had a small number of deaths each year (i.e. bone cancer, testicular cancer and cancer of the small intestine). However the changes in median age at death over time are much greater than for median age at diagnosis, which for most cancers has changed very little over the last 15 years. Two exceptions are cervical and prostate cancer where the median age at diagnosis has fallen from 49 to 40 and 75 to 70 years respectively between 1993-1998 and 2002-2007 during which the median age at death for these cancers increased by 2 years. (Table 1)

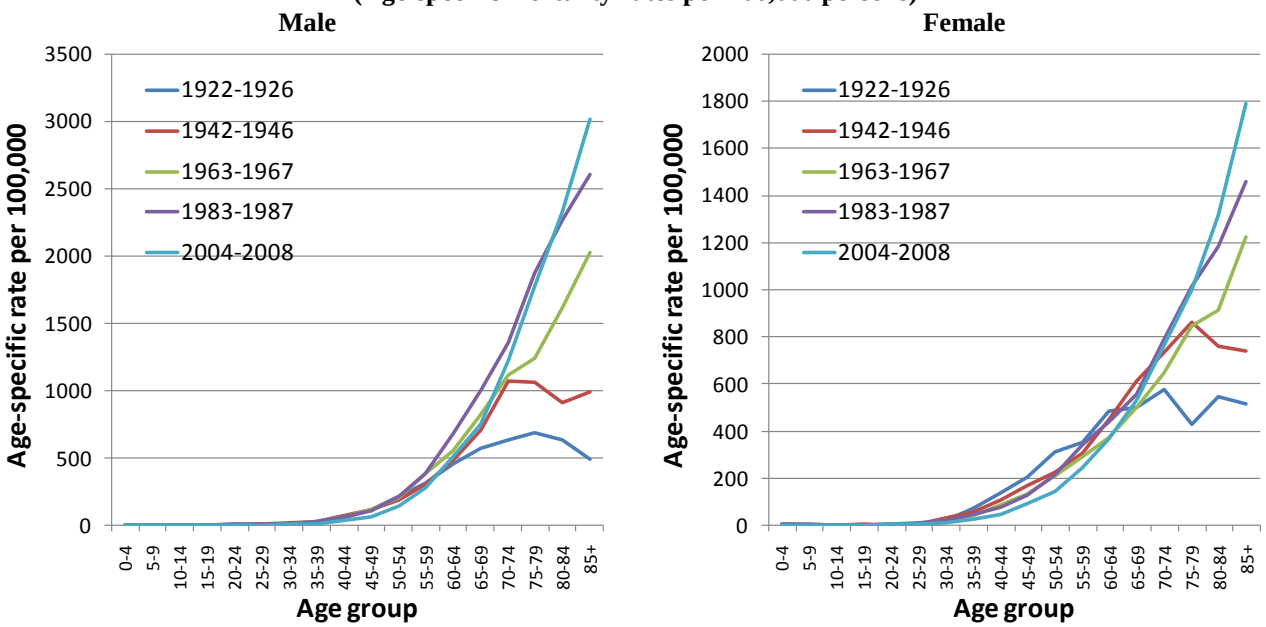
Table 1: Median age at diagnosis and death by sex and cancer site

Cancer site	Median age at diagnosis			Median age at death					
	2003-2007			1984-1988			2004-2008		
	Male	Female	All persons	Male	Female	All persons	Male	Female	All persons
Testis	35	-	35	45	-	45	38	-	38
Bone	29	42	36	64	60	64	45	56	50
Brain	57	58	58	61	60	60	62	64	62
Cervix	-	40	40	-	61	61	-	64	64
Small intestine	62	67	65	69	72	71	69	62	65
Head and Neck	64	65	64	69	74	70	69	71	69
Melanoma	60	57	59	65	66	65	70	72	70
Ovary	-	64	64	-	66	66	-	70	70
Breast	-	61	61	-	64	64	-	71	71
Kidney	68	68	68	67	72	68	71	74	71
Mesothelioma	71	72	72	70	70	70	72	76	72
Oesophagus	68	75	70	68	74	70	69	77	73
Liver	71	74	72	69	72	71	71	76	73
Pancreas	69	75	72	72	73	72	70	76	73
Lung	71	71	71	69	69	69	72	73	73
Colorectal	70	72	71	71	75	73	72	78	74
Uterus	-	64	64	-	73	73	-	74	74
Thyroid	57	52	53	65	74	70	82	72	74
Lymphoma	64	67	65	62	69	65	72	76	74
Leukaemia	66	67	66	67	72	69	73	78	74
Stomach	72	75	73	70	76	72	75	78	76
Myeloma	71	72	71	72	74	73	75	77	76
Gallbladder	72	76	74	70	72	71	78	79	78
Bladder	73	75	74	75	78	76	77	80	78
Prostate	70	-	70	76	-	76	79	-	79
Non-melanoma skin	71	74	72	80	76	78	75	88	82

5. AGE-SPECIFIC AND AGE-STANDARDISED MORTALITY RATES

Given this strong relationship between cancer and age, a younger population is more likely to have a lower number of cancer deaths than an older population of the same size. To compensate for differences in the age-structures of two populations, age-specific mortality rates can be used to make detailed comparisons. Age-specific mortality rates in Northern Ireland during 2004-2008 climbed exponentially with increasing age. For both males and females, rates peaked in the 85 and over age group with 3,012 deaths per 100,000 males and 1,788 deaths per 100,000 females aged 85 and over. (Fig. 7)

Figure 7: Age distribution of cancer deaths by sex and period of death, 1922-2008
(Age-specific mortality rates per 100,000 persons)



Note: Year of registration is used as an approximation for year of death prior to 1983 as historical data is only available by registration year. Intercensal populations prior to 1971 are interpolated by sex and five-year age group.

This distribution is however seen to vary considerably over time. Compared with 1983-1987 age-specific mortality rates in 2004-2008 have decreased for those aged 45-69 perhaps as a result of improved survival, while they have increased for those aged 80 and over. Compared with more historical data the changes are more marked, with age-specific mortality rates for males aged 25-59 and females aged 25-64 the lowest during 2004-2008 compared with any time period back as far as 1922. Among children and young people (i.e. less than 25 years) changes are more difficult to detect due to the small number of deaths, however there have been significant improvements in survival from cancers in these age groups, particularly lymphoma and leukaemia. In contrast, age-specific mortality rates among the elderly were much higher in 2004-2008 than in the past (Fig 7). This is likely to be due to a combination of reasons:

- deaths due to other causes such as heart disease are falling, allowing people to live longer and increasing the chances of the development of cancer;
- improvements in treatment improve survival time after diagnosis while some cancers which occur primarily among younger people (e.g. cervical cancer) are diagnosed and cured before they become malignant;
- more exposure to poor lifestyle factors has resulted in an increase in the number of cancers diagnosed and thus the number of deaths in the population. Most of the cancers caused by lifestyle choices (e.g. lung cancer as a result of a smoking habit) do not develop until later ages, and;
- cause of death is more accurately assigned amongst the elderly than in the past due to improvements in diagnostic techniques (e.g. needle biopsies, scanning etc).

An age-standardised rate is a summary measure based upon age-specific rates which utilises a standard population (in this article the European standard population) to produce a rate per 100,000 persons which removes the effect of different population sizes and age structures. This is useful when making comparisons over time or between geographic areas as the age structure is likely to be different. European age-standardised mortality rates (EASMR) are presented in Table 2 for the main causes of cancer death.

EASMRs were 43.9% higher among males than females for all cancers combined during 2004-2008. For most cancers male EASMRs were greater than female EASMRs, particularly for mesothelioma, laryngeal cancer, head and neck cancer and bladder cancer. Only thyroid cancer and cancer of the gallbladder had higher female than male EASMRs, although these differences were not statistically significant.

Table 2: Cases (2003-2007) and deaths (2004-2008) from cancer by sex and cancer site (Average number of cases/deaths per year and European age-standardised mortality rates (EASMR))

