# Deprivation and Cancer Survival in Scotland: Technical Report

## Foreword

We are delighted to publish the first report from the Macmillan Cancer Support partnership with the Information Services Division. This report looks at cancer survival in the most and least deprived communities in Scotland. Using the most up to date methods, it shows that people with cancer in the most deprived areas are significantly more likely to die from the illness than those in the least deprived areas. The report also goes a step further, carrying out the most comprehensive analysis ever completed in Scotland into the reasons behind the "cancer survival gap".

While the sheer number of factors that impact on survival means there is no magic bullet to solve the problem, this research points to where immediate action can be taken, including encouraging earlier diagnosis and the take up of screening in deprived areas.

The Scottish Government's cancer strategy, published in Spring 2016, recognised the need for action on cancer and deprivation. We hope this work will help inform its strategies and hope to work with them on this. We also hope this research sparks a renewed interest in the topic of cancer and deprivation and leads to more research in this area.

While this report sheds light on the reasons behind the cancer survival gap, it raises many questions. The research indicates that people in deprived communities are more likely to be diagnosed with advanced cancers. It also suggests that people from deprived communities with some cancers are less likely to receive surgery than those from the least deprived communities. However due to the limits of this research, we are unable to say why this happens.

Many questions remain. Are those from deprived communities less likely to recognise or seek help for symptoms? Are they less likely to be referred for tests? Are they less likely to receive surgery because their cancers are more advanced and less treatable? The answers to those questions will have a significant impact on how we tackle this problem.

There is also significant variation in survival between the most and least deprived groups that this research was not able to explain for some cancers. While lifestyle factors, which could not be included in this analysis due to data availability, would likely explain some of the gap, it is very unlikely to explain all of it. This means that despite accounting for the factors long believed to have an impact on cancer survival, those in deprived communities are still more likely on average to die from cancer. This is an area where further work is essential.

This report has taken our understanding of cancer and deprivation forward considerably and provides key insights that can be used to begin tackling the problem. We hope it is seen as a key milestone on the path to understanding and solving the cancer survival gap problem. While there is no doubt we are still a long way from the destination, it is vital for all those living in deprived communities in Scotland that we get there.

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# Executive Summary

The risk of death from cancer is influenced by a number of factors and in this analysis we have concentrated on the effect of deprivation (as measured by the Scottish Index of Multiple Deprivation-SIMD, with SIMD 1 the most deprived area to SIMD 5 the least deprived area). As a first stage net survival was calculated by deprivation quintile for the most common twenty cancers in Scotland. Of these, evidence of statistically significant differences between deprivation groups were observed in nine cancers (lung, breast, prostate, colorectal, head and neck, malignant melanoma of skin, oesophageal, liver and thyroid). For eight of these cancers further exploration was determined to be worthwhile. This was based on statistically significant differences between the most and least deprived groups and /or on evidence of a linear trend across all deprivation quintiles. The eight cancers were:

| | |
|---|---|
| Breast | Colorectal |
| Head and Neck | Liver |
| Lung | Melanoma of Skin |
| Oesophageal | Prostate |

Statistical modelling on a ninth cancer (thyroid cancer) was not possible due to small numbers.

These cancers were first modelled by deprivation group and the corresponding survival estimates compared. The differences in the hazard of death and the excess mortality rate were compared for all deprivation groups to those in the least deprived group (at baseline). The cancers were then analysed to determine the hazard of death whilst taking into account additional information – separately and then in combination. The additional factors vary by cancer, but typically include information on the patient (e.g. existing co-morbidities) the tumour (e.g. tumour grade or stage, evidence of metastases) and treatments (e.g. use of surgery, radiotherapy).

For some of the cancers analysed there were no differences in survival by deprivation; for other cancer types there were differences in survival by deprivation, but the other factors investigated account for the variation seen. For example, it may be that higher stage tumours or complexity of additional co-morbidities are contributing to lower survival in particular deprivation groups, but once these are controlled for, any statistically significant difference is no longer evident. For a final set of cancers, the factors were not able to explain all the variation in survival by deprivation.

If the impact of deprivation is explained by other factors then improving these other factors may still help with reducing inequalities. For example, if the differences are explained by variation in stage at diagnosis then interventions such as early detection awareness may improve the ability to detect cancer at an earlier stage and hence reduce differences in survival. Any unexplained variation is likely to be due to factors not accounted for in the model (e.g. smoking or access to care), measurement error, or a range of other issues, such as differing expectations of health services and support.

1. **Cancers where the difference by deprivation is accounted for through statistical modelling**

Both **malignant melanoma of skin** and **oesophageal cancer** displayed the weakest association with deprivation of the cancers investigated and, when compared to the least deprived group, any statistically significant differences in the most deprived groups were explained away. For melanoma

of skin, SIMD2 is significantly higher than the least deprived, but becomes non-significant when adjusted for patient and tumour characteristics.

Both **liver** and **lung** cancer analysis at baseline suggested significant differences between SIMD1 (and SIMD2 for lung cancer) and SIMD5 (least deprived). By factoring in patient, tumour, and treatment characteristics, these differences become non-significantly different to the least deprived group. In essence, the impact of deprivation on people's survival from these cancers is linked to the factors added to the model.

2. **Cancers where the difference by deprivation is <u>not</u> accounted for through statistical modelling**

For **prostate**, **breast**, **head & neck** and **colorectal cancers**, hazard ratios at baseline increase with increasing deprivation. When adjusted, the effect of deprivation is diminished but is still present, suggesting the remaining difference is a result of factors not accounted for (for example, smoking status) or measurement error (the difference between a measured value of quantity and its true value) in those used (e.g. Charlson index as a measure of co-morbidity).

# Introduction

The purpose of this report is to explore survival outcomes by deprivation for the most commonly diagnosed cancers in Scotland and to consider the influence of a number of factors.

In 2014, excluding non-melanoma skin cancer, there were just under 32,000 people in Scotland diagnosed with cancer[1]. While for many cancers, survival rates are improving over time, a deprivation gap still exists[2]. Overall, the age-standardised incidence rate of cancer is higher in those living in deprived communities than those living in the least deprived areas (757.8 per 100,000 compared with 579.0 per 100,000).

Of all cancers diagnosed in the five year period 2010-2014, 21.3% were in the most deprived quintile, so marginally higher than might be expected. However, for the same period, the proportion of deaths for the most deprived quintile was 23.6%.

This suggests people living in deprived communities are dying from cancer at a higher rate. This trend is also seen at UK level - recent Macmillan UK research finds that a higher proportion of cancer survivors are resident in the least deprived areas[3]. The type of cancer diagnosed in the different deprivation groups may account for some of this difference. For example, there are higher rates of better prognosis cancers in the least deprived groups (e.g. female breast cancer) and higher rates of poorer prognosis cancers in the most deprived groups (e.g. lung cancer).

An examination of incidence rates by deprivation for 2009-2013 in Scotland suggests that breast, prostate cancer and malignant melanoma of the skin all appear to have higher rates in the least deprived areas, whereas lung, head & neck, and cervical cancer have higher rates observed in the most deprived areas. Other cancers, such as colorectal or non-Hodgkins lymphoma appear to have no clear patterning by deprivation. However, patterns of survival by deprivation may differ to those of incidence. As a result, it is of most value to examine the survival of different deprivation groups for each cancer separately.

This work analyses one and five year survival by deprivation for the most commonly diagnosed twenty cancers in Scotland. These twenty cancers make up 93% of all the cancers diagnosed in 2013 and 89% of those diagnosed in 2014. Previous work carried out in Scotland[4] examined 5-year survival from the 18 most common cancers and found survival to be lower in those who lived in deprived areas. In addition, it was found that inequality in survival worsened over the period studied (1986-2000).

In March 2016 the Scottish Government published 'Beating Cancer: Ambition and Action' which acknowledges that, "The gap between least and most deprived areas is projected to continue to widen and action therefore needs to be taken to reverse this." To this end, nine action points were

[1] www.isdscotland.org/cancer
[2] https://www.isdscotland.org/Health-Topics/Cancer/Publications/2016-10-25/dim_cancer_all_types.xls
[3] http://www.macmillan.org.uk/_images/exploring-patterns-of-deprivation-for-people-living-with-cancer_tcm9-297571.pdf
[4] Shack LG, Rachet B, Brewster DH, Coleman MP. Socioeconomic inequalities in cancer survival in Scotland 1986-2000. *British Journal of Cancer*. 2007; 97(7): 999–1004.

devised specifically around improving survival, including significant investment in activities targeting outcomes by addressing health inequalities.

Consequently, in this report we provide updated information using the latest methodologies on survival outcomes by deprivation quintile for the most commonly diagnosed cancers in Scotland. Where significant differences in outcomes between deprivation groups are detected, further analysis is conducted to ascertain if these differences can be explained by patient and tumour characteristics at diagnosis or by treatment characteristics.

# Methodology

## Background

This chapter outlines the methodological approach for analysing survival by deprivation in the twenty most common cancers in Scotland. The cancers for inclusion were based on incidence levels in 2013 of malignant neoplasms (tumours that invade into surrounding tissues), which are conditions listed under anatomic site code numbers C00 to C97 in the International Classification of Diseases, Tenth Revision (ICD-10). More details on the cancers included can be found in the Results Chapter.

Methodological decisions were primarily based on the United Kingdom and Ireland Association of Cancer Registries (UKIACR) Standard Operating Procedure (SOP): Guidelines on Population Based Cancer Survival Analysis[5]. Further clarity was sought from the London School of Hygiene and Tropical Medicine[6] (LSHTM) on points that were more specific to this analysis.

## Net Survival

For a long time, survival analysis has been applied when studying time in relation to a particular event, in this case, death following a diagnosis of particular types of cancer. Net survival is the estimate of survival based only on the risk of death from the cancer in question and therefore compensates for the risk of death from other causes (i.e. the background mortality).

The UKIACR SOP suggests that the Pohar-Perme[7] is an unbiased estimator of net survival and should be used instead of the conventional relative survival. Net survival with this estimator deals well with the so-called "informative censoring" bias, i.e. the fact that some groups of patients are less likely than others to be observed until death, independently of their cancer prognosis.

Net survival is usually expressed as a percentage in the range 0% to 100%. Cancers and periods of follow-up have only been included where sufficient data are available to proceed with the analysis. Survival estimates can be unstable in some circumstances, for example, where the incidence of a particular cancer is low or where the number of patients at risk drops rapidly over time.

# Methodology for net survival analysis by deprivation

**What approach to net survival is taken?**

Net survival is estimated using the publicly available **stns** algorithm[8] in STATA 13 software.

**What time period and deprivation measure are used?**

[5] http://www.ukiacr.org/publication/guidelines-population-based-cancer-survival-analysis
[6] The Cancer Survival Group at LSHTM are seen as experts in the field of Cancer Survival and have collaborated with ONS and the CONCORD study.
[7] Pohar Perme M, Stare J, Estève J. On estimation in relative survival. *Biometrics*. 2012; 68:113-20.
[8] Clerc-Urmès I, Grzebyk M, Hédelin G. Net survival estimation with stns. *Stata Journal*. 2014;14:87-102

LSHTM advice is geared towards including those diagnosed with cancer relatively recently and avoiding periods which incorporate major changes (e.g. screening programmes, other detection methods and coding redefinitions).

One and five year survival was calculated for cancers diagnosed in the period 2004-2008.

One year survival was calculated for cancers diagnosed in the period 2009-2013.

SIMD 2009[9] was identified as the most appropriate deprivation measure for the time periods analysed.

**When are numbers too low to perform analysis?**

For some cancers, numbers are relatively low in each year, which means that analysis results may be unreliable when stratified by sex and deprivation. In these cases, several years' data have been aggregated to overcome this limitation. This aligns with previous work carried out in Scotland on socioeconomic inequalities in cancer survival[10] and with both Public Health England (PHE) and Information Services Division (ISD) published survival estimates.

For rare cancers where registrations and/or deaths may be low as more detailed levels are added to the analysis, the following rules were applied (provided by LSHTM):

1. Only report survival at time T if there are ten patients alive at T and if there were at least five events (i.e. deaths) in either the period before or the period after T.

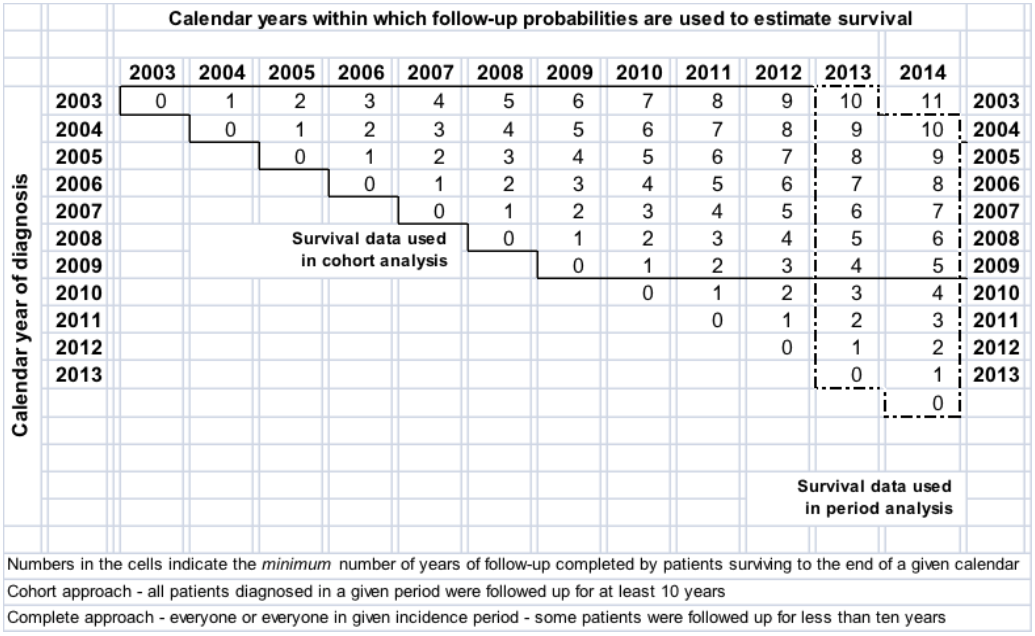
2. Additionally, at least one event should have occurred in the two years before T.

3. Do not report ten year survival for the 70-90 year old patients as net survival does not work well for long-term survival of older patients due to very large weightings applied to a very small number of patients.

Where these rules were not adhered to, no analysis was carried out.

[9] http://www.gov.scot/Topics/Statistics/SIMD/Background-Data-2009
[10] http://researchonline.lshtm.ac.uk/9060/

**What approach is taken to estimate net survival?**




| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 2003 |
| 2004 | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 2004 |
| 2005 | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 2005 |
| 2006 | | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 2006 |
| 2007 | | | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 2007 |
| 2008 | | | | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 2008 |
| 2009 | | | | | | | 0 | 1 | 2 | 3 | 4 | 5 | 2009 |
| 2010 | | | | | | | | 0 | 1 | 2 | 3 | 4 | 2010 |
| 2011 | | | | | | | | | 0 | 1 | 2 | 3 | 2011 |
| 2012 | | | | | | | | | | 0 | 1 | 2 | 2012 |
| 2013 | | | | | | | | | | | 0 | 1 | 2013 |
| | | | | | | | | | | | | 0 | |

Source: http://www.ukiacr.org/publication/guidelines-population-based-cancer-survival-analysis

***Figure 1: Illustration of approaches for estimation net survival***

The UKIACR SOP[11] details a number of approaches that can be used to estimate survival, which are summarised in the diagram above. The 'cohort approach' was deemed the most suitable as it means that patients were followed up over the entire interval of interest (either one or five years) and additionally, the results are easier to interpret and explain.