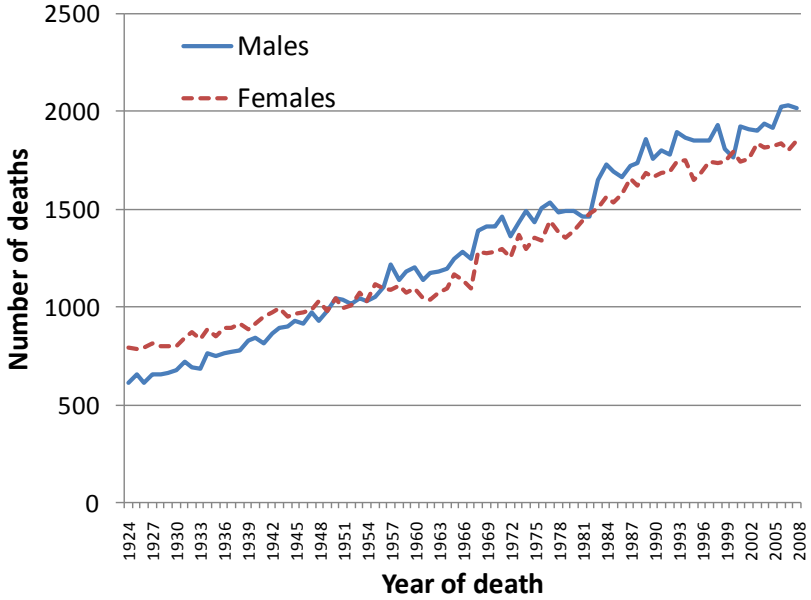
	Males			Females			All persons		
	Cases per year	Deaths per year	EASMR ± 95%CI	Cases per year	Deaths per year	EASMR ± 95%CI	Cases per year	Deaths per year	EASMR ± 95%CI
Head and Neck	169	56	6.4 ± 0.7	76	23	2.0 ± 0.4	245	79	4.0 ± 0.4
Oral	105	36	4.2 ± 0.6	55	17	1.5 ± 0.3	160	53	2.7 ± 0.3
Nose and Sinuses	8	2	0.2 ± 0.1	7	1	0.1 ± 0.1	14	3	0.1 ± 0.1
Larynx	57	18	2.0 ± 0.4	14	5	0.4 ± 0.2	71	23	1.1 ± 0.2
Oesophagus	112	105	11.8 ± 1.0	56	54	4.1 ± 0.5	168	159	7.6 ± 0.5
Stomach	137	91	9.9 ± 0.9	91	67	5.0 ± 0.6	228	158	7.1 ± 0.5
Small intestine	13	5	0.6 ± 0.2	8	3	0.3 ± 0.2	21	8	0.4 ± 0.1
Colorectal	574	236	26.0 ± 1.5	465	197	15.3 ± 1.0	1,039	433	20.1 ± 0.9
Colon	347	150	16.5 ± 1.2	321	143	11.0 ± 0.9	668	292	13.4 ± 0.7
Rectum	227	86	9.5 ± 0.9	144	54	4.4 ± 0.6	371	141	6.7 ± 0.5
Liver	43	45	5.1 ± 0.7	23	36	2.9 ± 0.5	66	81	3.9 ± 0.4
Gallbladder	22	6	0.6 ± 0.2	34	13	1.0 ± 0.3	56	19	0.8 ± 0.2
Pancreas	88	96	10.8 ± 1.0	89	94	7.4 ± 0.7	178	190	9.0 ± 0.6
Lung	567	518	56.8 ± 2.2	378	335	28.8 ± 1.4	945	853	40.8 ± 1.3
Bone	9	6	0.7 ± 0.2	7	3	0.3 ± 0.2	16	9	0.5 ± 0.1
Melanoma	99	25	2.9 ± 0.5	137	22	1.9 ± 0.4	236	48	2.4 ± 0.3
Non-melanoma skin	1,338	9	1.0 ± 0.3	1,175	8	0.5 ± 0.1	2,513	17	0.7 ± 0.2
Mesothelioma	41	33	3.7 ± 0.6	5	5	0.4 ± 0.2	46	38	1.8 ± 0.3
Connective and soft tissue	24	7	0.8 ± 0.3	18	8	0.7 ± 0.2	42	15	0.7 ± 0.2
Breast	3	1	0.1 ± 0.1	1,079	308	27.6 ± 1.4	1,082	309	15.2 ± 0.8
Cervix	-	-	-	85	26	2.4 ± 0.4	85	26	1.3 ± 0.2
Uterus	-	-	-	184	39	3.2 ± 0.5	184	39	1.8 ± 0.3
Ovary	-	-	-	182	123	11.3 ± 0.9	182	123	6.2 ± 0.5
Prostate	829	226	24.3 ± 1.4	-	-	-	829	226	9.4 ± 0.6
Testis	59	1	0.2 ± 0.1	-	-	-	59	1	0.1 ± 0.1
Kidney	126	56	6.3 ± 0.7	80	40	3.4 ± 0.5	206	96	4.7 ± 0.4
Bladder	151	61	6.5 ± 0.7	58	30	2.1 ± 0.4	210	91	3.9 ± 0.4
Brain	71	53	6.2 ± 0.7	51	34	3.5 ± 0.5	122	88	4.8 ± 0.5
Thyroid	10	3	0.3 ± 0.2	34	6	0.6 ± 0.2	44	9	0.4 ± 0.1
Lymphoma	158	55	6.1 ± 0.7	157	57	4.5 ± 0.6	315	112	5.2 ± 0.4
Hodgkin's lymphoma	25	4	0.5 ± 0.2	22	5	0.4 ± 0.2	47	9	0.4 ± 0.1
Non-Hodgkin's lymphoma	133	51	5.6 ± 0.7	135	53	4.1 ± 0.5	268	104	4.8 ± 0.4
Myeloma	74	41	4.5 ± 0.6	51	32	2.4 ± 0.4	124	73	3.3 ± 0.3
Leukaemia	87	50	5.5 ± 0.7	72	44	3.5 ± 0.5	159	94	4.3 ± 0.4
Other	187	198	-	243	222	-	430	420	-
All cancers	4,991	1,985	218.8 ± 4.3	4,838	1,829	152.0 ± 3.3	9,829	3,814	179.2 ± 2.6

EASMR: European age-standardised mortality rate per 100,000 persons; CI: Confidence interval

6. TRENDS

Mortality data has the advantage over incidence data in that detailed electronic data is available going back to 1974 while hard copy tables are available back to 1922. This allows examination of trends over a long period of time although coding changes at certain points may affect the trends. Between 1922 and 2008 the number of cancer deaths in Northern Ireland increased by an average of 17.5 male and 13.7 female deaths per year. (Fig. 8)

Figure 8: Long-term trends in deaths from all cancers combined: 1922-2008

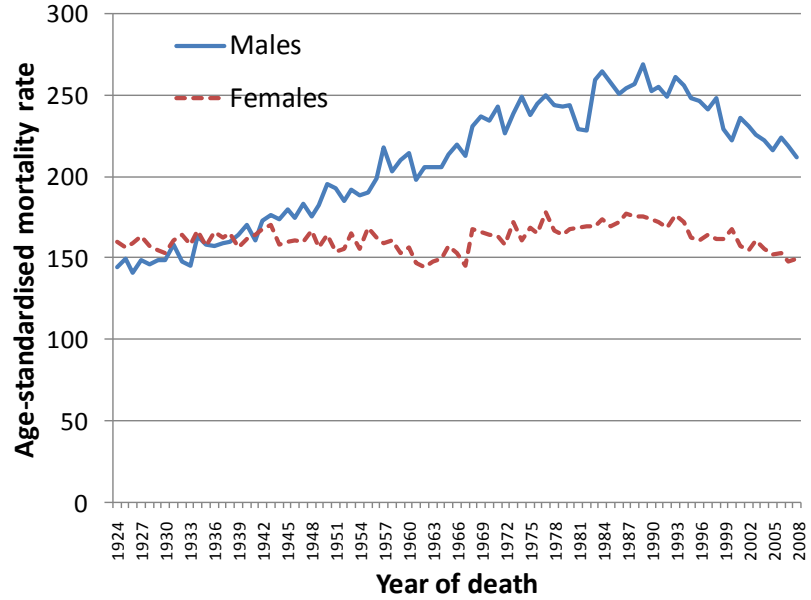


Note: Year of registration is used as an approximation for year of death prior to 1983 as historical data is only available by registration year.

The increase in deaths was largely a result of the ageing and growth of the population over the last 87 years. To investigate trends excluding the effects of age and population growth we analyse age-standardised mortality rates which are broken into separate sections where mathematical techniques[5,6] suggest that a change in the direction of the trend has occurred.

The change in mortality rates during the same period has not been constant. For males the long-term trend in cancer mortality can be broken into three separate sections. Firstly between 1922 and 1974 there was an annual percentage increase in rates of 1.1%, which corresponded to an increase of 17 male deaths per year. For the next 17 years up to 1991 rates continued to increase but at a slower rate of 0.5% per year. This reflects a greater average annual increase of 22.9 male deaths per year as the rate of population growth and ageing was greater than in the preceding period of time. During the most recent period (1991-2008) mortality rates among males have seen a decrease of 1.1% per year, however this still translates to an annual average increase of 11.4 male deaths per year once the effects of demographic change are included. (Fig. 9)

Figure 9: Long-term trends in mortality rates from all cancers combined: 1922-2008 (European age-standardised mortality rates per 100,000 persons

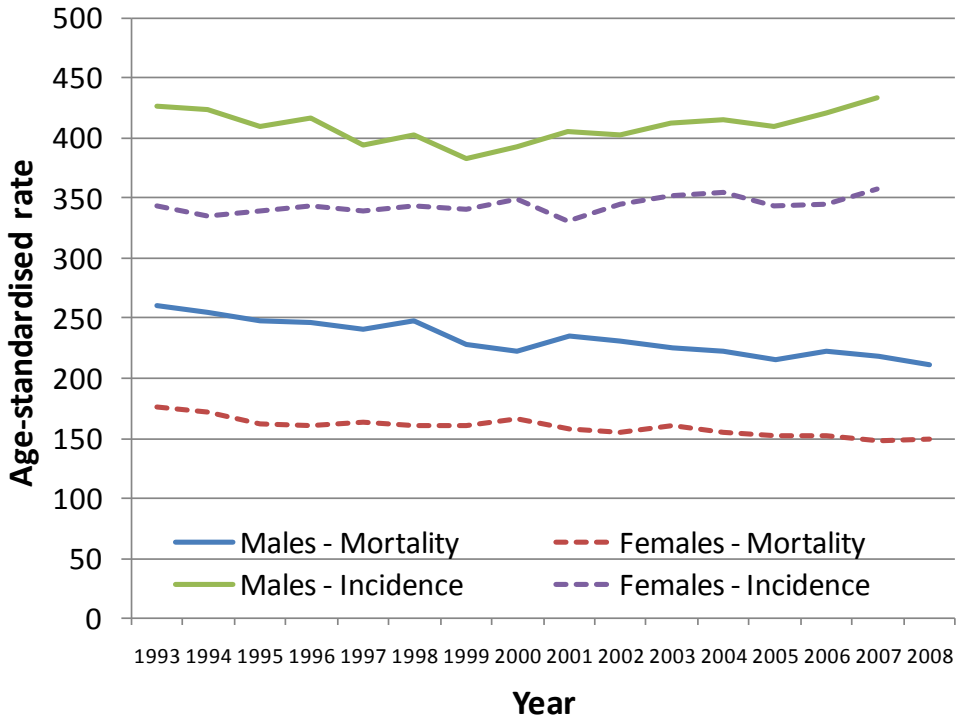


Note: Year of registration is used as an approximation for year of death prior to 1983 as historical data is only available by registration year. Intercensal populations prior to 1971 are interpolated by sex and five-year age group.

For females the trend in age-standardised rates was more constant over time. In 1922-1926, the average age-standardised rate was 155.9 deaths per 100,000 females compared to 152.0 deaths per 100,000 females in 2004-2008. Despite this small change there have been some fluctuations within the 87-year period. Between 1922 and 1961 rates exhibited no significant change although the actual number of deaths continued to increase due to population change. Between 1961 and 1988 age-standardised rates increased by 0.6% per year. Since that point EASMRs among females have declined by 0.8% per year although, as with males, the actual number of deaths continued to increase, by an average of 9.6 deaths per year. (Fig. 9)

In summary, although the number of deaths from all cancers combined has increased over the last 20 years among both males and females, when the effect of ageing and population growth is taken into account mortality rates have fallen. This indicates that the increase in the absolute number of deaths from cancer is a result of the ageing of the population as cancer is more common among the elderly. However, this general trend is not observed for diagnosis of cancer. European age-standardised incidence rates are actually increasing with an annual percentage increase of 1.2% per year among males since 1999 and an annual percentage increase of 0.3% per year among females since 1993. This suggests that reductions in mortality are a result of improvements in diagnosis and treatment rather than a result of cancer prevention. (Fig. 10)

Figure 10: Trends in incidence and mortality rates from all cancers combined (ex. NMSC): 1993-2007 (European age-standardised rates per 100,000 persons)



The increase in incidence rates and reduction in mortality rates over the last decade are not representative of all types of cancer with different cancer sites demonstrating very different trends. (Fig. 11)

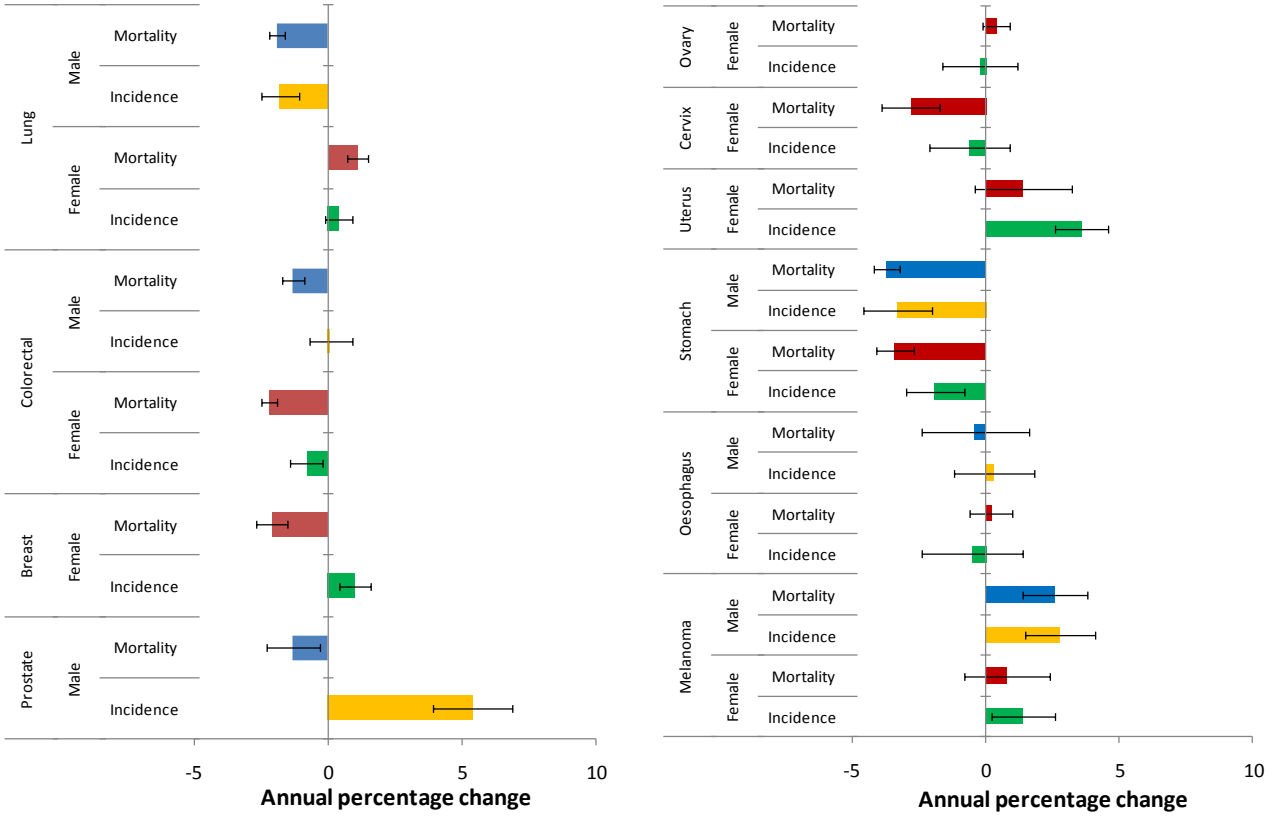
The decrease in mortality rates among males for all cancers combined is in part due to decreases in smoking rates among the male population. This is reflected in the mortality rate trends for lung cancer which saw an average annual decrease of 1.9% between 1983 and 2008, a decrease also reflected in incidence rate trends. Among females the news is not as positive. Due to increases in smoking prevalence female lung cancer mortality rates increased between 1983 and 2008 by an average of 1.1% per year, however changes in incidence, while positive, are not statistically significant suggesting that mortality rates for female lung cancer may level out over the next few years. (Fig. 11)

As a result of better and earlier diagnosis, as well as improvements in care, mortality rates from colorectal cancer have decreased for males and females since 1983. The rate of decline is slightly greater for females than males with an average annual decrease of 2.2% in rates for females compared to 1.3% for males. The difference in males and females is likely due to decreases in female incidence rates of colorectal cancer which have not occurred for males. (Fig. 11)

Breast cancer mortality rates among females were virtually static between 1983 and 1991 in Northern Ireland. Since that time mortality rates for this disease have shown a fall of 2.1% per year which is in keeping with trends in other countries (e.g. England and the Republic of Ireland). The start of this fall coincides with the start of the breast screening programme in Northern Ireland (during 1989-1993) which kick-started a range of improvements for breast cancer patients. However, the reduction in death rates is likely a result of improvements in treatment (e.g. availability of tamoxifen). Studies have shown that screening leads to survival improvements after approximately seven years and the impact of screening on breast cancer mortality in Northern Ireland would thus not have been expected until at least 2000. It is reassuring that the reduction in mortality has continued over time despite increases in breast cancer incidence rates over the last 15 years. (Fig. 11)

Mortality rates from prostate cancer increased between 1983 and 1995 by an average of 2.2% per year with the actual number of deaths increasing by 6.3 per year. Fortunately, this has seen a reversal with more recent trends from 1995 to 2008 illustrating a decrease in mortality rates of 1.4% per year although this still represents an increase of 1.7 deaths per year as a result of population growth and ageing. The reduction in mortality rates is likely a result of improvements in care including the introduction of new drugs such as anti androgen therapy. The reduction however is contrary to the trend in incidence rates which has seen a huge increase over the last decade, probably as a result of PSA testing. (Fig. 11)

Figure 11: Trends in cancer incidence (1993-2007) and mortality (1983-2008). (European age-standardised rates per 100,000 persons)



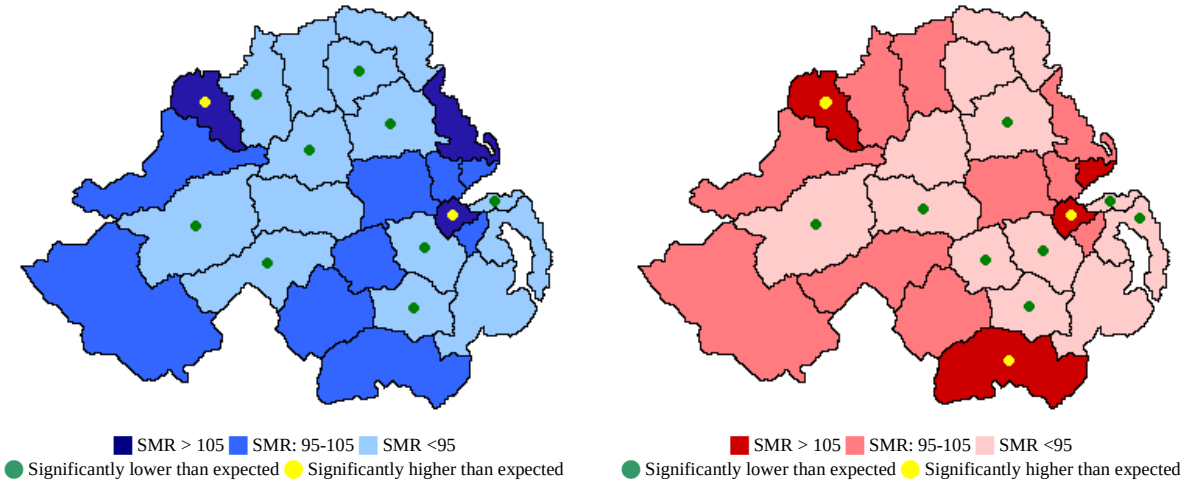
For other cancer sites, the small number of deaths per year makes detection of positive or negative trends difficult. There was no significant trend detected for deaths from head and neck cancer, oesophageal cancer, female liver cancer, pancreatic cancer, bone cancer, female melanoma, ovarian cancer, uterine cancer, female kidney cancer, female bladder cancer, brain cancer, multiple myeloma and lymphoma. However, declines were noted in death rates of stomach cancer, cancer of the gallbladder, cervical cancer, male bladder cancer and leukaemia. On the other hand, increases in male liver cancer, male melanoma and male kidney cancer between 1983 and 2008 were identified.