**How are cases identified to include in the analysis?**

Traditionally, in calculating net survival estimates, only records for patients with no other cancers diagnosed within the period of interest have been included in any analysis. Increasingly this approach is changing to include patients who may have had other primary cancers recorded within the period of interest. This approach is primarily being adopted by large international studies where direct comparisons in net survival are being made between cancer registries (which are likely to have been collecting data for different periods of time). However, some research[12] has shown that estimates including and excluding multiple primaries show little variation in their results.

[11] http://www.ukiacr.org/publication/guidelines-population-based-cancer-survival-analysis

[12] Rosso S, De Angelis R, Ciccolallo L, Carrani E, Soerjomataram I, Grande E, Zigon G, Brenner H; EUROCARE Working Group. Multiple tumours in survival estimates. *Eur J Cancer*. 2009; 45: 1080-94.

In following the UKIACR SOP recommended practices, patients who may have had multiple primaries are included on the following basis:

- patients who had multiple primaries are flagged
- the records of the subsequent primaries were excluded when all cancers together (using the first identified cancer) were analysed
- patients who had a primary prior to the period of interest were included but records for these previous primaries were not included in the analysis

This was based on cancer groupings (e.g. only the first instance of C18, C19 or C20 would be included in a calculation of colorectal survival).

**Inclusions and Exclusions**

Inclusions

1. Patients aged between 15 and 99 years old
2. Patients with multiple primary tumours in the period of diagnosis (e.g. 2004-2008) with eligible topography code (based on diagnosis date of first primary tumour)
3. Invasive, primary and malignant behaviour code tumours
4. Patients with zero follow-up time (i.e. patients known to have died on the same day as they were diagnosed)

Exclusions

1. Death Certificate Only (DCO) registrations and those diagnosed for the first time at autopsy
2. Missing or imputed sex, date of diagnosis, date of birth, age, deprivation

This is based on UKIACR recommendations.

**What life tables are used?**

Deprivation category-specific Scottish life tables (2003 – 2011) were provided to ISD by LSHTM and 2011 life table information was applied to 2012-2013 cases.

In constructing the tables, the death/population data were mapped onto population weighted quintiles. To construct the life tables for 2001, deprivation was assigned using SIMD 2004[13] and for 2011, SIMD 2012[14] was used. Interpolation was used to construct the life tables for the intercensal years (i.e. not 1991, 2001 or 2011). A deprivation variable ('dep') is included in the tables.

**Age weighting**

[13] http://www.gov.scot/Publications/2004/06/19421/38085
[14] http://simd.scotland.gov.uk/publication-2012/

Survival estimates are age-standardised to allow the comparison of survival between cancers with a different age profile. The weights used to age-standardise are ICSS weights as detailed in Coleman et al[15].

Where numbers breached the criteria given in relation to low numbers, age-groups were combined to provide robust enough numbers for standardisation for certain cancers. This is indicated in the output.

**What do the confidence intervals show?**

Confidence intervals indicate how sure we can be about the precision of the estimate. A 95% confidence interval is a measure of the uncertainty around the estimate. It gives a range of values, within which lies the true population parameter with a 95% level of confidence.

**How were differences in survival between deprivation groups identified?**

Initially, statistically significant differences were identified between the most and least deprived groups by inspecting the confidence intervals around age-standardised net survival estimates. In addition, a linear test for trend by deprivation was carried out using Poisson regression.

## Methodology for multivariate analysis of cancer sites where significant differences were found by deprivation

**What approach to multivariate analysis was taken?**

The program stpm2[16] within STATA 13 was used to model the impact of different factors on survival.

Reference categories for tumour and treatment related characteristics were identified for categorical variables to be the best outcome and for continuous variables as the average (see Appendix C for more details).

Only the earlier cohort (2004-2008) was included in the multivariate analysis to allow up to five years survival.

**Covariates of interest**

The full list of variables looked at are in Table 1 and were broadly classified within the following groupings:

- Personal characteristics (e.g. age, sex)
- Tumour specific characteristics (e.g. stage at diagnosis, grade of differentiation)

[15] Coleman MP, Babb P, Damiecki P, Grosclaude PC, Honjo S, Jones J, et al. *Cancer survival trends in England and Wales 1971-1995: deprivation and NHS Region. (Studies on Medical and Population Subjects No. 61)*. London: The Stationery Office; 1999.
[16] Lambert PC, Royston P. Further development of flexible parametric models for survival analysis. *The Stata Journal*. 2009; 9(2): 265-290.

- Health services related (e.g. detected through screening, treatment)

***Table 1: Factors included for each cancer***

| Cancer | Trachea, bronchus and lung | Female Breast | Colorectal | Prostate | Head and neck | Malignant melanoma of the skin | Oesophageal | Liver |
|---|---|---|---|---|---|---|---|---|
| **ICD-10 Code** | C33 - C34 | C50 | C18-C20 | C61 | C00-C14, C30-C32 | C43 | C15 | C22 |
| **Cases included** | 23835 | 19917 | 17630 | 13818 | 5162 | 4937 | 4167 | 1765 |
| **Personal Characteristics** | | | | | | | | |
| Gender | X | | X | | X | X | X | X |
| Age (average) | 72 | 67 | 75 | 75 | 67 | 65 | 72 | 72 |
| Charlson index of co-morbidity * | X | X | X | X | X | X | X | X |
| Inpatient bed days ** | X | X | X | X | X | X | X | X |
| **Tumour-related** | | | | | | | | |
| Grade of differentiation | X | X | X | | X | | X | X |
| TNM Stage | X | X | | | | | | |
| Dukes' stage | | | X | | | | | |
| Gleason Score | | | | X | | | | |
| Clark Level | | | | | | X | | |
| Breslow Thickness | | | | | | X | | |
| Clinical Extent of disease *** | X | | | | | | | |
| Metastases within 4 months | | | | X | X | X | X | X |
| ER Status | | X | | | | | | |
| Small Cell | X | | | | | | | |
| Tumour morphology **** | | X | X | | | X | X | X |
| Site/Subsite | | | | | X | X | X | X |
| **Health service-related** | | | | | | | | |
| Screen-detected | | X | X | | | | | |
| Clinical trial | | X | | | | | | |
| Surgery | X | X | X | X | X | | X | X |
| Radiotherapy | X | X | X | X | X | | X | |
| Chemotherapy | X | X | X | | X | | X | X |
| Hormonal Therapy | | X | | X | | | | |

* Co-morbidities between date of diagnosis and five years previous

** Inpatient bed days between 6 months and five years prior to date of diagnosis

***A simple classification of disease stage into 3 broad categories: localised; regional spread; and distant metastases

****Morphology and behaviour codes are defined by the International Classification of Diseases for Oncology, Second Edition (ICD-0-2).

## Interactions

It is possible that some of the explanatory variables could be interdependent in terms of their impact on the excess hazard of mortality. After testing for the interdependence of some factors (interactions) in the first few cancers, it was found that these models did little to explain more variance in the model. Adding these interaction terms to the model also added complexity to the analysis and interpretation and so it was decided interaction terms would not be included.

## What are excess hazard ratios and what do they mean?

**A hazard ratio** (HR) is a measure of **an effect** on **an outcome** of interest over time. Hazard ratios are often used when reporting survival. In the analysis here, the excess hazard ratio (i.e. the ratio of excess hazards) is the excess hazard of death from the cancer in question in the most deprived group divided by the excess hazard of death from the cancer in question in the least deprived group.

The Excess Hazard Ratio (EHR) is a ratio which is explained below:

EHR = 0.5: at any particular time, half the patients in the group of interest are experiencing an event compared to a reference group.

EHR = 1: at any particular time, even rates are the same in both groups,

EHR = 2: at any particular time, twice as many patients in the group of interest are experiencing an event compared to the reference group (e.g. people in the most deprived group (SIMD1, the group of interest) are twice as likely to die from cancer compared to the reference group (SIMD 5)).

Here, the excess hazard ratio (or excess mortality) is a measure of the mortality due to the cancer in question over and above the expected mortality. Expected mortality is derived from population life tables constructed by single years of age (0-99 years) and single calendar year, sex and deprivation category for the entire population of Scotland.

# Results

## Survival by deprivation: 20 most common cancers

Table 2 shows the one and five year net survival for males and females separately for the 20 most common cancers in Scotland during 2004-2008, ordered by most common. One year survival figures for the period 2009-2013 were also produced and are available in Appendix A. The period of 2004-2008 was used for all further survival and multivariate analysis due to completeness, number of cases identified, and the ability to look at five years survival. The numbers on which these survival figures are produced are available in Appendix B.

***Table 2. Cancer survival for the top 20 most common cancers in males and females by 1-year and 5-year survival and deprivation (SIMD), Scotland, 2004-2008.***

| | | Males | | | | | | Females | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1-year Survival (M) | | | 5-year Survival (M) | | | 1-year Survival (F) | | | 5-year Survival (F) | | |
| Cancer | Deprivation | Survival (%) | *95% CI* | | Survival (%) | *95% CI* | | Survival (%) | *95% CI* | | Survival (%) | *95% CI* | |
| Lung[2] | 1 (most deprived) | 27 | 24 | 31 | 7 | 5 | 9 | 33 | 30 | 37 | 10 | 8 | 13 |
| | 2 | 28 | 24 | 31 | 8 | 6 | 10 | 33 | 29 | 37 | 9 | 7 | 12 |
| | 3 | 32 | 28 | 36 | 10 | 7 | 13 | 35 | 30 | 39 | 10 | 7 | 13 |
| | 4 | 32 | 27 | 37 | 10 | 6 | 13 | 34 | 29 | 39 | 11 | 8 | 15 |
| | 5 (least deprived) | 34 | 28 | 39 | 11 | 7 | 15 | 37 | 31 | 43 | 12 | 8 | 16 |
| Breast (female)[1] | 1 (most deprived) | | | | | | | 91 | 89 | 94 | 76 | 72 | 80 |
| | 2 | | | | | | | 94 | 92 | 95 | 79 | 75 | 82 |
| | 3 | | | | | | | 94 | 92 | 95 | 80 | 77 | 84 |
| | 4 | | | | | | | 95 | 93 | 96 | 81 | 78 | 85 |
| | 5 (least deprived) | | | | | | | 96 | 94 | 97 | 85 | 82 | 89 |
| Colorectal[1] | 1 (most deprived) | 71 | 66 | 75 | 49 | 43 | 55 | 72 | 67 | 77 | 50 | 43 | 57 |
| | 2 | 75 | 70 | 80 | 54 | 48 | 60 | 75 | 71 | 80 | 53 | 47 | 60 |
| | 3 | 77 | 72 | 81 | 55 | 49 | 61 | 76 | 71 | 81 | 58 | 51 | 64 |
| | 4 | 77 | 72 | 82 | 56 | 50 | 63 | 78 | 73 | 82 | 57 | 50 | 63 |
| | 5 (least deprived) | 82 | 77 | 86 | 59 | 53 | 65 | 79 | 75 | 84 | 62 | 55 | 68 |
| Prostate[2] | 1 (most deprived) | 95 | 91 | 98 | 79 | 72 | 86 | | | | | | |
| | 2 | 95 | 91 | 98 | 80 | 74 | 86 | | | | | | |
| | 3 | 94 | 90 | 97 | 81 | 75 | 87 | | | | | | |
| | 4 | 97 | 95 | 99 | 89 | 85 | 93 | | | | | | |
| | 5 (least deprived) | 97 | 95 | 99 | 89 | 85 | 93 | | | | | | |
| Head and Neck[3] | 1 (most deprived) | 69 | 63 | 74 | 43 | 37 | 50 | 74 | 66 | 81 | 47 | 38 | 56 |
| | 2 | 74 | 69 | 80 | 49 | 42 | 57 | 74 | 66 | 82 | 50 | 40 | 60 |
| | 3 | 75 | 69 | 81 | 51 | 43 | 59 | 76 | 67 | 85 | 57 | 46 | 68 |
| | 4 | 80 | 73 | 86 | 58 | 49 | 67 | 82 | 75 | 90 | 64 | 53 | 76 |
| | 5 (least deprived) | 80 | 73 | 87 | 60 | 51 | 70 | 79 | 68 | 90 | 64 | 49 | 80 |
| Malignant Melanoma of the Skin[4] | 1 (most deprived) | 92 | 87 | 98 | 76 | 65 | 86 | 95 | 91 | 99 | 85 | 77 | 93 |
| | 2 | 93 | 88 | 98 | 75 | 66 | 85 | 98 | 95 | 100 | 91 | 84 | 98 |
| | 3 | 95 | 91 | 99 | 82 | 73 | 91 | 96 | 93 | 99 | 90 | 84 | 96 |
| | 4 | 96 | 92 | 100 | 87 | 78 | 96 | 97 | 94 | 100 | 93 | 86 | 100 |
| | 5 (least deprived) | 97 | 94 | 100 | 87 | 81 | 94 | 98 | 96 | 100 | 91 | 84 | 97 |
| Non-Hodgkin's Lymphoma[3] | 1 (most deprived) | 68 | 61 | 76 | 55 | 45 | 64 | 73 | 66 | 80 | 62 | 53 | 71 |
| | 2 | 68 | 61 | 75 | 52 | 43 | 61 | 77 | 71 | 84 | 59 | 51 | 68 |
| | 3 | 77 | 70 | 84 | 62 | 52 | 71 | 80 | 74 | 86 | 64 | 56 | 72 |
| | 4 | 76 | 70 | 83 | 62 | 53 | 71 | 80 | 74 | 87 | 65 | 56 | 73 |
| | 5 (least deprived) | 75 | 68 | 82 | 62 | 53 | 70 | 80 | 74 | 86 | 67 | 58 | 76 |
| Kidney[3] | 1 (most deprived) | 64 | 56 | 72 | 43 | 33 | 52 | 63 | 54 | 73 | 49 | 38 | 59 |
| | 2 | 68 | 60 | 75 | 47 | 38 | 56 | 60 | 51 | 69 | 46 | 36 | 56 |
| | 3 | 68 | 60 | 75 | 51 | 42 | 60 | 64 | 54 | 74 | 46 | 35 | 57 |
| | 4 | 71 | 64 | 79 | 50 | 41 | 59 | 65 | 56 | 75 | 49 | 39 | 59 |
| | 5 (least deprived) | 70 | 62 | 77 | 47 | 38 | 56 | 69 | 59 | 79 | 54 | 41 | 66 |
| Oesophagus[3,4] | 1 (most deprived) | 37 | 30 | 43 | 10 | 6 | 15 | 37 | 28 | 46 | 10 | 5 | 16 |
| | 2 | 37 | 30 | 44 | 10 | 5 | 14 | 39 | 31 | 47 | 14 | 8 | 20 |
| | 3 | 40 | 33 | 47 | 11 | 6 | 16 | 37 | 28 | 45 | 10 | 4 | 16 |
| | 4 | 41 | 33 | 49 | 10 | 5 | 15 | 42 | 33 | 51 | 18 | 11 | 26 |
| | 5 (least deprived) | 42 | 34 | 51 | 12 | 7 | 18 | 44 | 33 | 55 | 18 | 9 | 26 |
| Bladder[3] | 1 (most deprived) | 69 | 62 | 77 | 48 | 38 | 57 | 60 | 50 | 70 | 36 | 25 | 47 |
| | 2 | 74 | 67 | 82 | 53 | 43 | 62 | 59 | 49 | 69 | 35 | 25 | 45 |
| | 3 | 74 | 67 | 81 | 52 | 43 | 61 | 65 | 54 | 77 | 41 | 28 | 54 |
| | 4 | 76 | 69 | 83 | 51 | 41 | 61 | 65 | 53 | 77 | 44 | 30 | 57 |
| | 5 (least deprived) | 81 | 74 | 88 | 54 | 43 | 64 | 72 | 61 | 83 | 43 | 28 | 58 |
| Pancreas[4] | 1 (most deprived) | 14 | 9 | 19 | 2 | 0 | 4 | 16 | 11 | 22 | 4 | 1 | 7 |
| | 2 | 15 | 9 | 20 | 3 | 0 | 5 | 17 | 11 | 23 | 2 | 0 | 5 |
| | 3 | 19 | 13 | 26 | 5 | 1 | 9 | 20 | 13 | 27 | 4 | 1 | 8 |
| | 4 | 21 | 14 | 27 | 4 | 0 | 7 | 19 | 12 | 26 | 4 | 1 | 8 |
| | 5 (least deprived) | 18 | 11 | 25 | 4 | 1 | 7 | 22 | 14 | 30 | 4 | 0 | 7 |
| Corpus uteri[3] | 1 (most deprived) | | | | | | | 85 | 79 | 90 | 70 | 62 | 78 |
| | 2 | | | | | | | 86 | 81 | 91 | 69 | 62 | 77 |
| | 3 | | | | | | | 88 | 84 | 93 | 75 | 68 | 82 |
| | 4 | | | | | | | 86 | 81 | 91 | 75 | 68 | 82 |
| | 5 (least deprived) | | | | | | | 89 | 85 | 94 | 77 | 69 | 84 |