8. Geographic Patterns

Recent geographic patterns (1999-2008) of cancer deaths are examined using standardised mortality ratios which take account of differences in the number of people living in a geographic area and any differences in their age structure. During 1999-2008 Belfast and Derry Local Government Districts had higher male mortality rates of all cancers combined than the average rate for all of Northern Ireland. Significantly lower than average male mortality rates occurred in nine Local Government Districts. Among females, mortality rates were also higher than expected in Belfast and Derry but also in Newry & Mourne Local Government District, while significantly lower than average female mortality rates occurred in eight Local Government Districts. (Fig. 12)

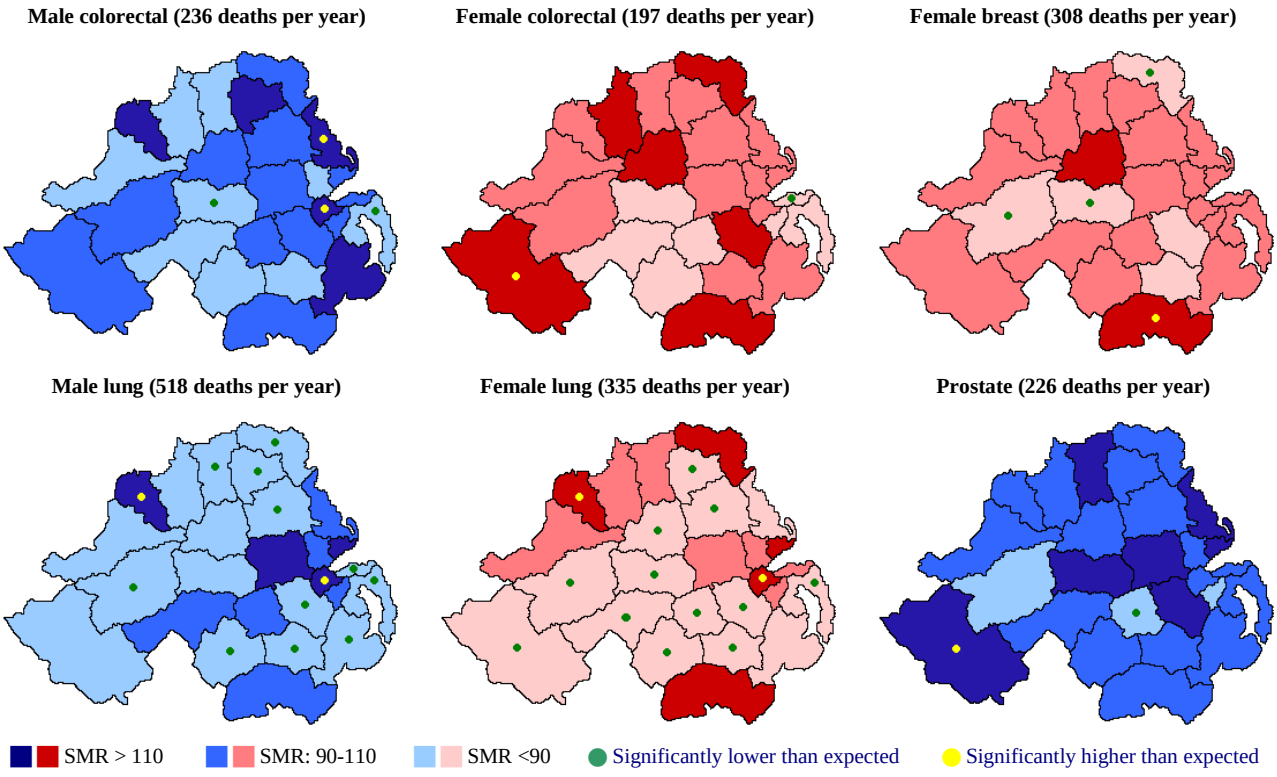
Figure 12: Geographical variations in cancer mortality rates for all cancers combined: 1999-2008 (Standardised mortality ratios for Local Government Districts relative to all of Northern Ireland)

Male **Female**



The relationship between mortality rates and geographic area differed depending upon cancer site as a result of different lifestyle factors; smoking levels in particular causing higher rates of many cancers in certain Local Government Districts. For lung cancer Belfast and Derry dominated the distribution of lung cancer deaths across Northern Ireland in 1999-2008. Colorectal cancer had a much more even distribution, although Larne and Belfast had higher than expected mortality rates for males while female colorectal cancer mortality was higher than expected in Fermanagh. Both female breast cancer and male prostate cancer also had a fairly even distribution of deaths across Northern Ireland, however significantly higher than expected mortality rates were present in Newry & Mourne for breast cancer and in Fermanagh for prostate cancer. (Fig. 13)

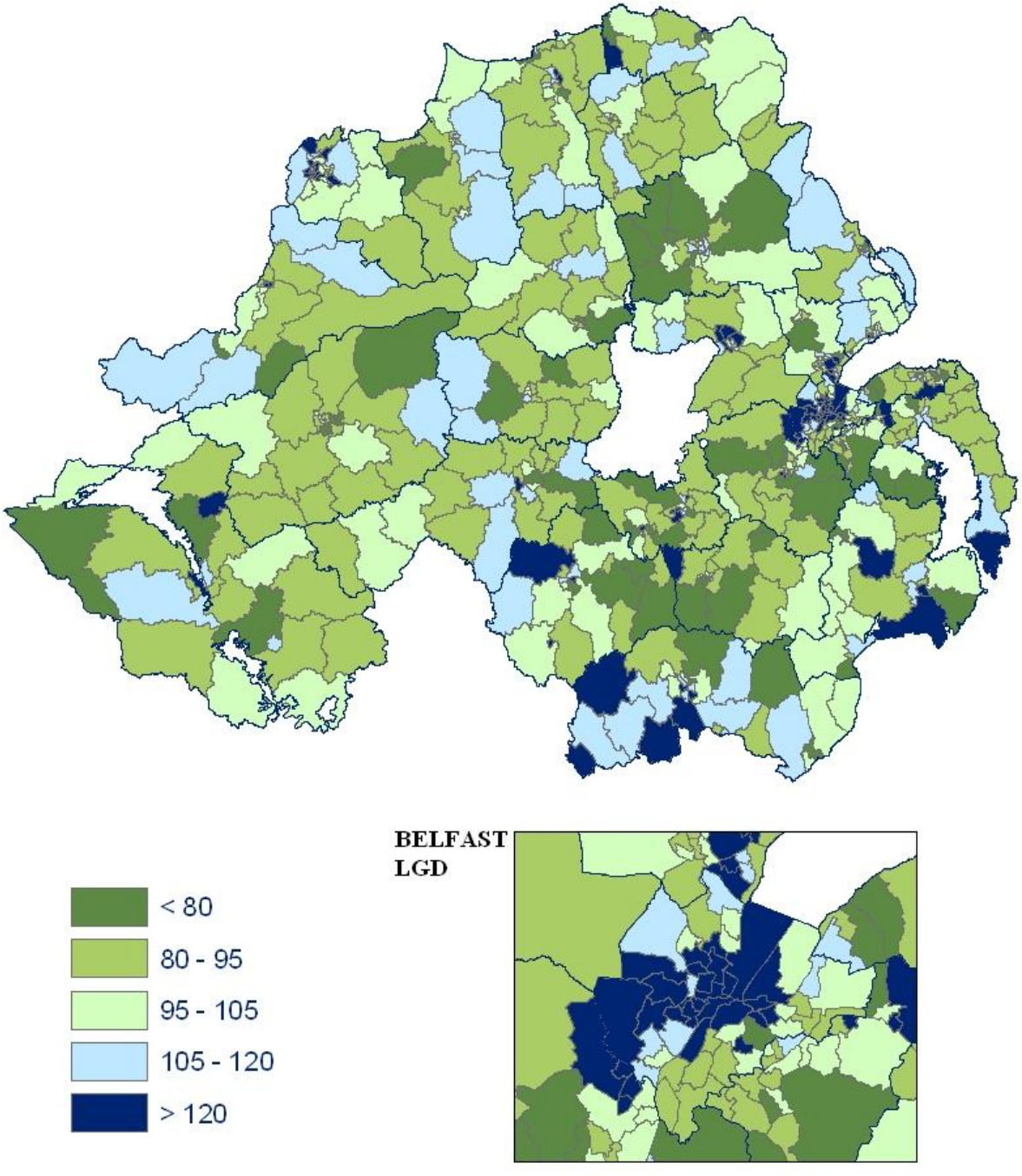
Figure 13: Geographical variations in cancer mortality rates for selected cancers: 1999-2008 (Standardised mortality ratios for Local Government Districts relative to all of Northern Ireland)



When looking at rates for lower geographic levels such as electoral ward, differences in mortality rates can be difficult to detect due to the small number of deaths. As a result large periods of time must be considered in small geographical area analysis even though changes will undoubtedly have occurred throughout the time period examined.

Over the 15 year period from 1994 to 2008 only 66 of the 582 electoral wards in Northern Ireland had higher than expected mortality rates (at a 95% confidence level). Of the 10 wards with the highest mortality rates, six were located in North & West Belfast. In addition, many other electoral wards in North & West Belfast and various parts of Derry had high mortality rates relative to Northern Ireland. This is in agreement with the pattern found at Local Government District level but illustrates that not all areas of Belfast and Derry Local Government Districts experience higher cancer mortality. Out of the 98 electoral wards that had lower than expected mortality rates only five of these were located in Belfast and none were located in Derry. (Fig. 14)

Figure 14: Geographic variations in cancer mortality rates, 1994-2008
(Standardised mortality ratios for Electoral Wards relative to all of Northern Ireland for all cancers combined)

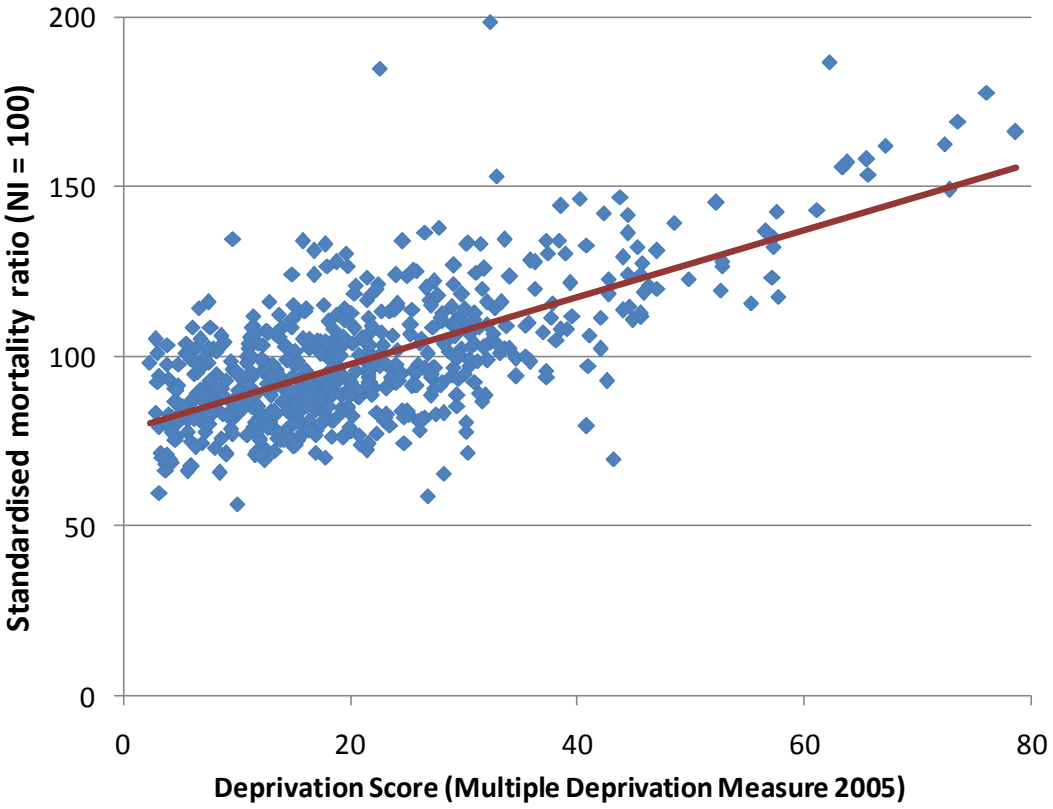


It is likely that the variation in cancer mortality is strongly related to smoking patterns although no small geographic area data on smoking levels is available to verify this hypothesis. However, other lifestyle, environmental and genetic factors will also be relevant.