| | | Males | | | | | | Females | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Survival | | | | | | | | | | | |
| | | 1-year Survival (M) | | | 5-year Survival (M) | | | 1-year Survival (F) | | | 5-year Survival (F) | | |
| Cancer | Deprivation | Survival (%) | *95% CI* | | Survival (%) | *95% CI* | | Survival (%) | *95% CI* | | Survival (%) | *95% CI* | |
| **Stomach**[3] | **1 (most deprived)** | 39 | 33 | 46 | 15 | 10 | 20 | 38 | 29 | 47 | 16 | 9 | 23 |
| | **2** | 39 | 31 | 46 | 16 | 10 | 22 | 41 | 31 | 51 | 17 | 9 | 25 |
| | **3** | 36 | 28 | 44 | 17 | 10 | 23 | 40 | 29 | 51 | 18 | 9 | 27 |
| | **4** | 41 | 32 | 50 | 12 | 5 | 18 | 43 | 33 | 54 | 16 | 8 | 25 |
| | **5 (least deprived)** | 47 | 37 | 57 | 19 | 12 | 27 | 45 | 33 | 58 | 24 | 13 | 35 |
| **Liver**[4] | **1 (most deprived)** | 21 | 14 | 27 | 6 | 2 | 10 | 30 | 18 | 41 | 8 | 1 | 15 |
| | **2** | 29 | 21 | 37 | 9 | 4 | 15 | 26 | 15 | 37 | 8 | 1 | 15 |
| | **3** | 32 | 23 | 41 | 12 | 5 | 19 | 24 | 13 | 36 | 8 | 1 | 15 |
| | **4** | 33 | 24 | 43 | 18 | 9 | 27 | 25 | 13 | 37 | 7 | 0 | 14 |
| | **5 (least deprived)** | 37 | 26 | 48 | 8 | 2 | 14 | 38 | 22 | 54 | 15 | 3 | 27 |
| **Ovary**[2] | **1 (most deprived)** | | | | | | | 65 | 58 | 73 | 36 | 29 | 44 |
| | **2** | | | | | | | 65 | 59 | 72 | 38 | 31 | 46 |
| | **3** | | | | | | | 68 | 61 | 75 | 37 | 30 | 45 |
| | **4** | | | | | | | 69 | 62 | 76 | 40 | 32 | 47 |
| | **5 (least deprived)** | | | | | | | 73 | 67 | 79 | 41 | 33 | 49 |
| **Leukaemia**[3] | **1 (most deprived)** | 68 | 59 | 76 | 44 | 33 | 54 | 70 | 60 | 79 | 58 | 46 | 70 |
| | **2** | 73 | 65 | 81 | 48 | 38 | 58 | 68 | 59 | 77 | 54 | 43 | 65 |
| | **3** | 76 | 69 | 83 | 53 | 43 | 62 | 69 | 60 | 78 | 54 | 43 | 65 |
| | **4** | 76 | 69 | 83 | 60 | 51 | 70 | 72 | 62 | 81 | 52 | 40 | 64 |
| | **5 (least deprived)** | 72 | 63 | 80 | 57 | 47 | 67 | 72 | 62 | 82 | 54 | 42 | 65 |
| **Brain and CNS**[5] | **1 (most deprived)** | 30 | 23 | 37 | 9 | 5 | 14 | 27 | 19 | 35 | 11 | 5 | 17 |
| | **2** | 26 | 19 | 32 | 7 | 3 | 11 | 23 | 16 | 30 | 11 | 6 | 16 |
| | **3** | 27 | 20 | 34 | 10 | 5 | 14 | 25 | 17 | 32 | 8 | 3 | 13 |
| | **4** | 31 | 24 | 37 | 10 | 5 | 15 | 31 | 23 | 39 | 12 | 6 | 18 |
| | **5 (least deprived)** | 31 | 24 | 38 | 11 | 6 | 15 | 34 | 26 | 43 | 13 | 7 | 19 |
| **Cervix**[4] | **1 (most deprived)** | | | | | | | 76 | 71 | 82 | 57 | 50 | 64 |
| | **2** | | | | | | | 78 | 72 | 84 | 60 | 53 | 67 |
| | **3** | | | | | | | 81 | 74 | 88 | 59 | 51 | 67 |
| | **4** | | | | | | | 87 | 80 | 94 | 67 | 58 | 77 |
| | **5 (least deprived)** | | | | | | | 86 | 79 | 93 | 69 | 60 | 79 |
| **Thyroid***[4] | **1 (most deprived)** | 83 | *72* | *94* | 71 | *56* | *85* | 91 | *86* | *96* | 91 | *83* | *99* |
| | **2** | 82 | *70* | *94* | 64 | *45* | *82* | 91 | *86* | *97* | 92 | *85* | *100* |
| | **3** | 96 | *90* | *100* | 95 | *83* | *100* | 92 | *86* | *97* | 93 | *84* | *100* |
| | **4** | 82 | *70* | *93* | 77 | *61* | *92* | 93 | *88* | *97* | 93 | *87* | *99* |
| | **5 (least deprived)** | 90 | *79* | *100* | 78 | *58* | *98* | 94 | *89* | *99* | 94 | *87* | *100* |
| **Mesothelioma*** | **1 (most deprived)** | 34 | 23 | 46 | 4 | -1 | 9 | 50 | *33* | *67* | 7 | *0* | *14* |
| | **2** | 35 | 25 | 45 | 6 | 1 | 10 | 42 | *26* | *58* | 3 | *0* | *7* |
| | **3** | 35 | 24 | 46 | 3 | -1 | 7 | 26 | *9* | *43* | 4 | *0* | *11* |
| | **4** | 41 | 30 | 52 | 3 | -1 | 7 | 37 | *10* | *64* | 10 | *0* | *25* |
| | **5 (least deprived)** | 40 | 28 | 53 | 5 | 0 | 11 | 26 | *7* | *44* | 12 | *0* | *25* |

* Thyroid cancer in Men and Women and Mesothelioma in Women are not age standardised due to small numbers, Mesothelioma in Men standardised as in (4)

[1] Age standardisation using the following age groups: 15-44, 45-54, 55-64, 65-74, 75+

[2] Age standardisation using the following age groups: 15-54, 55-64, 65-74, 75+

[3] Age standardisation using the following age groups: 15-64, 65-74, 75+

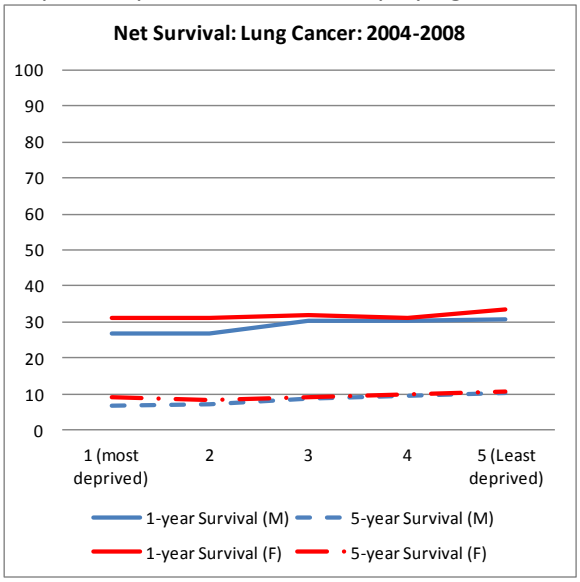
[4] Age standardisation using the following age groups: 15-64, 65+

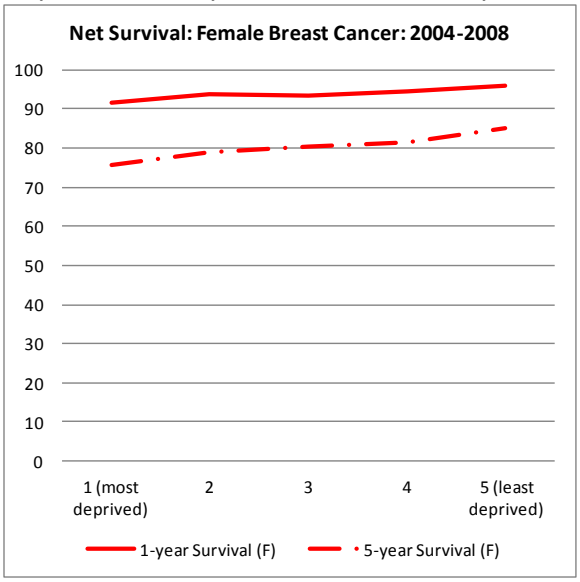
[5] Age standardisation using the following age groups: 15-44, 45+

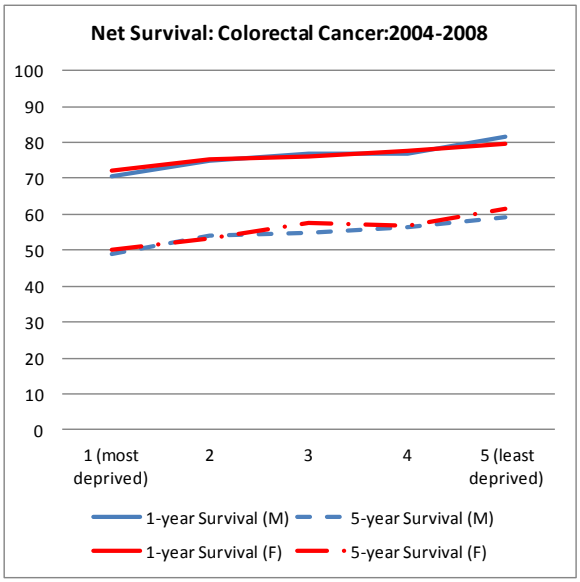
Oesophageal cancer age standardised as in (3) for men and (4) for women

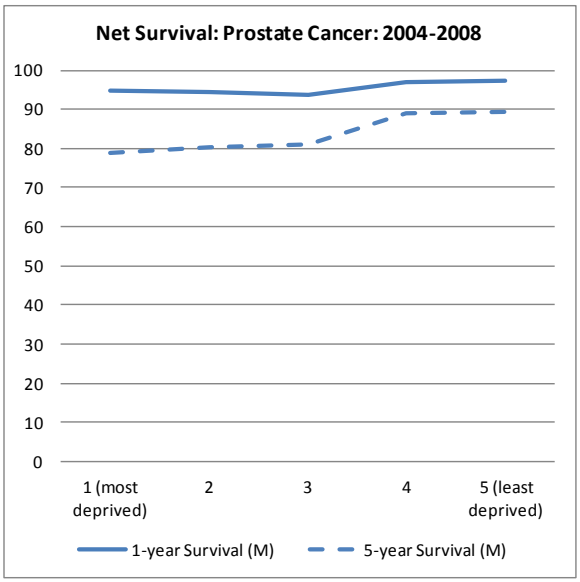
Survival by cancer type for the 20 most common cancers is presented in the graphs below, for SIMD 1 (most deprived) and SIMD5 (least deprived). It should be noted that the age standardisation used may differ across cancers due to restrictions from low numbers (for more detail of numbers see Appendix B).

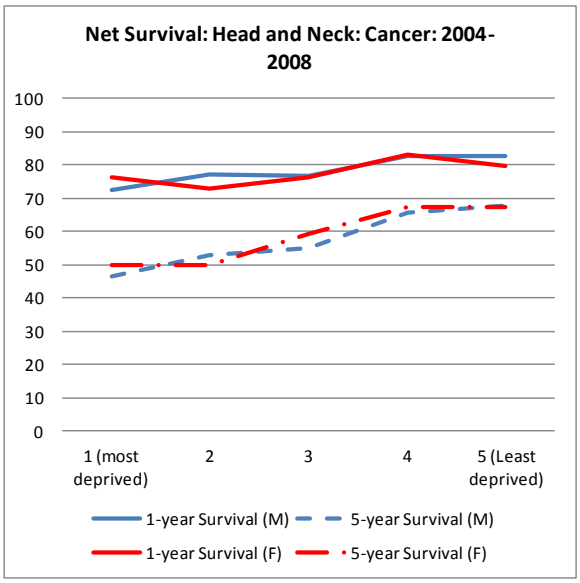
Graphs are presented below displaying one and five year survival by sex for each cancer by SIMD:

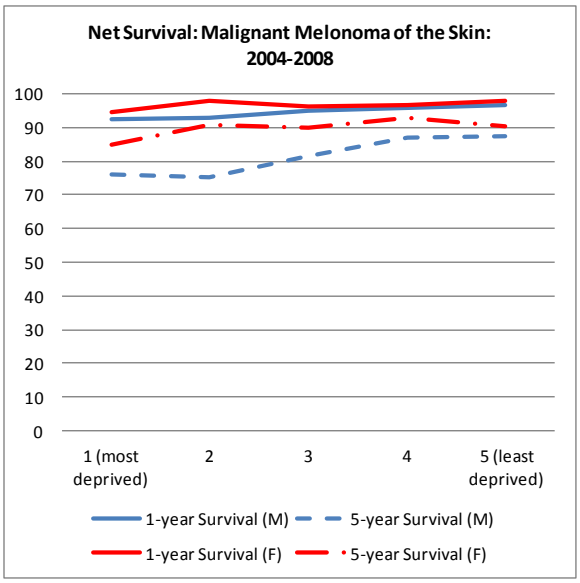


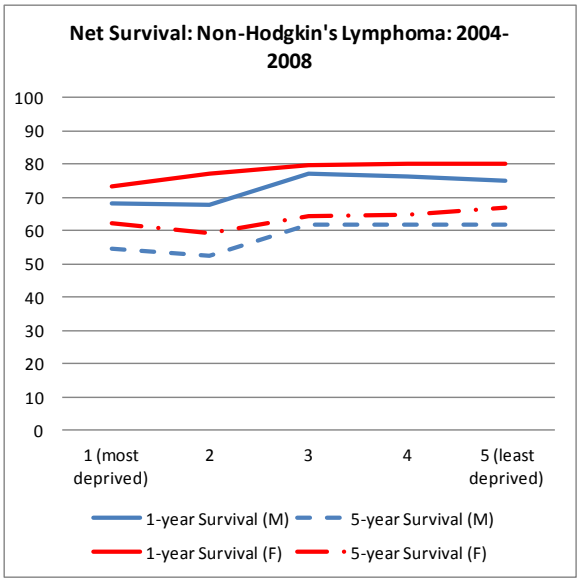



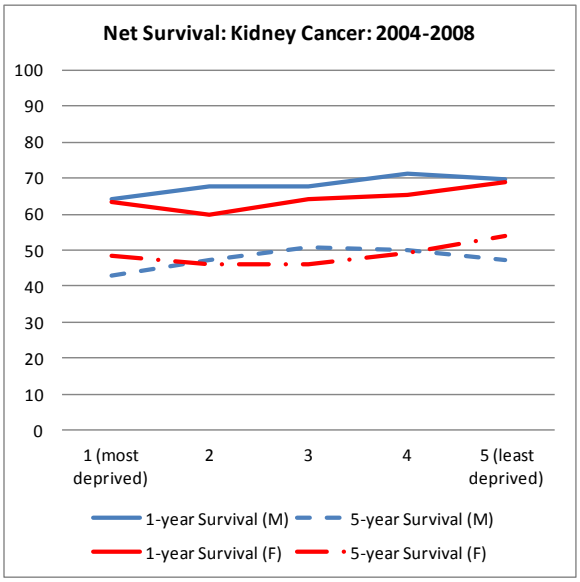



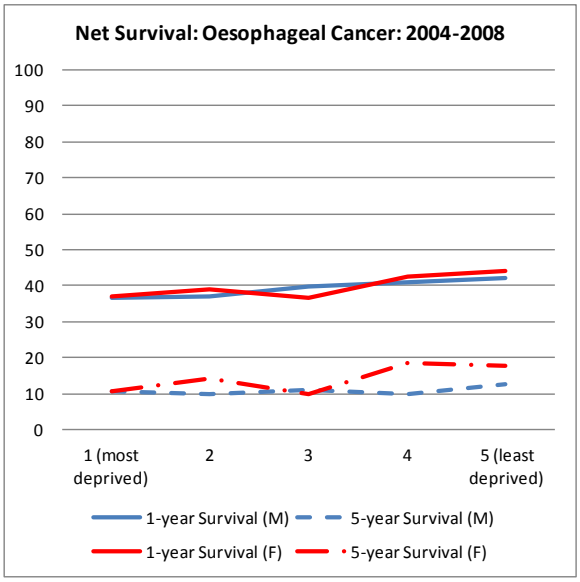



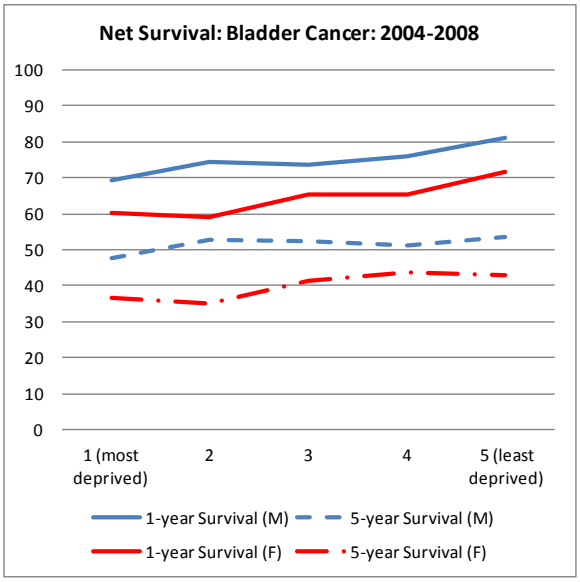



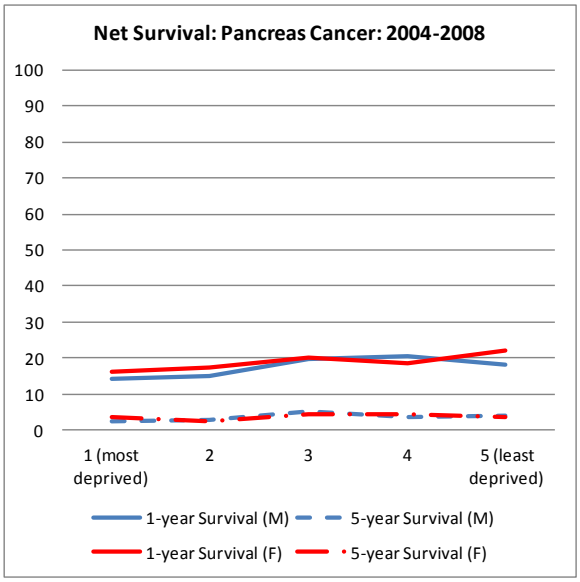



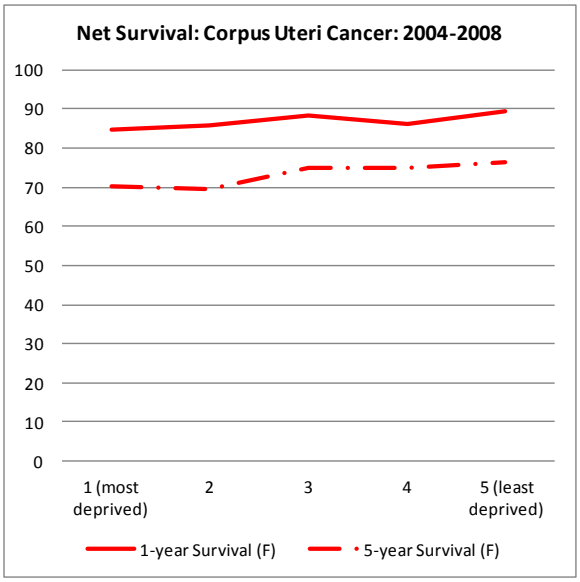

Net Survival: Non-Hodgkin's Lymphoma: 2004-2008
100
90
80
70
60
50
40
30
20
10
0
1 (most deprived)
2
3
4
5 (least deprived)
1-year Survival (M)
5-year Survival (M)
1-year Survival (F)
5-year Survival (F)

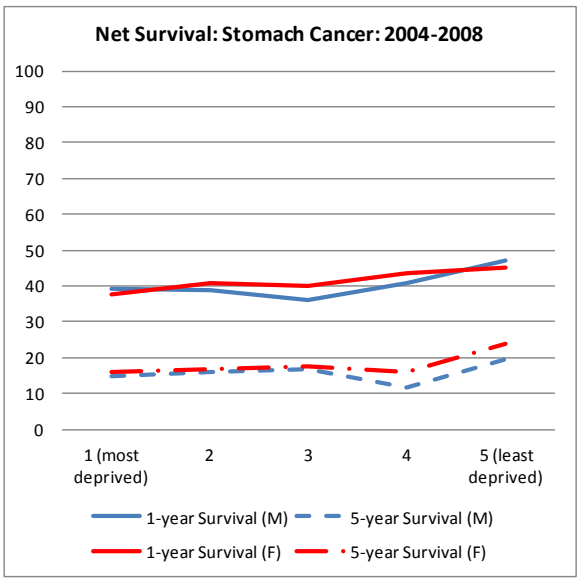

Net Survival: Kidney Cancer: 2004-2008
100
90
80
70
60
50
40
30
20
10
0
1 (most deprived)
2
3
4
5 (least deprived)
1-year Survival (M)
5-year Survival (M)
1-year Survival (F)
5-year Survival (F)

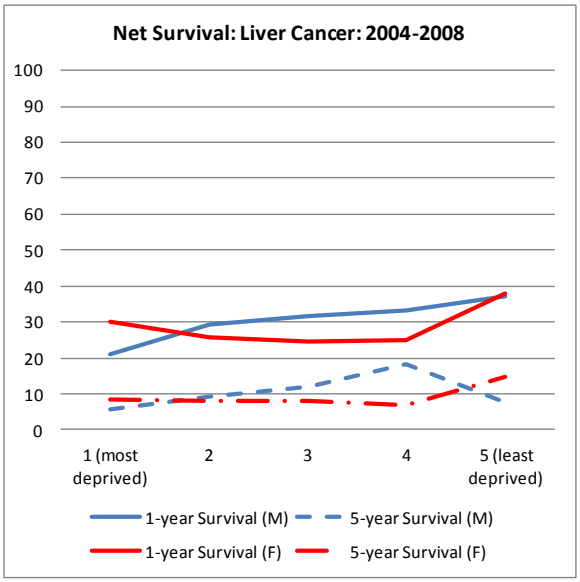

Net Survival: Oesophageal Cancer: 2004-2008
100
90
80
70
60
50
40
30
20
10
0
1 (most deprived)
2
3
4
5 (least deprived)
1-year Survival (M)
5-year Survival (M)
1-year Survival (F)
5-year Survival (F)

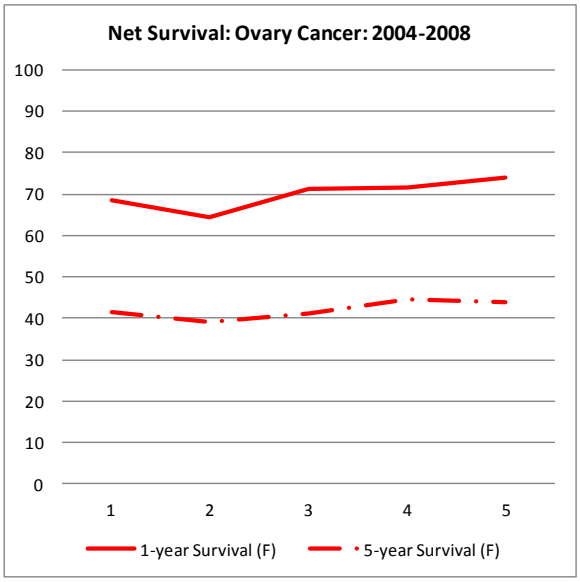

Net Survival: Bladder Cancer: 2004-2008
100
90
80
70
60
50
40
30
20
10
0
1 (most deprived)
2
3
4
5 (least deprived)
1-year Survival (M)
5-year Survival (M)
1-year Survival (F)
5-year Survival (F)

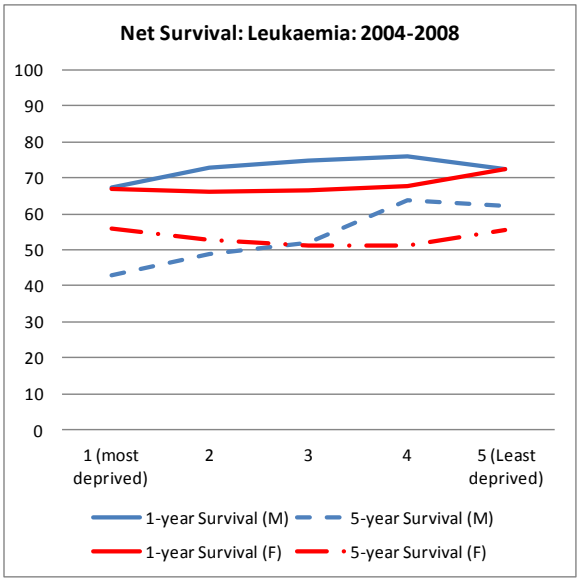

Net Survival: Pancreas Cancer: 2004-2008
100
90
80
70
60
50
40
30
20
10
0
1 (most deprived)
2
3
4
5 (least deprived)
1-year Survival (M)
5-year Survival (M)
1-year Survival (F)
5-year Survival (F)

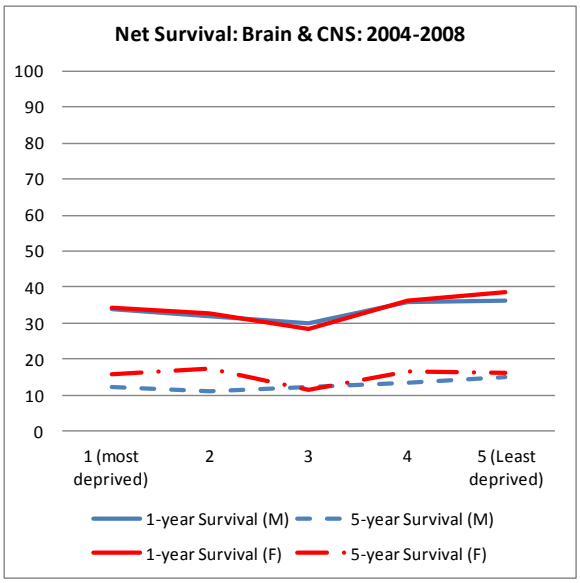

Net Survival: Corpus Uteri Cancer: 2004-2008
100
90
80
70
60
50
40
30
20
10
0
1 (most deprived)
2
3
4
5 (least deprived)
1-year Survival (F)
5-year Survival (F)

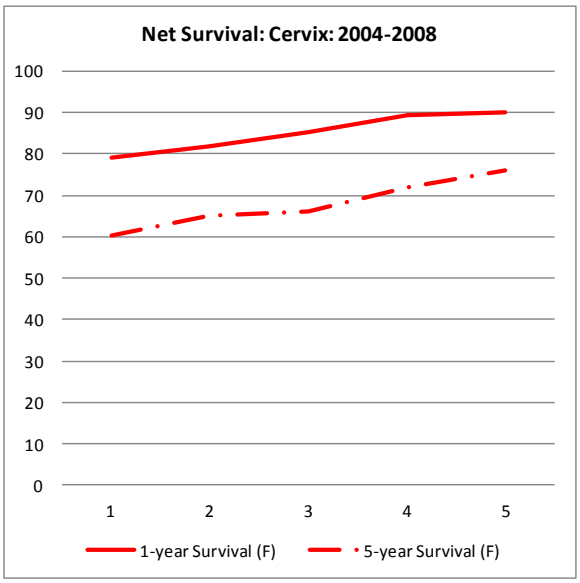

Net Survival: Stomach Cancer: 2004-2008
100
90
80
70
60
50
40
30
20
10
0
1 (most deprived)
2
3
4
5 (least deprived)
1-year Survival (M)
5-year Survival (M)
1-year Survival (F)
5-year Survival (F)


Net Survival: Liver Cancer: 2004-2008
100
90
80
70
60
50
40
30
20
10
0
1 (most deprived)
2
3
4
5 (least deprived)
1-year Survival (M)
5-year Survival (M)
1-year Survival (F)
5-year Survival (F)


Net Survival: Ovary Cancer: 2004-2008
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
1-year Survival (F)
5-year Survival (F)


Net Survival: Leukaemia: 2004-2008
100
90
80
70
60
50
40
30
20
10
0
1 (most deprived)
2
3
4
5 (Least deprived)
1-year Survival (M)
5-year Survival (M)
1-year Survival (F)
5-year Survival (F)


Net Survival: Brain & CNS: 2004-2008
100
90
80
70
60
50
40
30
20
10
0
1 (most deprived)
2
3
4
5 (Least deprived)
1-year Survival (M)
5-year Survival (M)
1-year Survival (F)
5-year Survival (F)


Net Survival: Cervix: 2004-2008
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
1-year Survival (F)
5-year Survival (F)

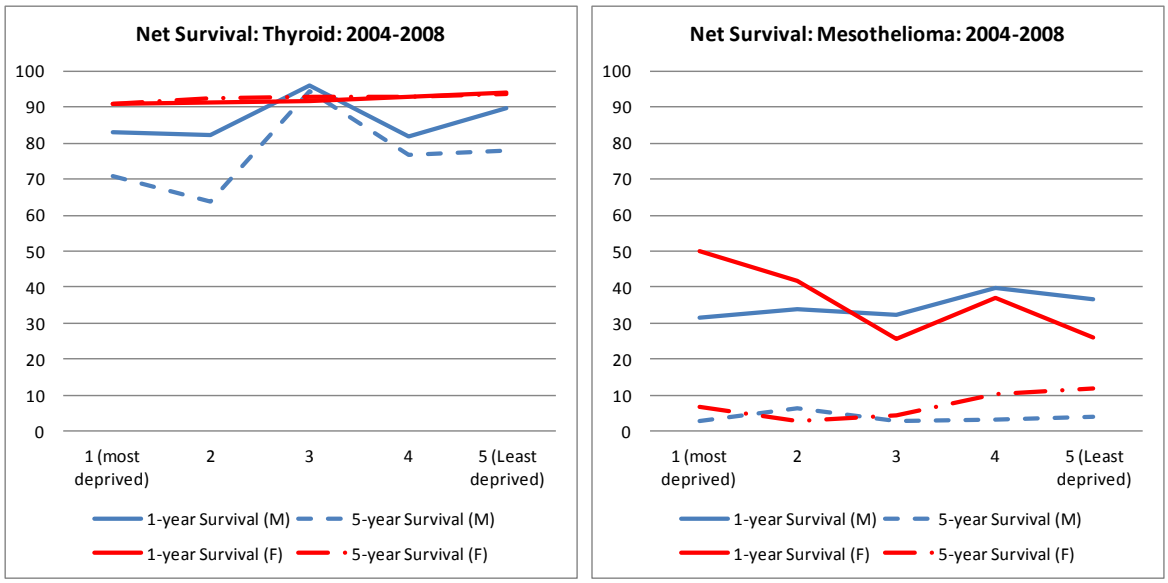



***Figure 2: Graphs displaying one and five year survival by sex for each cancer***

The above charts suggest that while many cancers have very similar survival patterns by sex, others, such as bladder cancer, do appear to differ, with these gender differences corresponding to other findings [17] [18] [19].