9. Deprivation and Socio-Economic Status

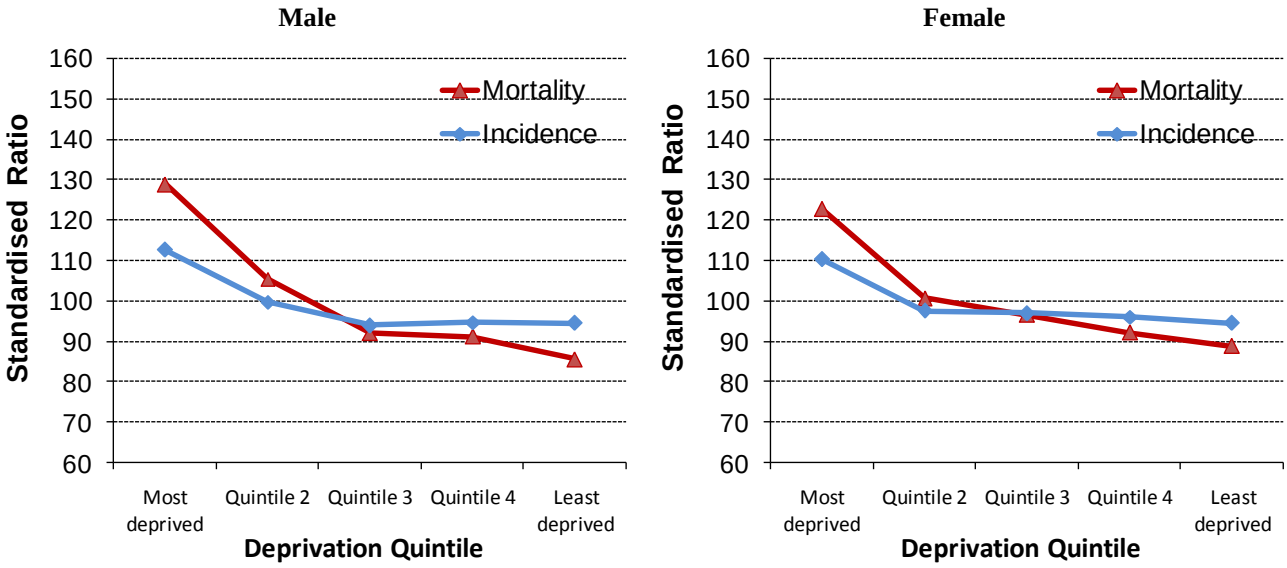
The distribution of mortality rates is however highly correlated to the deprivation level of each electoral ward (correlation coefficient: 0.66). Some of the wards with the highest levels of deprivation also have the highest cancer mortality rates, for example, Falls (Belfast), Upper Springfield (Belfast), Whiterock (Belfast), Shankill (Belfast), New Lodge (Belfast), Creggan Central (Derry) and Brandywell (Derry). This in turn is most likely a result of variations in lifestyle factors. (Fig. 15)

Figure 15: Correlation between deprivation score (2005) and standardised mortality ratio (1994-2008) at electoral ward level.



Quantifying this inequality, mortality rates in the most deprived areas during 2004-2008 were 29% higher than the Northern Ireland average for males and 23% higher for females. In contrast mortality rates in the least deprived areas were 14% lower relative to the Northern Ireland average for males and 11% lower for females. This was similar to the pattern for incidence rates in 2003-2007, although the inequality was not as great with rates 12% higher than the Northern Ireland average for males and 10% higher for females. (Fig. 16)

Figure 16: Cancer incidence (2003-2007) and mortality (2004-2008) rates by deprivation for all cancers combined
(Standardised mortality ratios by area based deprivation quintile relative to all of Northern Ireland)

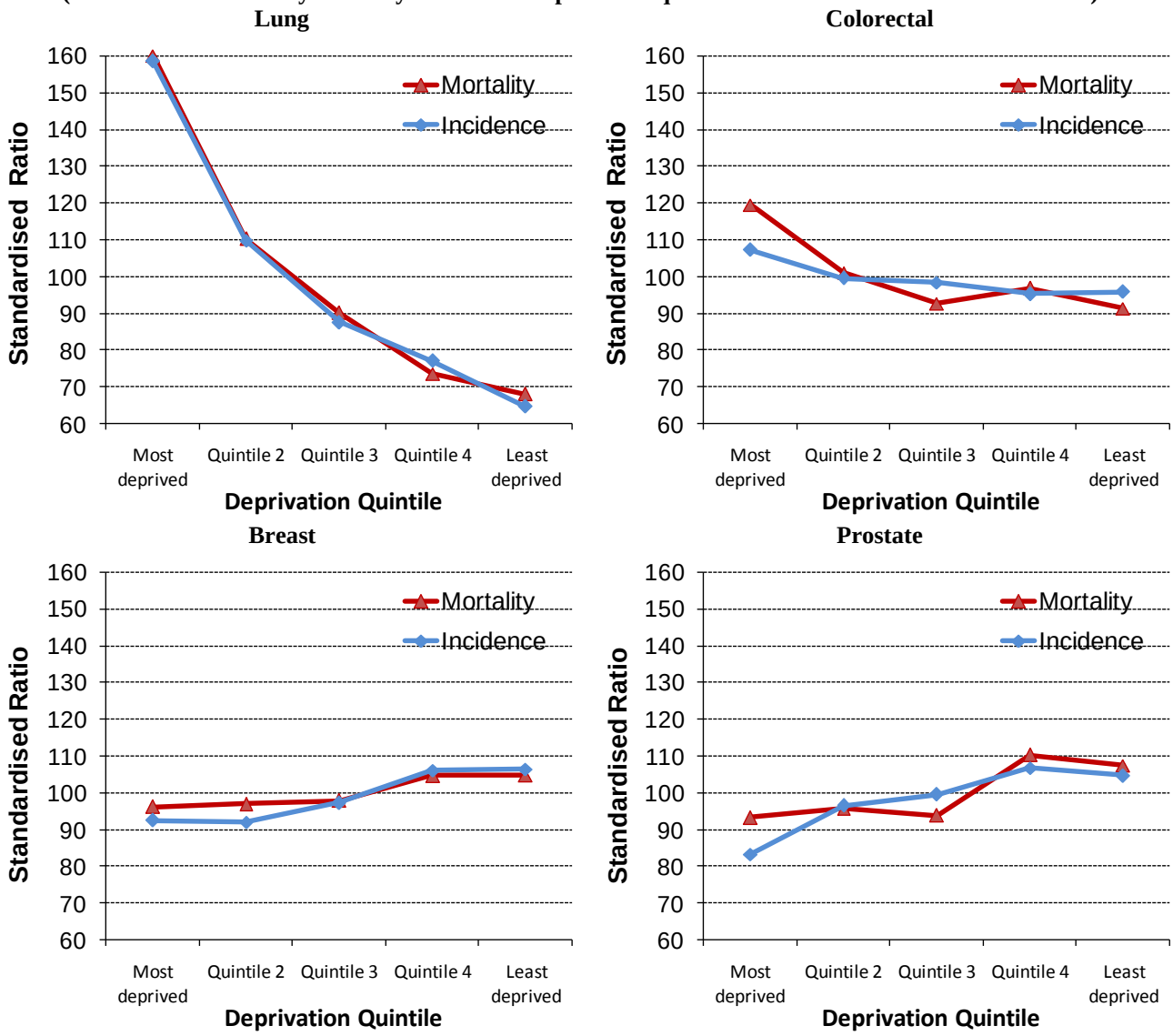


During the 2004-2008 period 781 fewer deaths per year would have been recorded if mortality rates in the least deprived areas were applied to the most deprived areas.

The inequality between most deprived and least deprived areas is only present for certain cancer sites and varies in magnitude for those cancers where the inequality exists.