Survival by deprivation in some cancers appears to show little significant difference (for example, stomach cancer). In some cases, such as head and neck cancer, there is a trend in survival by deprivation quintile, whereas in others, there is also a widening of the survival gap between one and five year survival (e.g. female breast and prostate cancers).

In addition, thyroid cancer survival appears very different between males and females, especially five years male survival. However, this difference does not appear to be statistically significant. As can be seen in Appendix B, the numbers diagnosed with thyroid cancer are low, resulting in wide confidence intervals and estimates which are imprecise.

Statistically significant differences between SIMD1 (most deprived) and SIMD5 (least deprived) are observed in men at one year for colorectal cancer. For head and neck cancers, a statistically significant difference is observed at five years in men. Breast cancer appears to have statistically significant differences between SIMD1 and SIMD5 at both one and five years.

Further tests for linear trend by deprivation were carried out and showed significant differences at one and five years for lung, colorectal, and head and neck cancers in men. Significant differences were also found at one and five years in breast and thyroid cancers for women.

For men only, significant differences at one year were observed for melanoma of the skin, oesophageal and liver cancers and at five years for prostate cancer. For women, a significant

[17] ONS. 'Statistical Bulletin: Cancer Survival in England-Adults Diagnosed: 2009 to 2013, followed up to 2014'. (2015)
[18] ISD. 'Cancer Survival in Scotland: 1987-2011' (2015)
[19] Shack LG, Rachet B, Brewster DH, Coleman MP. Socioeconomic inequalities in cancer survival in Scotland 1986-2000. *Br J Cancer*. 2007; 97(7): 999-1004

difference was found at one year for colorectal cancer. However, it should be noted that these results are only based on linear tests for trend between SIMD 1 through to SIMD 5.

Further multivariate analysis of the following cancers has been carried out in order to investigate which factors are driving the differences in survival between the deprivation groups:

| | |
|---|---|
| Breast Cancer | Colorectal Cancer |
| Head & Neck Cancer | Liver Cancer |
| Lung Cancer | Melanoma of Skin |
| Oesophageal Cancer | Prostate Cancer |

Although significant differences in survival were identified at one and five years for thyroid cancer in women it was not possible to standardise this analysis by age as the numbers were too low. Multivariate analysis of thyroid cancer was not possible due to small numbers.

# Further Investigation of selected cancers

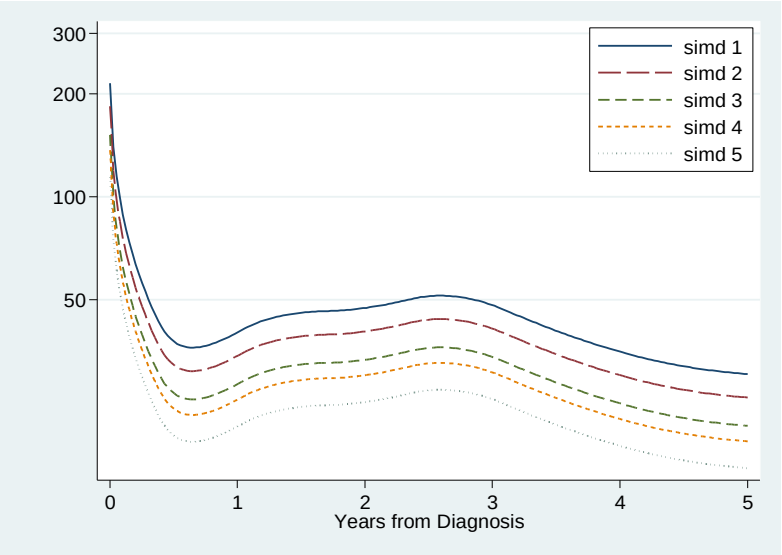
## Breast Cancer

As shown in Table 2, age standardised net survival from female breast cancer is estimated to be 91% (CI 89%-93.6%) at one year in the most deprived quintile compared with 96% (CI 94.3%-97%) in the least deprived quintile, suggesting a 5% statistically significant difference in survival. This difference in survival appears to widen over time so that by five years, survival in the most deprived group is 76% (CI 72%-80%) compared with 85% (82%-89%) in the least deprived, a difference in survival of 9%. Additionally, a linear test for trend across the deprivation quintiles resulted in statistical significance ($p<0.05$) at one year survival.

**Excess Mortality**

It is likely that much of the difference in survival may be related to differences in patient and tumour characteristics at the time of diagnosis (for example, existing co-morbidities or stage at presentation) and subsequent treatment. Consequently, the excess hazard of death - the measure of mortality due to breast cancer over and above expected mortality - has been calculated over time and presented below, factoring in some of these aspects. These are: age, Charlson Index of co-morbidity, inpatient bed days, grade of differentiation, oestrogen receptor (ER) status, stage, prognosis, screen-detected, clinical trial, use of surgery, radiotherapy, chemotherapy and hormonal therapy. Further information on the details of the variables used and how they are grouped can be found in Appendix C.

A baseline model of excess mortality is shown below (Figure 3) and suggests a large difference in excess mortality between those in the least and most deprived groups, which increases with increasing deprivation. There is an initial drop in excess mortality in the first six months which then remains reasonably constant over time, rising slightly in all deprivation groups up to three years after diagnosis, then falling in years four and five (to almost no excess mortality in the least deprived group at five years following diagnosis. Also worth noting is that the difference in excess mortality by deprivation group remains fairly constant over time.

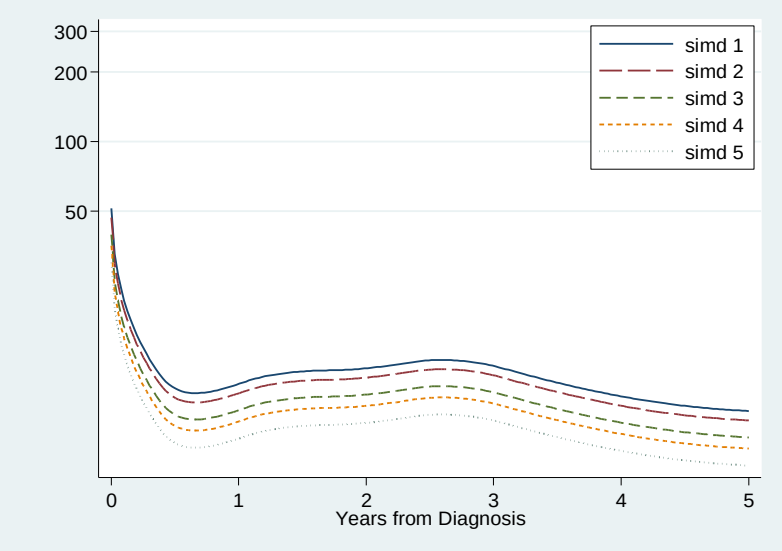



| Unadjusted HR | | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.89 | 1.61 | 2.16 |
| 2 | 1.61 | 1.37 | 1.85 |
| 3 | 1.33 | 1.13 | 1.53 |
| 4 | 1.20 | 1.01 | 1.39 |
| 5 (Least deprived) | 1.00 | | |

***Figure 3: Excess Mortality from breast cancer by deprivation***

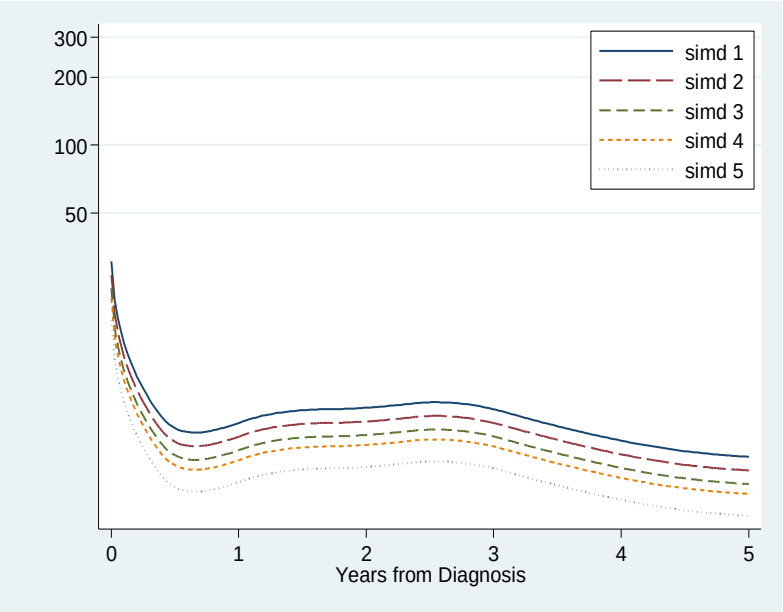
The addition of **age group**, **co-morbidities** (Charlson index of co-morbidity, and number of inpatient bed days in the previous five years, not including the six months prior to diagnosis), or **oestrogen receptor** (ER) status all alter the amount and pattern of excess mortality over time and associated Excess Hazard Ratios (EHR) very little when added separately to the model (these results are available on request).

The addition of tumour **morphology (prognosis)** (Figure 4) or **detection through screening or not** (Figure 5) to the model, reduced excess mortality and associated hazard ratios, but again the pattern and difference between deprivation groups looks very similar.




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.72 | 1.48 | 1.97 |
| 2 | 1.57 | 1.35 | 1.79 |
| 3 | 1.33 | 1.13 | 1.52 |
| 4 | 1.18 | 1.01 | 1.36 |
| 5 (Least deprived) | 1.00 | | |

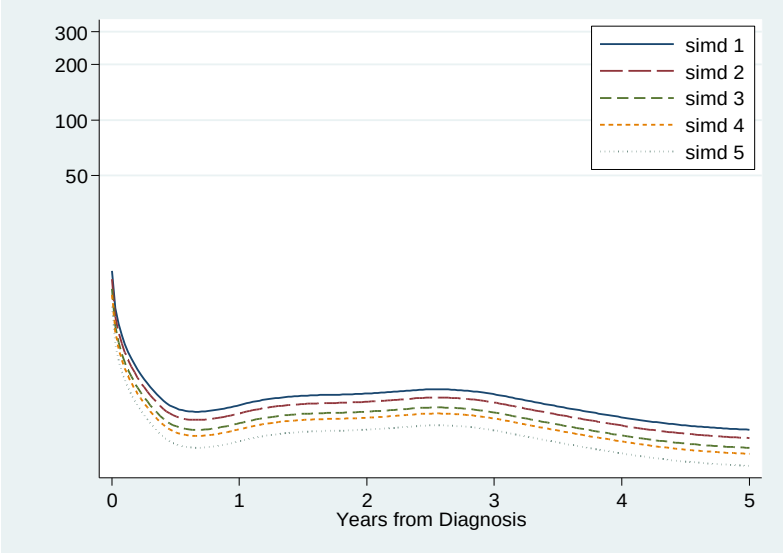
***Figure 4: Excess Mortality from breast cancer by deprivation (incorporating morphology (prognosis))***




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.83 | 1.56 | 2.09 |
| 2 | 1.59 | 1.36 | 1.82 |
| 3 | 1.38 | 1.18 | 1.59 |
| 4 | 1.25 | 1.06 | 1.44 |
| 5 (Least deprived) | 1.00 | | |

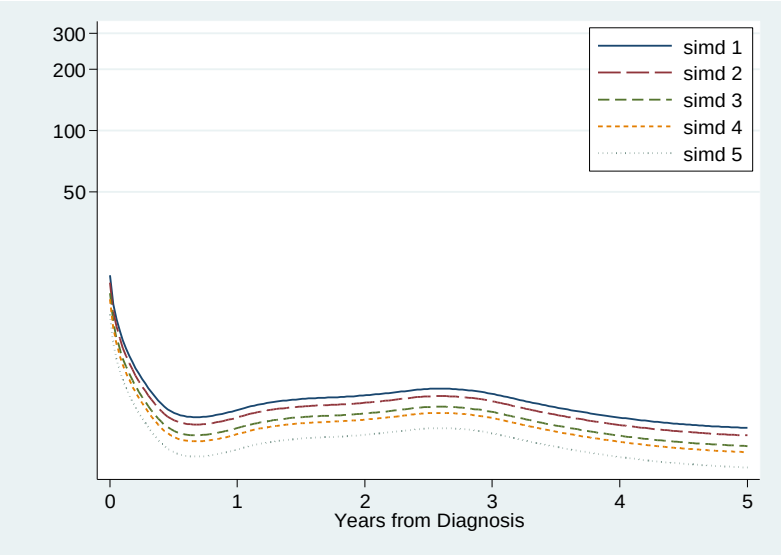
***Figure 5: Excess Mortality from breast cancer by deprivation (incorporating detection through screening or not)***

Larger drops in excess mortality and an apparent narrowing of the difference between deprivation groups are seen when adding **grade of differentiation** (see Figure 6) or **stage at presentation** (see Figure 7) separately to the model.




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.57 | 1.35 | 1.78 |
| 2 | 1.41 | 1.22 | 1.61 |
| 3 | 1.25 | 1.07 | 1.43 |
| 4 | 1.16 | 0.99 | 1.33 |
| 5 (Least deprived) | 1.00 | | |

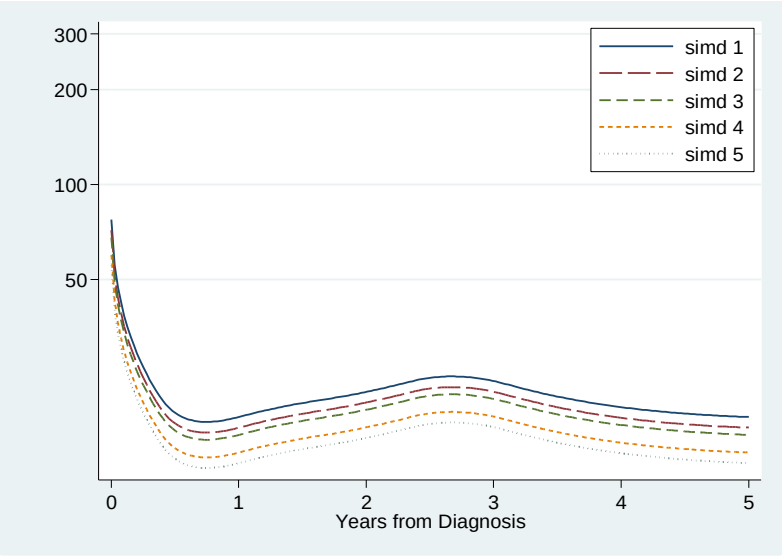
***Figure 6: Excess Mortality from breast cancer by deprivation (incorporating grade of differentiation)***




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.56 | 1.35 | 1.78 |
| 2 | 1.44 | 1.24 | 1.63 |
| 3 | 1.27 | 1.09 | 1.45 |
| 4 | 1.19 | 1.02 | 1.36 |
| 5 (Least deprived) | 1.00 | | |

***Figure 7: Excess Mortality from breast cancer by deprivation (incorporating stage)***

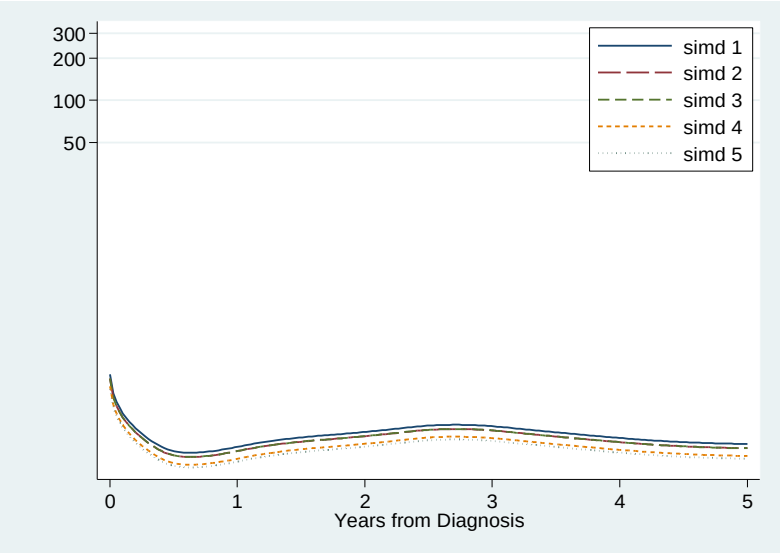
In terms of treatments, it was surgery that seemed to have the greatest impact on reducing excess mortality from breast cancer (see Figure 8). Other treatments explored included chemotherapy, radiotherapy and hormonal therapy.




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.40 | 1.22 | 1.58 |
| 2 | 1.30 | 1.13 | 1.46 |
| 3 | 1.23 | 1.07 | 1.39 |
| 4 | 1.08 | 0.94 | 1.22 |
| 5 (Least deprived) | 1.00 | | |

***Figure 8: Excess Mortality from breast cancer by deprivation (incorporating surgery)***

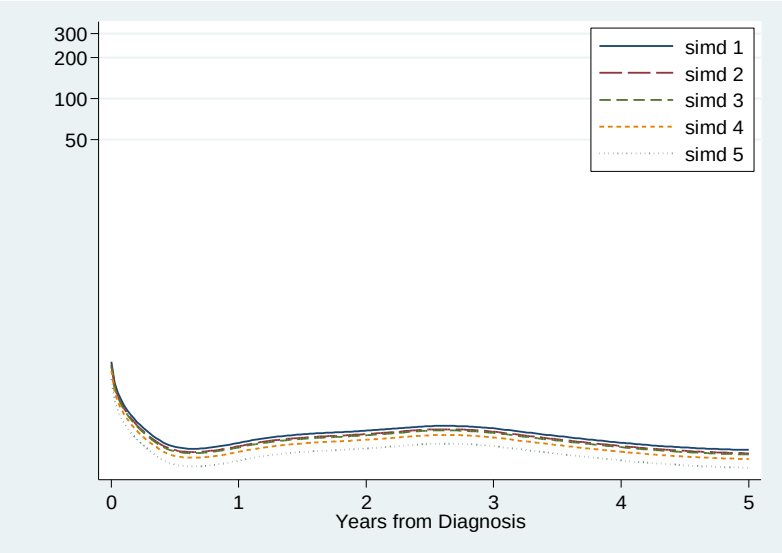
A multivariate model including all the factors previously mentioned in the model together produces the lowest excess mortality rates. As shown in Figure 9, there is now a grouping together of mortality by deprivation group, suggesting that the vast majority of the excess mortality is explained by a combination of patient and tumour characteristics at the time of diagnosis. However, there is still an Excess Hazard Ratio (EHR) of 1.27 (CI 1.11-1.43) for those people from the most deprived groups compared with the least deprived group.




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.27 | 1.11 | 1.43 |
| 2 | 1.19 | 1.04 | 1.34 |
| 3 | 1.19 | 1.04 | 1.34 |
| 4 | 1.05 | 0.91 | 1.18 |
| 5 (Least deprived) | 1.00 | | |

***Figure 9: Excess Mortality from breast cancer by deprivation (incorporating all previously mentioned variables in the model)***

There is a complication with adding treatment factors to the model because treatments may be used for curative or palliative purposes. For this reason, the full model without treatment characteristics is presented in Figure 10 below.




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.35 | 1.18 | 1.53 |
| 2 | 1.28 | 1.11 | 1.44 |
| 3 | 1.25 | 1.08 | 1.42 |
| 4 | 1.16 | 1.00 | 1.31 |
| 5 (Least deprived) | 1.00 | | |

***Figure 10 Excess Mortality from breast cancer by deprivation (incorporating all previously mentioned variables in the model except treatments)***

A comparison of Excess Hazard Ratios (EHR) or risk of death from breast cancer for an unadjusted five year model (shown in dark green in Figure 11 below) shows a statistically significant EHR for SIMD 1-3 when compared to the least deprived. This increases with increasing deprivation. When adjustment is made for the patient, tumour and treatment characteristics previously described, the EHR reduce but remain significantly different for SIMD 1-3 compared with those in the least deprived group. The factors that have been added to the model explain a great deal of the excess

mortality seen in breast cancer but do not account for all the differences by deprivation (for example, no smoking factors are included).

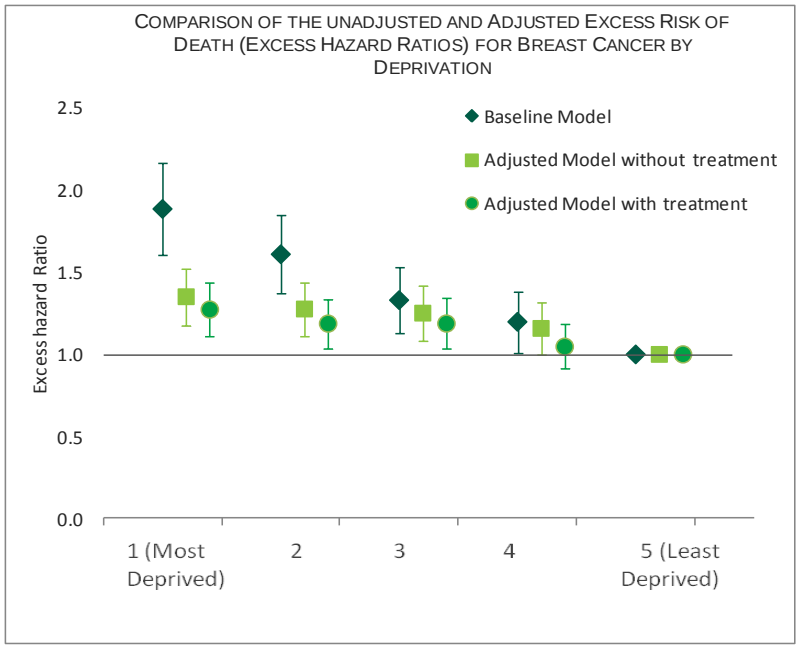



***Figure 11: A comparison of unadjusted and adjusted model Excess Hazard Ratios (showing with and without treatment) for Breast Cancer***

## Colorectal Cancer

As shown in Table 2, age standardised net survival from colorectal cancer in men is estimated to be **71% (CI 66%-75%)** at one year following diagnosis in the most deprived quintile compared with **82% (CI 77%-86%)** in the least deprived quintile, resulting in a statistically significant **11%** difference in survival. This difference in survival appears to be maintained over time so that by five years, survival in the most deprived group is **49% (CI 43%-55%)** compared with **59% (CI 53%-65%)** in the least deprived, a difference in survival of **10%**.

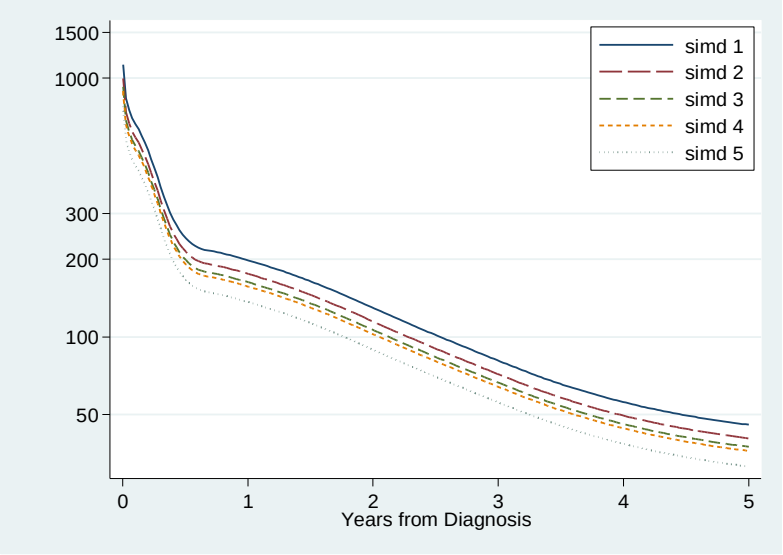
For women, the differences in the estimates of age standardised net survival between the least and most deprived quintiles are lower than in men. At one year, net survival in the most deprived quintile is estimated as **72% (CI 67%-77%)** and **79% (CI 75%-84%)** in the least deprived, a difference of **7%**. Survival widens by deprivation during follow-up for women with a difference of **12%** at five years (**50% (CI 43%-57%**) in the most deprived and **62% (CI 55%-68%)** in the least deprived quintile. A linear test for trend across the deprivation quintiles resulted in statistical significance ($p < 0.05$) for men at one and five year survival and women at one year.

### Excess Mortality

It is likely that much of the difference in survival may be related to differences in patient, tumour and treatment characteristics at the time of diagnosis (for example existing co-morbidities or stage at presentation) and subsequent treatment. Consequently, the excess hazard of death - the measure of mortality due to colorectal cancer over and above expected mortality - has been calculated over time and presented below, factoring in some of these aspects. These are: age, sex, Charlson Index of co-morbidity, inpatient bed days, grade of differentiation, Dukes' stage, screen-detection,

morphology, use of surgery, radiotherapy and chemotherapy. Further information on the details of the variables used and how they are grouped can be found in Appendix C.

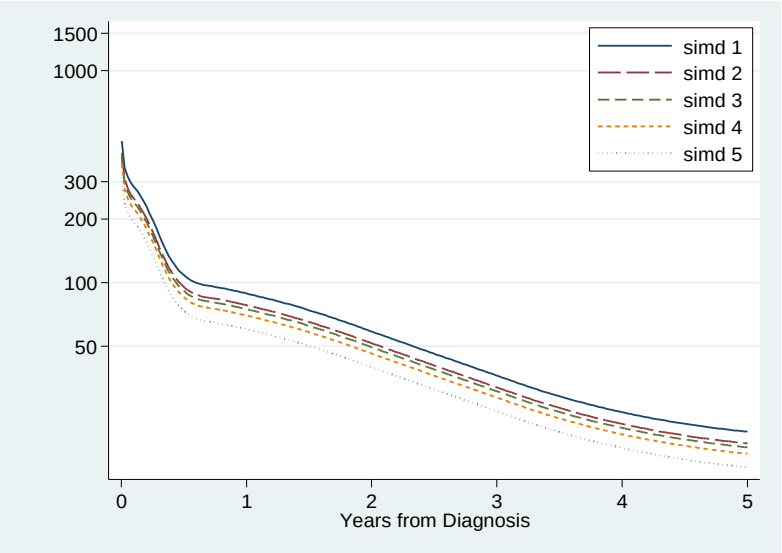
A baseline model of excess mortality is shown below (Figure 12) and suggests a difference in excess mortality between those in the least and most deprived groups, which increases with increasing deprivation. There is a very sharp decrease in excess mortality in the first few months following diagnosis across all deprivation groups which then levels out, although it continues to decrease more gradually over time since diagnosis. When looking at Excess Hazard Ratios (EHR) throughout the first five years after diagnosis, all deprivation groups appear statistically significantly higher compared with the least deprived group, with the largest excess mortality in SIMD1 (EHR=1.45 (CI 1.33-1.57).




| Unadjusted HR | | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.45 | 1.33 | 1.57 |
| 2 | 1.29 | 1.18 | 1.39 |
| 3 | 1.19 | 1.10 | 1.29 |
| 4 | 1.15 | 1.05 | 1.25 |
| 5 (Least deprived) | 1.00 | | |

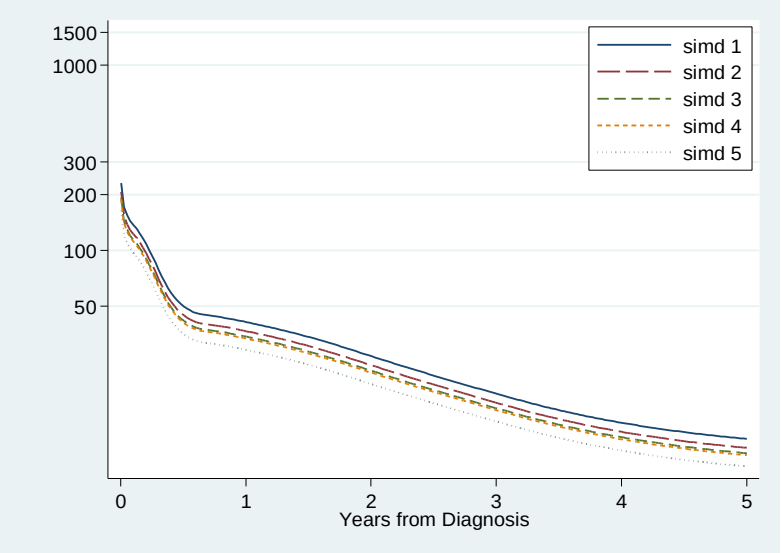
***Figure 12: Excess Mortality from colorectal cancer by deprivation***

The addition of **sex, age, co-morbidities** (Charlson index of co-morbidity and number of inpatient bed days in the previous five years (not including the six months prior to diagnosis) have little impact on the amount and pattern of excess mortality over time and associated excess hazard ratios (EHR) when added separately to the model (results are available on request).