- For colorectal cancer mortality rates were 18% higher in deprived areas than the Northern Ireland average in 2004-2008 while they were 10% lower than expected in the least deprived areas. The differences were marginally higher than for incidence rates, which were also higher in the most deprived areas relative to Northern Ireland.
- For lung cancer the gradient in mortality rates by deprivation quintile was very high with rates 57% higher in the 20% most deprived areas than the country-wide average, with a very similar pattern observed for incidence rates.
- For breast and prostate cancers there was no significant difference in mortality between the most deprived and least deprived areas, despite higher incidence rates in the least deprived areas. The lack of significance in the mortality trends compared to the incidence trend for these cancers is likely due to the smaller number of deaths than cases. (Fig. 17)

Figure 17: Cancer incidence (2003-2007) mortality (2004-2008) rates and deprivation for selected cancers (Standardised mortality ratios by area based deprivation quintile relative to all of Northern Ireland)

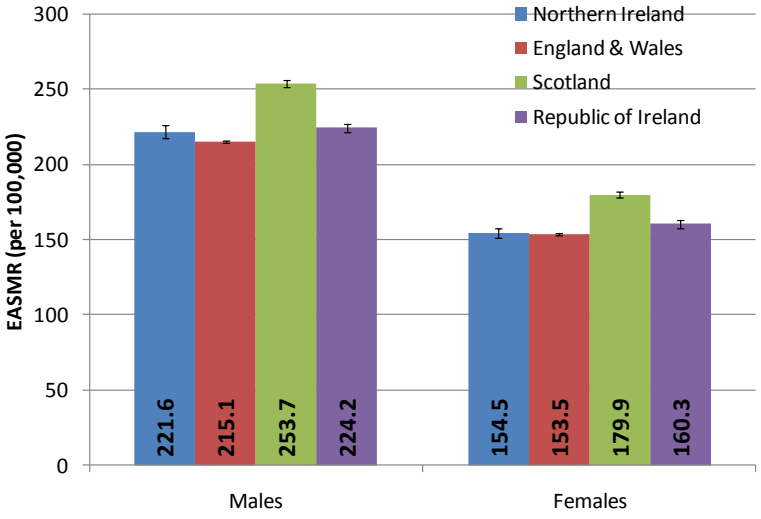


10. Comparisons with UK And Ireland

The prevention and treatment of cancer is an extremely large and complex area of healthcare. Thus even with a successful, high quality health service there may be some areas where there is room for improvement. Identifying these areas can be assisted through international comparisons. These help identify countries/other health services that can help the health service in Northern Ireland to identify and, if appropriate, adopt good practices present in other countries, or at least provide reassurance that the best possible approach is currently being adopted.

Even within the UK and Ireland, significant variation in rates of cancer death exist between some of the constituent countries. For males age-standardised cancer mortality rates in Northern Ireland during 2003-2007 were 3.0% higher than in England and Wales, but were 12.6% lower than those in Scotland. However, during the same time period female mortality rates in Northern Ireland were similar to those in England and Wales but were 14.1% below those in Scotland. Comparisons with Republic of Ireland however are slightly more complex and difficult to interpret due to different mortality trends in each country. During 2000-2004 mortality rates were 3.9% lower for males and 3.6% lower for females in Northern Ireland than in Republic of Ireland. Since then however age-standardised mortality rates have decreased in the Republic of Ireland within three years by 5.3% for males and 3.9% for females compared to 2.2% for males and 2.8% for females in Northern Ireland. Consequently, in 2003-2007 there was no statistically significant difference between the two countries. Whether this is a "blip" in the general trend in one or both countries causing a temporary reduction in the difference in mortality rates or something more permanent remains to be seen. (Fig. 18)

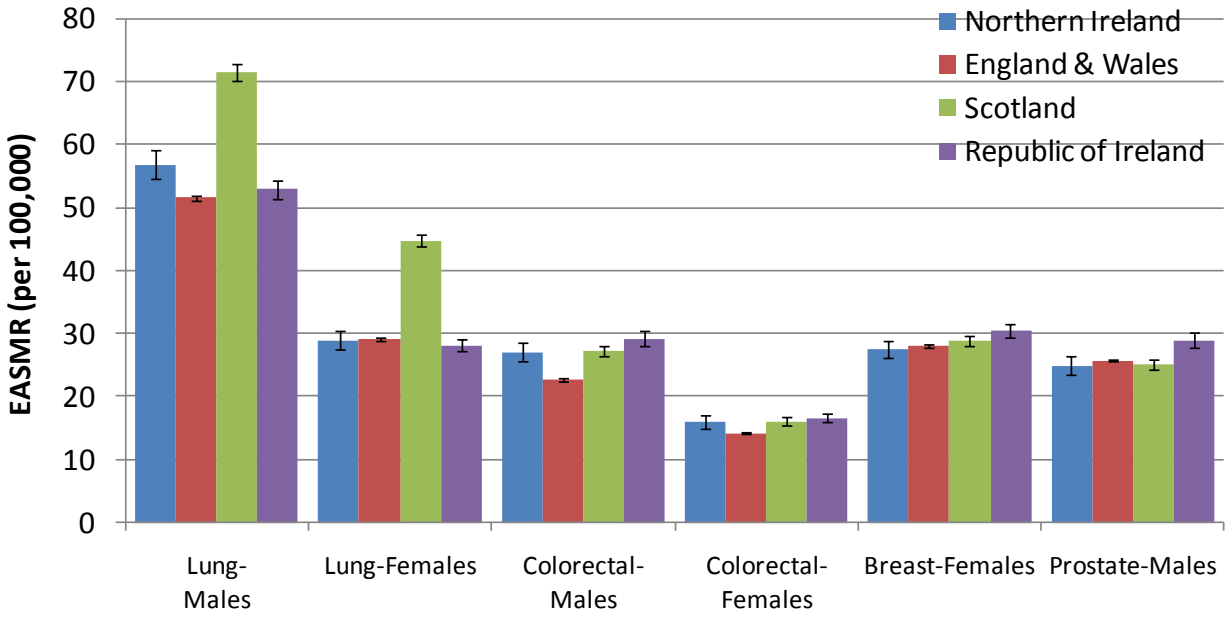
Figure 18: Mortality rates for all cancers combined in UK and Ireland: 2003-2007 (European age-standardised mortality rates)



Source: ONS, ISD, CSO, GRO

While a useful overall comparison, mortality from all cancers combined is limited as a comparative measure as variations in this statistic often reflect the different mix of cancers diagnosed within different populations. It is thus more informative to investigate differences in death rates from particular types of cancer. If we focus on the four main causes of cancer death during 2003-2007, we see that lung cancer mortality in Northern Ireland was higher than in England & Wales and Ireland, but was much lower than in Scotland. Among females, while Scotland also had much higher mortality rates than in the rest of UK and Ireland, levels of death from this disease were similar in the other countries. These patterns are likely related to smoking patterns throughout UK and Ireland, although historical asbestos exposure which was concentrated in areas of heavy industry, especially shipbuilding, also plays a part. For colorectal cancer, Northern Ireland, Republic of Ireland and Scotland all had similar death rates, despite some variation that is not statistically significant. England and Wales however had lower levels of colorectal cancer mortality for both sexes. This may suggest better diagnosis or treatment, however recent international comparisons of incidence indicated that the rates of new cases of colorectal cancer are also lower in England and Wales than in the other three countries, **Error! Reference source not found.** suggesting that lifestyle and genetic factors are the likely cause of the mortality variations. Breast cancer variations within the UK are not statistically significant although mortality from the disease was higher in Republic of Ireland. Similarly prostate cancer mortality was equivalent across the UK, but was higher in Republic of Ireland. The exact reasons for the elevated levels in Republic of Ireland are unknown but are under investigation. (Fig. 19)

Figure 19: Mortality rates for selected cancers in UK and Ireland: 2003-2007 (European age-standardised mortality rates)



Source: ONS, ISD, CSO, GRO

11. SURVIVAL

Mortality is a good measure of the outcomes of having cancer however it is not an accurate depiction of the burden of cancer within the population. This is because some cancers have very good survival rates and thus have a low number of deaths compared to the number of cancers diagnosed. For example, in 2002-2006 breast cancer, prostate cancer, cancer of the uterus, melanoma and testicular cancer all had mortality to incidence ratios of less than 0.3 (i.e. for every 100 cases diagnosed there were less than 30 deaths). Other cancers had a large number of deaths compared to cases diagnosed. In particular lung cancer, pancreatic cancer, oesophageal cancer and liver cancer had high mortality to incidence ratios indicating that most patients diagnosed with these cancers die. In fact, it can happen that in a given period of time there are more deaths from these cancers than cases diagnosed. This is mostly due to the delay between diagnosis and death and random effects which can cause peaks or troughs in the number of cases or deaths in a given year compared to surrounding years. It can also occur if incidence of the disease is falling.

However, for particular cancers more deaths can be registered than diagnosed in a given year as the death is the result of a cancer of one site metastasising and spreading to a second site which is then assigned as the cause of death. This is particularly common with liver cancer, and to a lesser extent pancreatic cancer. This highlights an important point that cancer patients can have several outcomes. They can be successfully treated and live long lives, they can die from their cancer or they can die from a completely unrelated cause. Table 3 illustrates this range of possibilities. During 2002-2006, 55.7% of patients diagnosed with a cancer other than non-melanoma skin cancer (NMSC) (which is excluded as it is rarely fatal) were still alive at the end of 2006. When considered by cancer site, the pattern is naturally similar to the mortality to incidence ratio, with cancers with a high ratio having a low percentage of patients alive at the end of 2006. Thus at the end of 2006 only 18.3% of lung cancer patients, 20.4% of liver cancer patients and 11.3% of pancreatic cancer patients diagnosed in 2002-2006 were still alive.

In the majority of cases where patients died, they died as a result of their cancer with only a small percentage dying of a different cancer or another cause of death. Overall, 4.0% of patients died from a cancer other than the one they were diagnosed with. This can happen for several reasons in addition to metastasis. Firstly, a patient may have more than one cancer in their lifetime (in fact excluding NMSC 3.5% of patients have more than one tumour). While the analysis conducted here has matched the cause of death to diagnosis of cancer site in the event that a patient has more than one tumour, the cancer that killed the patient may have been diagnosed before the 2002-2006 period. Secondly, and probably more commonly, there are inaccuracies in death certificates which may affect some cancers more than others.