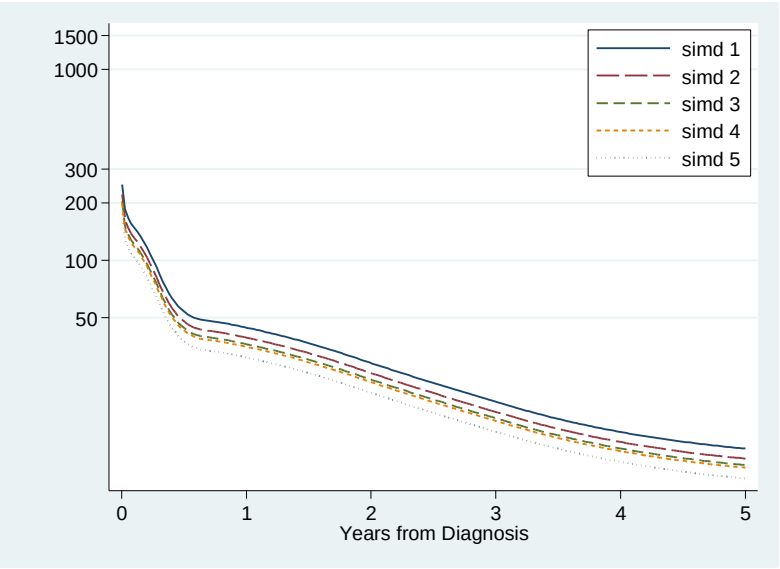

| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.47 | 1.36 | 1.59 |
| 2 | 1.30 | 1.19 | 1.40 |
| 3 | 1.24 | 1.14 | 1.34 |
| 4 | 1.16 | 1.06 | 1.26 |
| 5 (Least deprived) | 1.00 | | |

***Figure 13: Excess Mortality from colorectal cancer by deprivation (incorporating grade of differentiation)***




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.41 | 1.30 | 1.53 |
| 2 | 1.26 | 1.16 | 1.36 |
| 3 | 1.18 | 1.08 | 1.28 |
| 4 | 1.15 | 1.05 | 1.25 |
| 5 (Least deprived) | 1.00 | | |

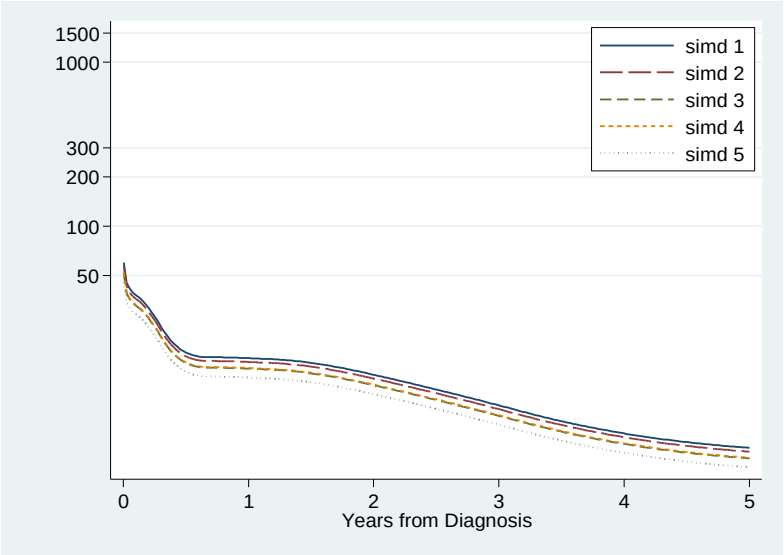
***Figure 14: Excess Mortality from colorectal cancer by deprivation (<u>incorporating screening</u>)***




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.43 | 1.32 | 1.55 |
| 2 | 1.27 | 1.17 | 1.37 |
| 3 | 1.18 | 1.08 | 1.27 |
| 4 | 1.14 | 1.04 | 1.23 |
| 5 (Least deprived) | 1.00 | | |

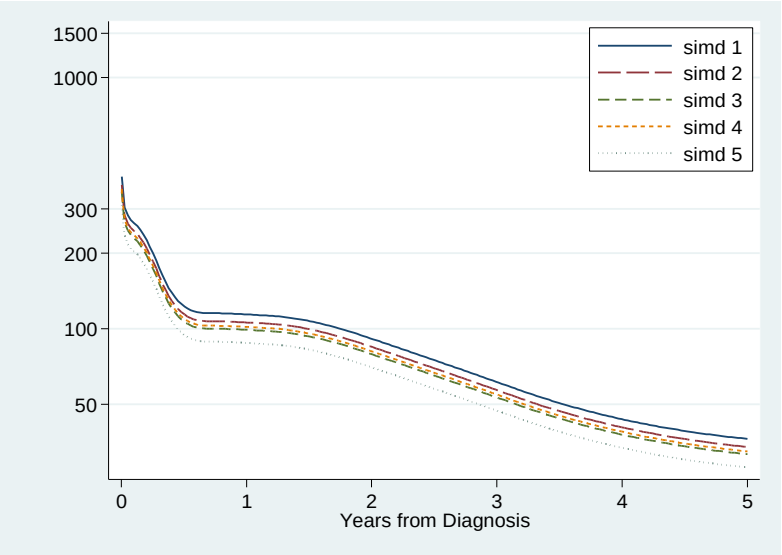
***Figure 15: Excess Mortality from colorectal cancer by deprivation (incorporating morphology)***

Larger drops in excess mortality are seen when adding **grade of differentiation**, **screening (Y/N), morphology** and, in particular, **Dukes' stage** separately to the model. **Dukes' stage** also seems to explain some of the difference previously observed between deprivation groups (see Figure 16).




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.31 | 1.21 | 1.42 |
| 2 | 1.24 | 1.15 | 1.34 |
| 3 | 1.13 | 1.04 | 1.22 |
| 4 | 1.14 | 1.05 | 1.24 |
| 5 (Least deprived) | 1.00 | | |

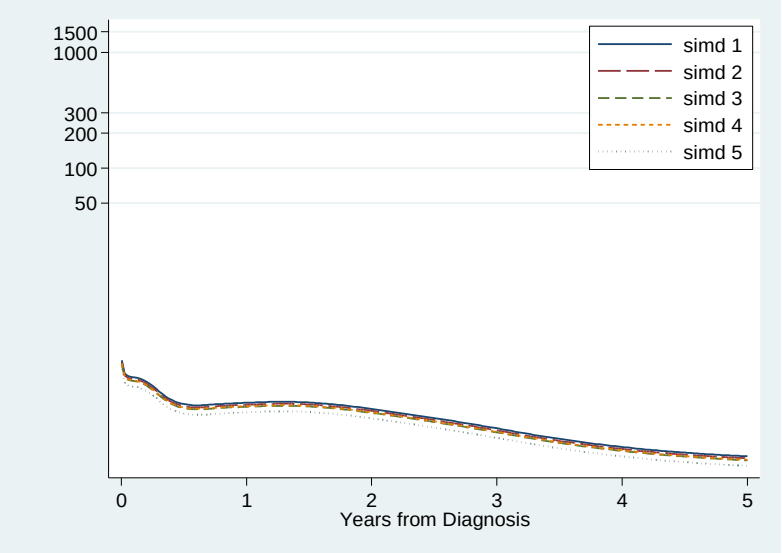
***Figure 16: Excess Mortality from colorectal cancer by deprivation (incorporating Dukes' stage)***




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.30 | 1.20 | 1.40 |
| 2 | 1.21 | 1.11 | 1.30 |
| 3 | 1.13 | 1.04 | 1.22 |
| 4 | 1.16 | 1.06 | 1.25 |
| 5 (Least deprived) | 1.00 | | |

***Figure 17: Excess Mortality from colorectal cancer by deprivation (incorporating surgery)***

Out of all the treatment variables, it is only **surgery** that has an impact on excess mortality and on the resulting EHR, although inclusion of variables on use of **radiotherapy** and **chemotherapy** reduce the EHR somewhat (results are available on request).

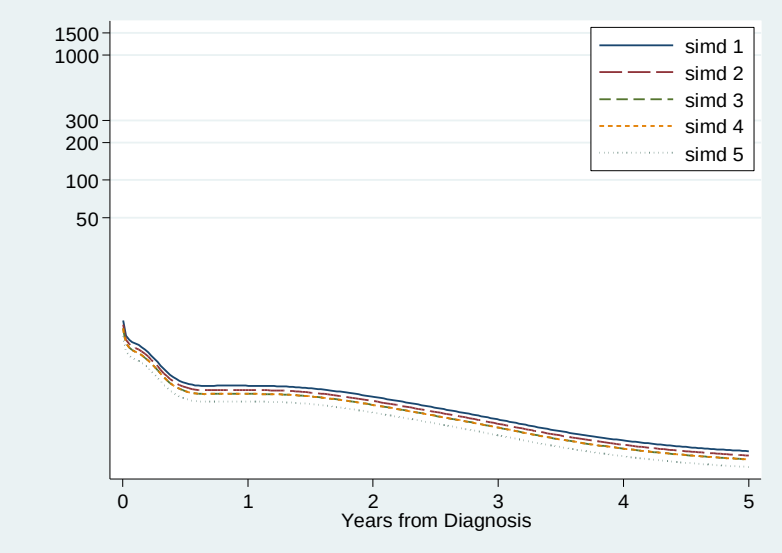



| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.21 | 1.11 | 1.30 |
| 2 | 1.16 | 1.07 | 1.25 |
| 3 | 1.12 | 1.03 | 1.21 |
| 4 | 1.13 | 1.04 | 1.22 |
| 5 (Least deprived) | 1.00 | | |

***Figure 18: Excess Mortality from colorectal cancer by deprivation (incorporating all previously mentioned variables in the model)***

The multivariate model including all the factors previously mentioned in the model together produces the lowest excess mortality rates, and also reduces the mortality by deprivation group. This suggests that factors included in the model explain some but not all of the variation by deprivation. There is still a EHR of 1.21 (CI 1.11-1.30) for the most deprived group compared with the least deprived group and this is also observed to a lesser degree for SIMD2-4.

There is a complication with adding treatment factors to the model because treatments may be used for curative or palliative purposes. For this reason, the full model without treatment characteristics is presented in Figure 19 below.




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.34 | 1.23 | 1.44 |
| 2 | 1.24 | 1.14 | 1.33 |
| 3 | 1.15 | 1.06 | 1.24 |
| 4 | 1.15 | 1.06 | 1.25 |
| 5 (Least deprived) | 1.00 | | |

***Figure 19: Excess Mortality from colorectal cancer by deprivation (incorporating all previously mentioned variables in the model except treatment)***

A comparison of Excess Hazard Ratios (EHR) or excess risk of colorectal cancer death (i.e. the hazard of death on top of the expected hazard of death, therefore related to colorectal cancer) for an unadjusted five year model is shown in dark green in Figure 20 below. This shows a statistically significant EHR for SIMD1-4 when compared to the least deprived (SIMD 5), which increases with increasing deprivation. When adjustment is made for the patient, tumour and treatment characteristics previously described, the EHR reduce but remain significantly different to those in the least deprived group. The factors that have been added to the model explain a great deal the excess mortality seen in colorectal cancer but perhaps do not account for the differences by deprivation (for example, no smoking factors are included).

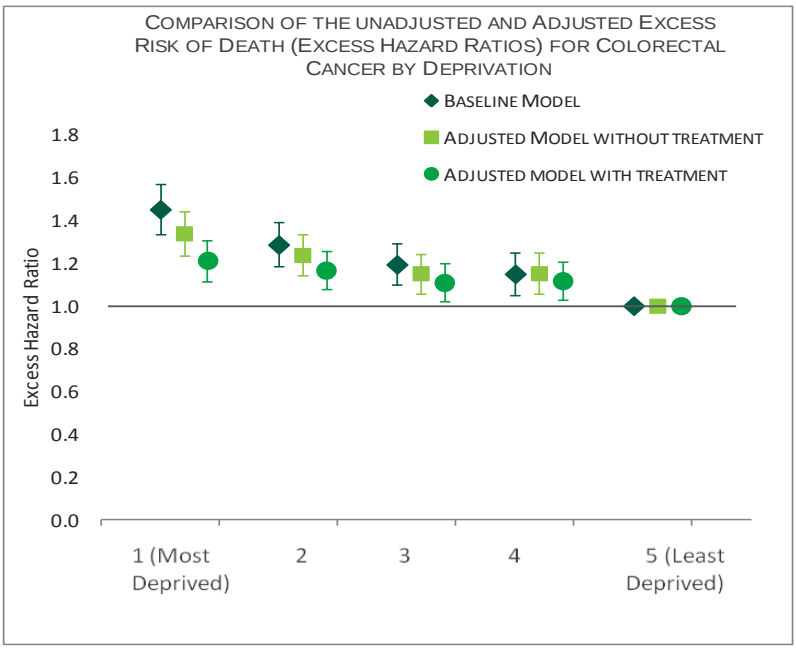



***Figure 20: A comparison of unadjusted and adjusted model Hazard Ratios (showing with and without treatment) for Colorectal Cancer***

## Head and Neck Cancer

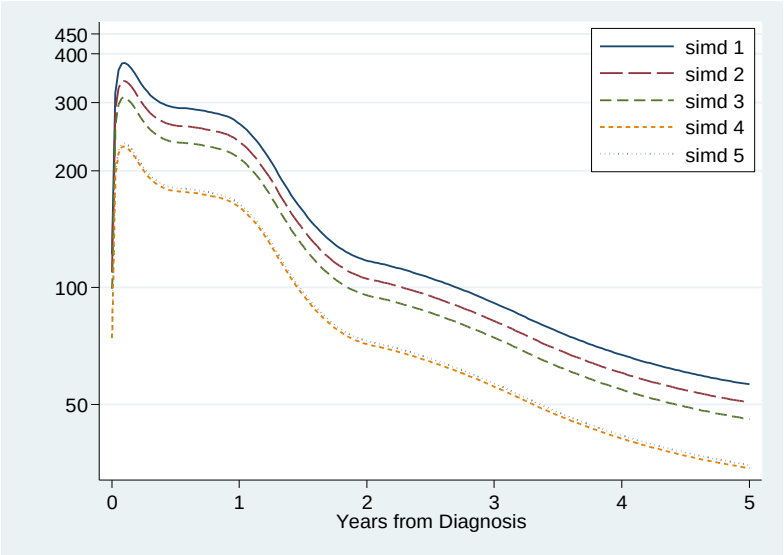
As shown in Table 2, age standardised net survival from head and neck cancer in men is estimated to be **69% (CI 63%-74%)** at one year following diagnosis in the most deprived quintile compared with **80% (CI 73%-87%)** in the least deprived quintile, resulting in an **11%** difference that is not statistically significant. This difference in survival appears to increase over time so that by five years, survival in the most deprived group is **43% (CI 37%-50%)** compared with **60% (CI 51%-70%)** in the least deprived, a difference in survival of **18%,** which is statistically significant.

For women, no statistically significant difference is found in net survival between the least and most deprived quintiles. A linear test for trend across the deprivation quintiles was statistically significant ($p < 0.05$) for men at one and five year survival only.

### Excess Mortality

It is likely that much of the difference in survival may be related to differences in patient and tumour characteristics at the time of diagnosis (for example existing co-morbidities, smoking status or stage at presentation) and subsequent treatment. Consequently, the excess hazard of death - the measure of mortality due to head and neck cancer over and above expected mortality - has been calculated over time and presented below, factoring in some of these aspects. These are: age, sex, Charlson index of co-morbidity, inpatient bed days, grade of differentiation, metastases within 4 months, site, use of surgery, radiotherapy or chemotherapy. Further information on the details of the variables used and how they are grouped can be found in Appendix C.

A baseline model of excess mortality is shown below (Figure 21) and suggests a difference in excess mortality between those in the least and most deprived groups, which increases with increasing deprivation; this is with the exception of SIMD4 and SIMD5 which appear very similar. There is a decrease in excess mortality following diagnosis across all deprivation groups but the gap between SIMD1, 2 and 3 categories (the more deprived groups) and all the other categories is maintained at least until five years following diagnosis. For the least deprived quintiles at five years since diagnosis, the excess mortality has almost reduced to that of the background population. When looking at Excess Hazard Ratios (EHR) throughout the first five years after diagnosis, deprivation groups SIMD 1-3 appear statistically significantly different compared with the least deprived group (SIMD 5), with the largest excess mortality in SIMD1 (EHR=1.61 (CI 1.34-1.88)).