Table 3: Outcomes after a diagnosis of cancer: 2002-2006

(Number of patients diagnosed in 2002-06 with vital status at the end of 2006 along with cause of death as coded on death certificate)

	Patients diagnosed in 2002-06 but deceased at end of 2006					
	Death from same cancer as diagnosis	Death from different cancer than diagnosis	Death from diseases of circulatory system	Death from other cause	Patients alive at end of 2006	Total number of patients (2002-06)
Head and Neck	21.9%	5.8%	1.8%	3.0%	67.4%	1,118
Oesophagus	68.9%	2.1%	1.8%	1.6%	25.7%	774
Stomach	59.5%	10.2%	2.1%	2.3%	25.9%	1,142
Colorectal	31.8%	5.9%	2.3%	1.6%	58.5%	4,741
Liver	68.2%	6.4%	1.0%	4.1%	20.4%	314
Pancreas	82.6%	3.1%	1.1%	2.0%	11.3%	852
Lung	74.7%	2.7%	2.1%	2.1%	18.3%	4,496
Melanoma	7.8%	1.0%	1.2%	1.1%	88.9%	1,157
Breast	12.1%	0.5%	1.2%	1.2%	85.0%	5,110
Cervix	18.5%	1.4%	0.2%	0.0%	79.9%	417
Uterus	16.6%	2.6%	1.2%	0.9%	78.6%	847
Ovary	42.5%	2.7%	1.4%	1.3%	52.0%	912
Prostate	15.6%	1.0%	2.2%	1.2%	80.0%	3,739
Testis	2.4%	0.3%	0.0%	0.0%	97.3%	295
Kidney	36.8%	3.9%	2.2%	2.8%	54.2%	915
Bladder	28.6%	2.7%	3.2%	2.4%	63.1%	963
Brain	52.9%	1.5%	1.0%	6.7%	37.9%	597
Lymphoma	28.1%	2.0%	1.3%	1.6%	67.0%	1,470
Leukaemia	39.0%	1.8%	2.9%	4.1%	52.2%	785
All cancers (excluding NMSC)	36.6%	4.0%	1.9%	1.9%	55.7%	34,450

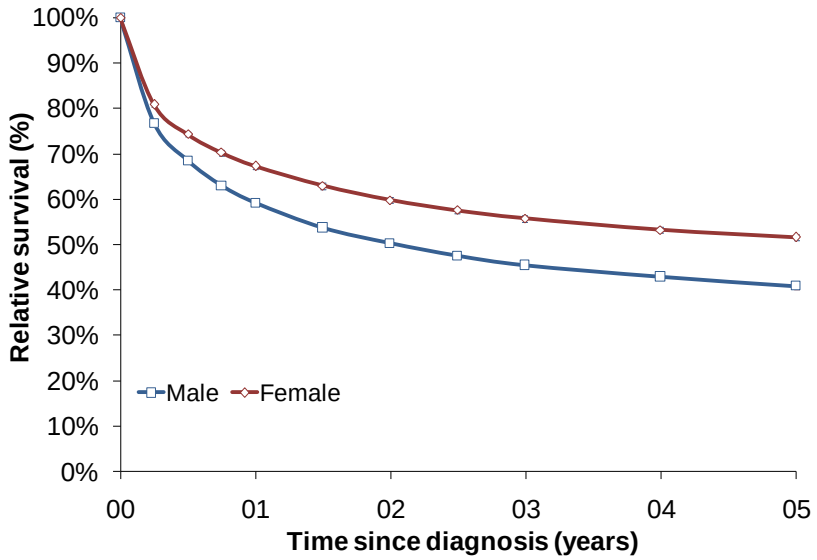
Notes: "Same cancer as diagnosis" refers to range of ICD10 codes dictated and not individual ICD10 codes.

Table refers to the number of patients. Some patients can have more than one tumour. In this event if the patient has died then the cancer diagnosis is taken to be the same as the cause of death. If the patient is alive at the end of 2006 then the cancer diagnosis is that of the first cancer diagnosed within 2002-2006. NMSC: Non-melanoma skin cancer

In addition to death from cancer 3.8% of cancer patients diagnosed during 2002-2006 died from a cause other than cancer. While some of these may be the result of side effects and worsening of general health as a result of any cancer, it highlights the need to take care when analysing patient survival and to only include deaths as a result of cancer. The preferred measure of survival, which is used in international studies, is thus relative survival which is the ratio of the survival of a given group of patients regardless of cause of death (known as observed survival) to the expected survival for a group of persons in the general population with the same characteristics (usually sex and age).

In Northern Ireland five-year relative survival for patients with cancer (excluding NMSC) diagnosed during 1998-2002 was 40.9% for males and 51.6% for females. While this seems like a considerable inequality between sexes this is due in the most part to a different range of cancers being diagnosed among males and females and different survival from gender specific cancers. (Fig. 20)

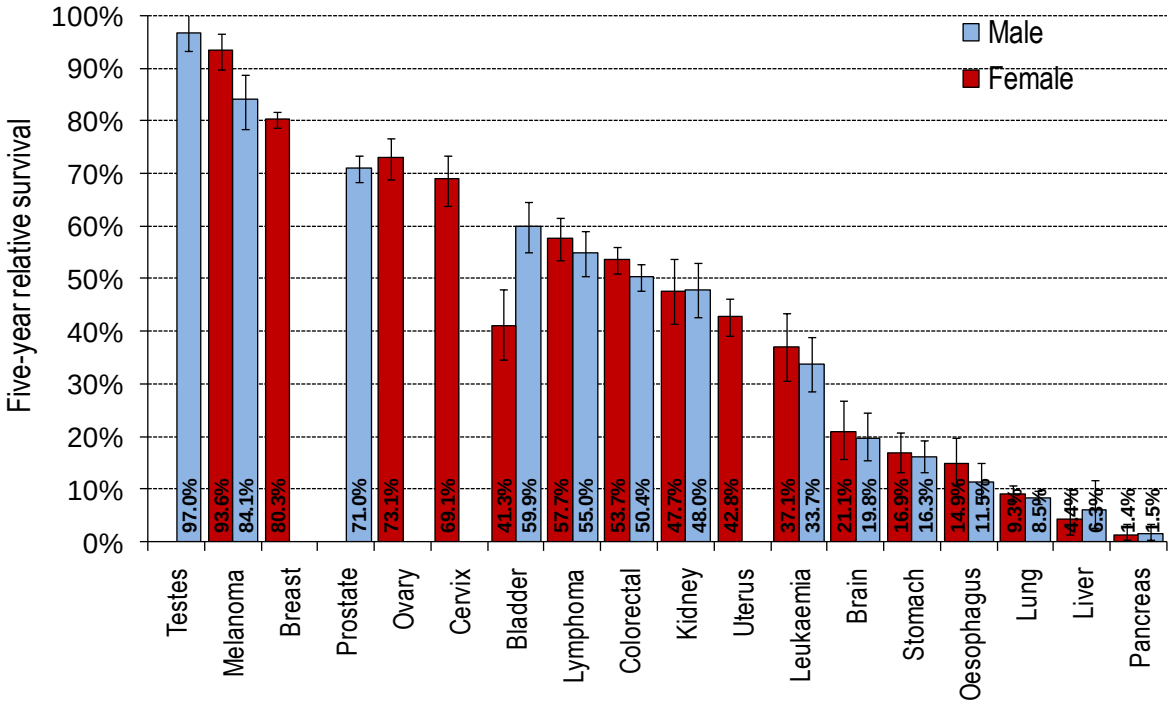
Figure 20: Survival of patients with cancer (ex. NMSC) by sex: 1998-2002
(Relative survival with follow up of patients to end 2007)



Survival varies considerably by cancer site with five-year relative survival for male patients diagnosed in 1998-2002 ranging from 1.5% for pancreatic cancer to 97.0% for testicular cancer. Among females five-year relative survival ranged from 1.4% for pancreatic cancer to 93.6% for malignant melanoma. Lung, liver, oesophageal, stomach and brain cancer also had very poor survival for both males and females, while five-year relative survival from male prostate cancer was over 70% compared to above 80% for female breast cancer. (Fig. 21)

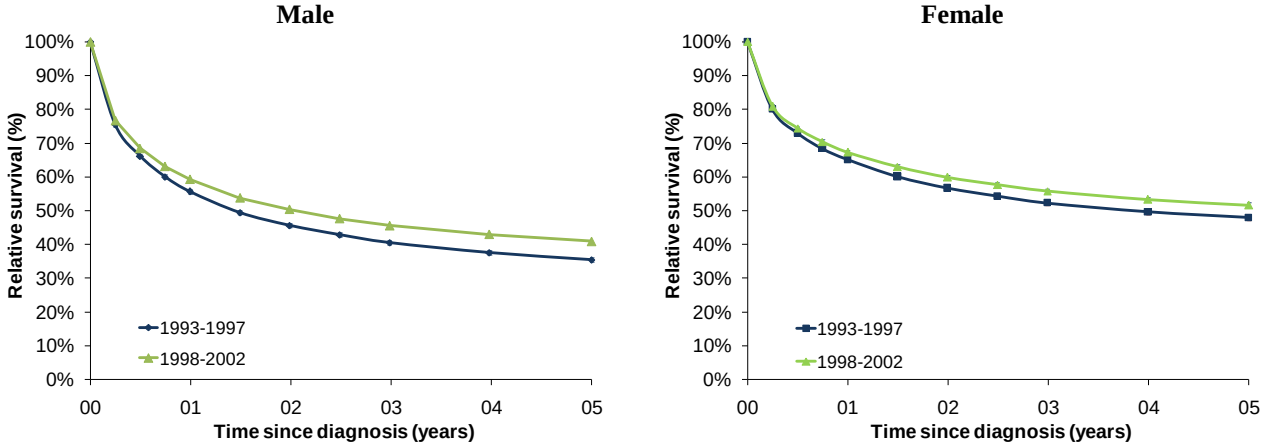
For most cancers five-year relative survival appeared higher among females than males, although few of these differences were statistically significant. The only cancer where survival was conclusively higher among females was malignant melanoma, while male survival from bladder cancer was higher than that for females. Survival from prostate cancer (the most common male cancer) was lower than that from breast cancer (the most common female cancer) for patients diagnosed in 1998-2002. (Fig. 21)

Figure 21: Survival of patients by sex and cancer site.
(Five-year relative survival with follow up of patients to end 2007)



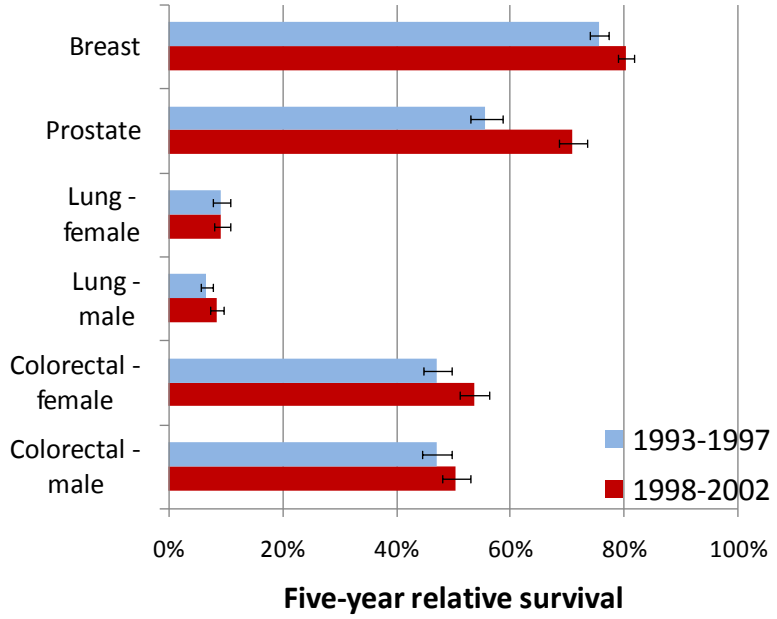
Fortunately survival in Northern Ireland is improving. Five-year relative survival for patients with cancer (ex. NMSC) improved by 5.5% for males and 3.8% for females between 1993-1997 and 1998-2002. This is in line with the reductions in mortality seen over recent years and is a result of increased detection at an earlier stage, better treatment and a reduction among men in the number of serious tobacco related cancers which have poor survival. (Fig. 22)

Figure 22: Survival of patients with cancer (excluding NMSC) by year: 1993-2002
(Relative survival with follow up of patients to end 2007)



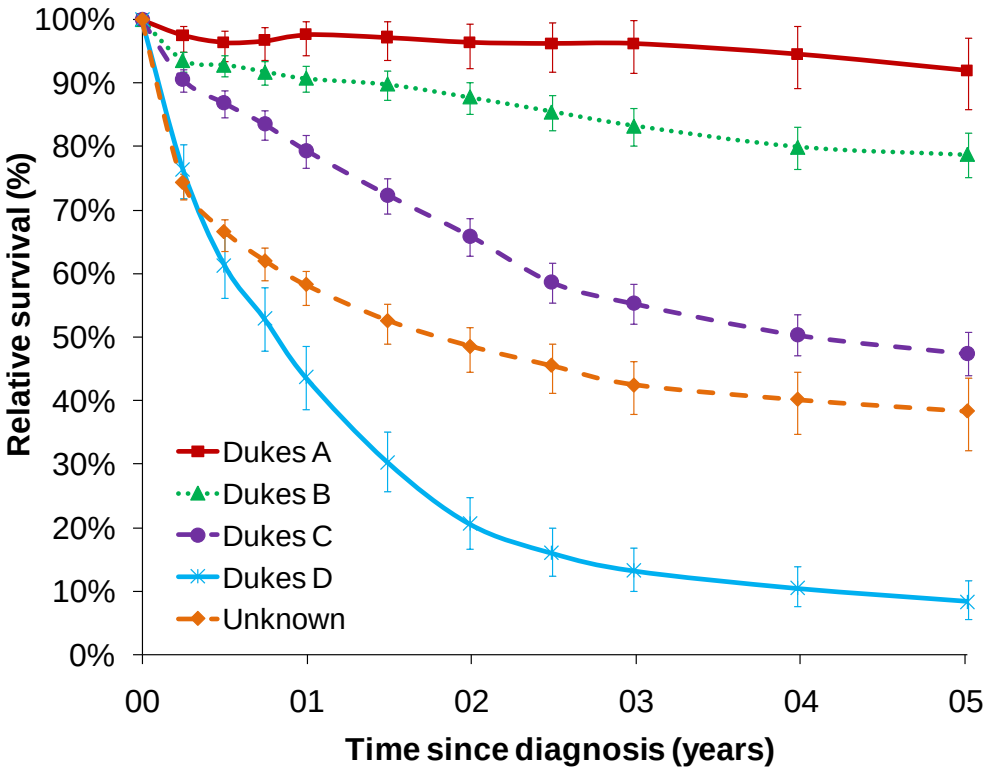
Examination of the improvement in survival by cancer site illustrates improvement in almost all forms of cancer. Although most apparent improvements were not statistically significant (e.g. for cervical cancer and lymphoma) three of the four most common cancers showed significant improvement. Five-year relative survival for patients diagnosed in 1998-2002 was higher than for those diagnosed in 1993-1997 by 6.4% for female colorectal cancer, 4.7% for female breast cancer and 15.3% for male prostate cancer. The latter was at least in part due to detection of an increased number of prostate cancers at an earlier stage and in younger men as a result of Prostate Specific Antigen (PSA) testing. Survival did not worsen for any cancer site. (Fig. 23)

Figure 23: Changes in survival over time for patients with cancer by sex for four main cancer sites, 1993-2002 (Five-year relative survival by sex, cancer site and period of diagnosis)



Further improvements in survival could be attained through earlier diagnosis as survival from cancer is highly related to the stage at diagnosis. Considering colorectal cancer as an example, five-year relative survival for patients diagnosed in 1998-2002 ranged from 92.0% at the earliest stage (Dukes Stage A) to 8.3% at the most severe stage (Dukes Stage D). A redistribution of cancer patients which moves more patients from the later to earlier stages could thus have a considerable impact on survival rates. (Fig. 24)

Figure 24: Survival of patients with colorectal cancer by stage at diagnosis: 1998-2002 (Relative survival with follow up of patients to end 2007)



12. DISCUSSION

The task of reducing levels of cancer mortality in Northern Ireland faces many challenges in the years ahead. The most rapidly changing factor affecting cancer incidence and mortality is the changing population size and age distribution. In 2008 the population was 1,775,003, a 14.5% increase since 1983. In addition the average age of the population in Northern Ireland is increasing with a rise in the percentage of the population aged 60 and over from 16.8% to 19.2% and a decrease in the percentage of the population aged under 15 from 26.0% to 20.0% between 1983 and 2008.[10] With the recent increase in the number of countries in the European Union also expected to result in a further increase in the population due to migration,[11] the annual number of cancer cases is set to rise.

As a result of this change in the population, the number of deaths from cancer in Northern Ireland is increasing. However, excluding age and population growth as a factor, cancer mortality rates have shown a slight decline, yet cancer incidence levels have steadily increased. Improvements in treatment, early and increased detection and successes and failures in cancer prevention all play a fundamental role in dictating these trends.

Further reduction in cancer mortality would be best achieved through prevention. Eradication of smoking, adoption of healthier diets along with regular exercise, maintenance of a health body weight and a reduction in the level of alcohol consumption would result in a considerable reduction in the number of deaths from cancer.[12] Considerable resources are invested into prevention programmes in Northern Ireland with the aim of educating people as to the connection between lifestyle factors and cancer (as well as other diseases). Some successes are apparent, in particular historical reductions in the levels of smoking[13] among men has resulted in a reduction in the number of cases and deaths from lung cancer. However many women, particularly young women, continue to smoke and risk serious disease. In addition, despite many attempts to alert the public to the benefits of a healthy diet and body weight, incidence of cancer of the uterus, a cancer strongly linked with obesity[14] is climbing very quickly.

More proactive approaches to combat exposure to lifestyle factors that increase the risk of developing cancer, such as smoking bans in work places and vaccinations against the HPV virus, also exist. These have the potential to reduce incidence and mortality of many cancers, particularly lung cancer by reducing exposure to second-hand cigarette smoke, and cervical cancer, the majority of which is caused by the HPV virus.[15]

Environmental factors such as ultraviolet (UV) and ionising radiation can also play a role in the development of cancer.[16,17] With regard to UV exposure the Northern Ireland Care in the Sun programme focuses on educating the public on the dangers of UV radiation from the sun or sunbeds. While these have proven moderately successful many sections of the community retain misconceptions about safety in the sun and fail to take adequate precautions and thus the incidence of melanoma, particularly among men, is increasing rapidly. Further effort in this area is thus required, with parents of young children and adolescents particularly in need of education as the skin damage which leads to melanoma in later life can result from sunburn in the first 20 years of life.[18]

The method by which many other cancers develop is still not clearly understood. In particular the lack of understanding of the causes of brain cancer, lymphoma, myeloma and leukaemia is a major hindrance to the development of prevention strategies for these diseases.

Eradication of cancer caused by lifestyle and environmental factors would still leave many cancers developing as a result of other causes (e.g. genetic factors). Early detection remains the best chance for mortality reduction among these cancers as the stage at which cancer is diagnosed is a major factor in survival. [19] Diagnosis of cancer at an early stage however can sometimes be difficult due to the lack of symptoms, or presence of vague symptoms; with many patients presenting at a late stage.

Screening programmes increase the possibility of early diagnosis and thereby reduce mortality. This is evidenced by the cervical cancer screening programme which exists in Northern Ireland for women aged 20-65 and is organised on a population basis. Three yearly population based screening for breast cancer among women aged 50-65 has been in place throughout Northern Ireland since 1993, and is due to be extended to women aged up to 69. A colorectal screening programme for people aged 60-69 is also being planned for introduction in 2010. There is no evidence yet about the effectiveness of screening for stomach cancer[20] while for prostate cancer the introduction of PSA testing has resulted in cancers being diagnosed at a point much closer to when the cancer first developed. However its effectiveness in reducing mortality rates is contested and an over diagnosis of less significant cancers is an unavoidable side effect.[21,22] No effective population based screening processes exist for many other forms of cancer, including lung cancer.[20]

Without the existence of an early diagnostic test for these cancers the onus is thus on the general population to ensure that they check any possible symptoms with a doctor.

Treatment of cancer is dictated by several factors including cancer site, tumour stage, general health, morphology, depth of tumour invasion and presence of metastasis. For most cancers surgery is the most effective form of treatment with chemotherapy, radiotherapy and hormone therapy applied to treat any residual disease or prevent recurrence. Not all cancer sites respond to these treatments. Hormone therapy is primarily used for prostate and breast cancer, while chemotherapy is rarely used for prostate cancer and surgery is not applicable for haematological cancer. For some cancers (e.g. lung cancer) these treatments are rarely curative and are applied mainly for palliative purposes with overall survival from the disease very poor. For other cancers (e.g. breast cancer) treatment can result in the patients being disease free with excellent survival particularly when the cancer is identified at an early stage.

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