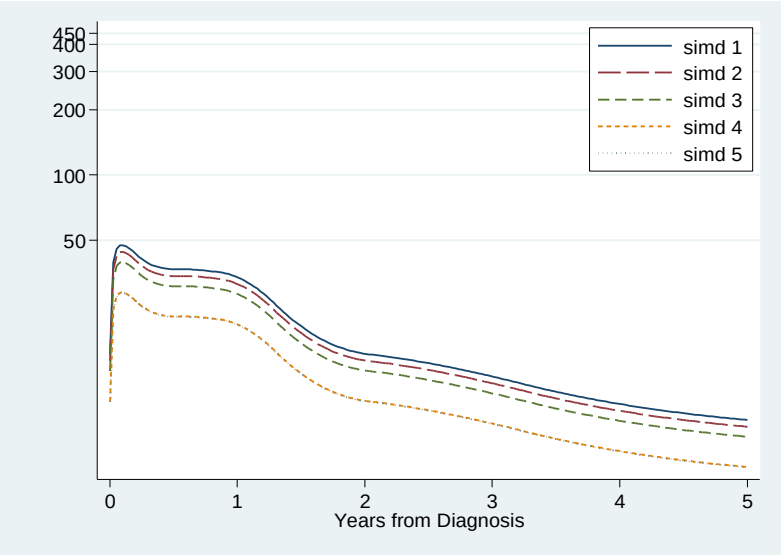



| Unadjusted HR | | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.61 | 1.34 | 1.88 |
| 2 | 1.45 | 1.20 | 1.70 |
| 3 | 1.31 | 1.07 | 1.55 |
| 4 | 0.98 | 0.78 | 1.18 |
| 5 (Least deprived) | 1.00 | | |

***Figure 21: Excess Mortality from head and neck cancer by deprivation***

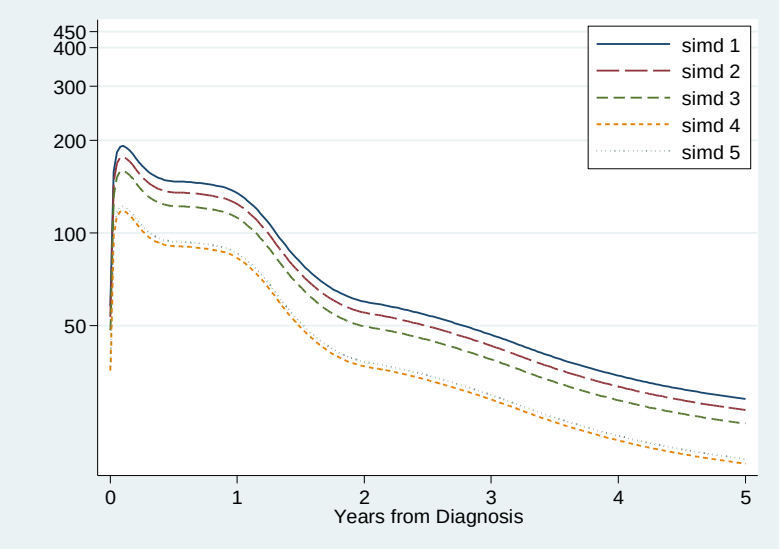
The addition of **sex, age, co-morbidities** (Charlson index of co-morbidity and number of inpatient bed days in the previous five years -not including the 6 months prior to diagnosis), **use of radiotherapy** and **metastases within 4 months** have little impact on the amount and pattern of excess mortality over time and associated excess hazard ratios (EHR) when added separately to the model (results are available on request).

The addition of **grade of differentiation** (Figure 23) and **site** (Figure 22) to the model reduce excess mortality and associated hazard ratios, but again the pattern and difference between deprivation groups looks very similar.



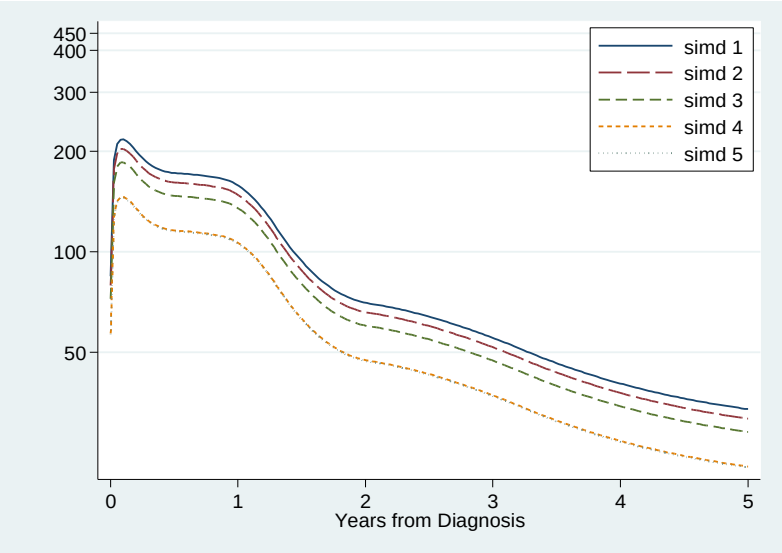

| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.66 | 1.38 | 1.94 |
| 2 | 1.54 | 1.27 | 1.82 |
| 3 | 1.39 | 1.13 | 1.64 |
| 4 | 1.00 | 0.80 | 1.21 |
| 5 (Least deprived) | 1.00 | | |

***Figure 22: Excess Mortality from head and neck cancer by deprivation (<u>incorporating site</u>)***




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.57 | 1.30 | 1.83 |
| 2 | 1.44 | 1.19 | 1.70 |
| 3 | 1.30 | 1.07 | 1.54 |
| 4 | 0.97 | 0.77 | 1.16 |
| 5 (Least deprived) | 1.00 | | |

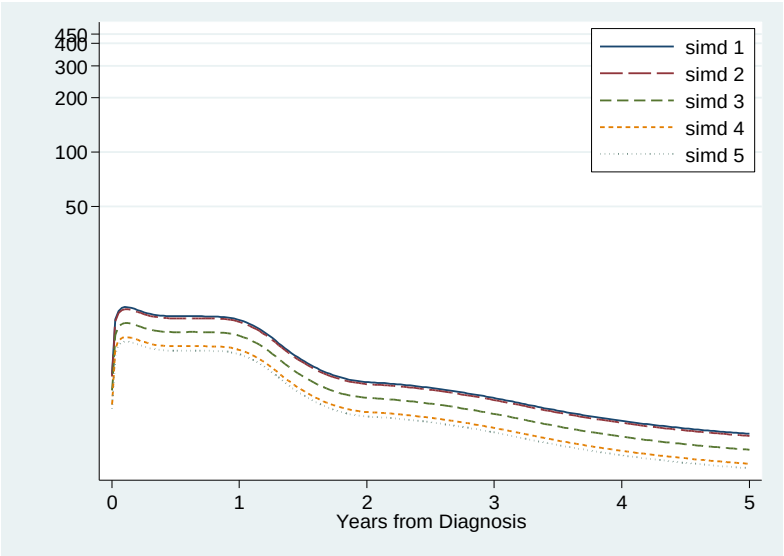
***Figure 23: Excess Mortality from head and neck cancer by deprivation (<u>incorporating grade of differentiation</u>)***




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.49 | 1.25 | 1.74 |
| 2 | 1.40 | 1.16 | 1.64 |
| 3 | 1.28 | 1.04 | 1.51 |
| 4 | 1.01 | 0.81 | 1.21 |
| 5 (Least deprived) | 1.00 | | |

***Figure 24: Excess Mortality from head and neck cancer by deprivation (incorporating surgery)***

Out of all the treatment variables, it is only **surgery** that has an impact on excess mortality, although inclusion of variables on use of **radiotherapy** and **chemotherapy** reduce the EHR somewhat (results are available on request).



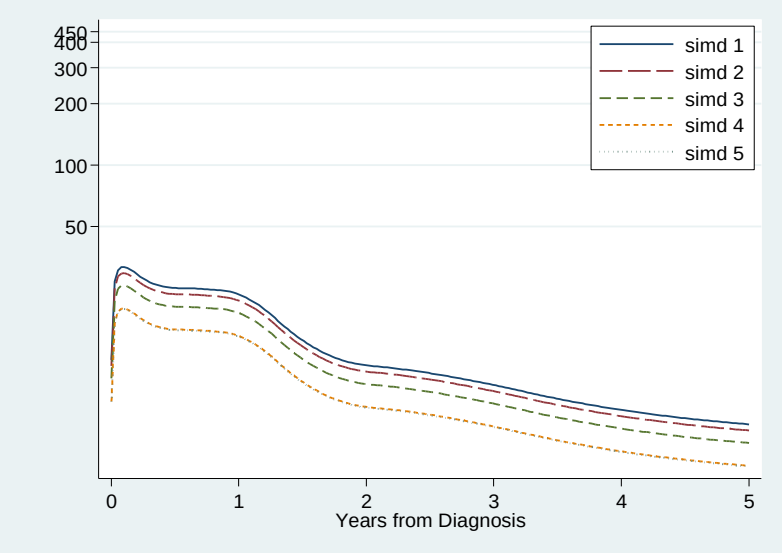

| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.55 | 1.29 | 1.81 |
| 2 | 1.51 | 1.25 | 1.78 |
| 3 | 1.27 | 1.04 | 1.50 |
| 4 | 1.06 | 0.85 | 1.27 |
| 5 (Least deprived) | 1.00 | | |

***Figure 25: Excess Mortality from head and neck cancer by deprivation (incorporating all previously mentioned variables in the model)***

The multivariate model including all the factors previously mentioned in the model together produces the lowest excess mortality rates and reduces the mortality by deprivation group, although some variation by deprivation still remains. This suggests that factors included in the model do not explain all the variation by deprivation. There is still an EHR of 1.55 (CI 1.29-1.81) for the most deprived group compared with the least deprived group. All deprivation groups, with the exception of SIMD4, appear to have a statistically significantly higher EHR than SIMD5, the reference group

(Figure 25). It appears that for the majority of the deprivation groups, the EHR are higher in this multivariate model than in the univariate model with use of surgery alone.

There is a complication with adding treatment factors to the model because treatments may be used for curative or palliative purposes. For this reason, the full model, <u>without treatment characteristics</u> is presented in Figure 26 below.




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.61 | 1.34 | 1.88 |
| 2 | 1.50 | 1.24 | 1.76 |
| 3 | 1.30 | 1.07 | 1.54 |
| 4 | 1.01 | 0.81 | 1.21 |
| 5 (Least deprived) | 1.00 | | |

***Figure 26: Excess Mortality from head and neck cancer by deprivation (<u>incorporating all previously mentioned variables in the model except treatments</u>)***

A comparison of Excess Hazard Ratios (EHR) or excess risk of head and neck cancer death (i.e. the hazard of death on top of the expected hazard of death, therefore related to head and neck cancer) for an unadjusted five year model is shown in dark green in Figure 27 below. It shows EHR is statistically significantly different from the least deprived group for SIMD1, 2 and 3. When adjustment is made for the patient, tumour and treatment characteristics previously described, the difference reduces for SIMD1 and SIMD3 but remains significantly different (this shown in light green in the figure below). The factors that have been added to the model explain some of the excess mortality seen in head and neck cancer but do not account for the differences by deprivation.

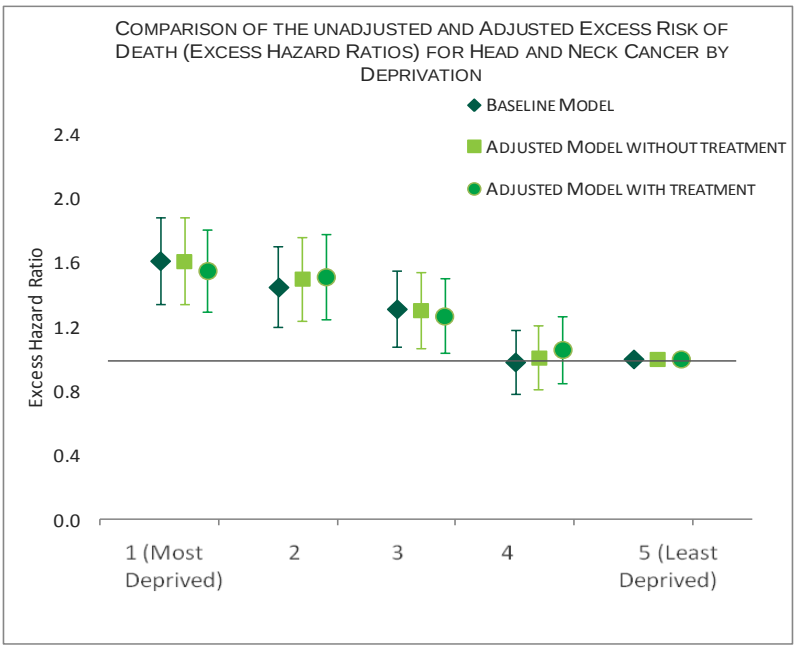



***Figure 27: A comparison of unadjusted and adjusted model Excess Hazard Ratios (showing with and without treatment) for Head and Neck Cancer***

## Liver Cancer

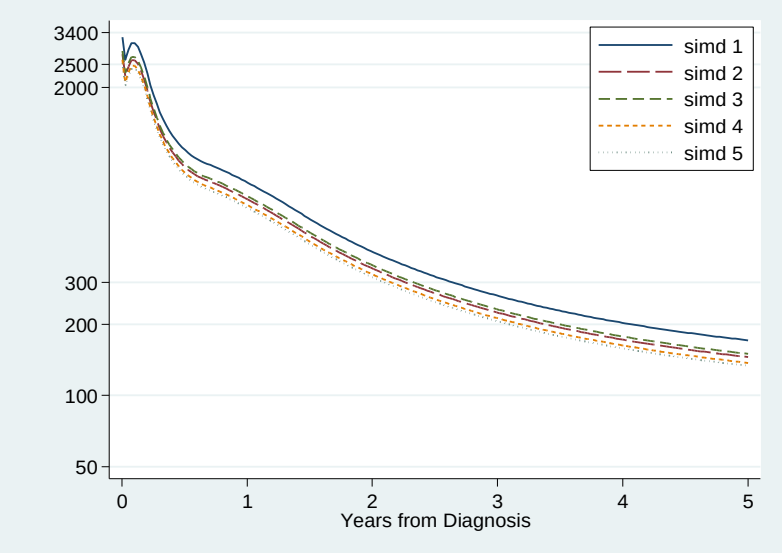
As shown in Table 2, age standardised net survival from primary liver cancer in men is estimated to be **21% (CI 14%-27%)** at one year following diagnosis in the most deprived quintile compared with **37% (CI 26%-48%)** in the least deprived quintile suggesting a non-statistically significant **16%** difference in survival in men. There is no statistical significance seen at five years net survival in men. For women, the differences in the estimates of age standardised net survival between the least and most deprived quintiles are also not statistically significant at either one or five years. A linear test for trend across the deprivation quintiles resulted in statistical significance ($p<0.05$) for men at one year survival only.

### Excess Mortality

It is likely that much of the difference in survival may be related to differences in patient and tumour characteristics at the time of diagnosis (for example existing co-morbidities or grade of differentiation) and subsequent treatment. Consequently, the excess hazard of death - the measure of mortality due to liver cancer over and above expected mortality - has been calculated over time and presented below, factoring in some of these aspects. These are: age, sex, Charlson index of co-morbidity, inpatient bed days, grade of differentiation, metastases within 4 months, histology, use of surgery and chemotherapy. Further information on the details of the variables used and how they are grouped can be found in Appendix C.

A baseline model of excess mortality in Figure 28 shows some evidence of increasing excess mortality with increasing deprivation quintile, although larger differences are observed in SIMD 1 compared to the less deprived quintiles. There is an initial drop then rise in excess mortality in the first few weeks, which then declines steeply within the first year and more gradually over the

remaining years. The difference in excess mortality by deprivation group remains fairly constant over time. The Excess Hazard Ratio (EHR) suggests a significant difference between the most and least deprived groups without accounting for any factors (EHR=1.28 (CI 1.06-1.50)

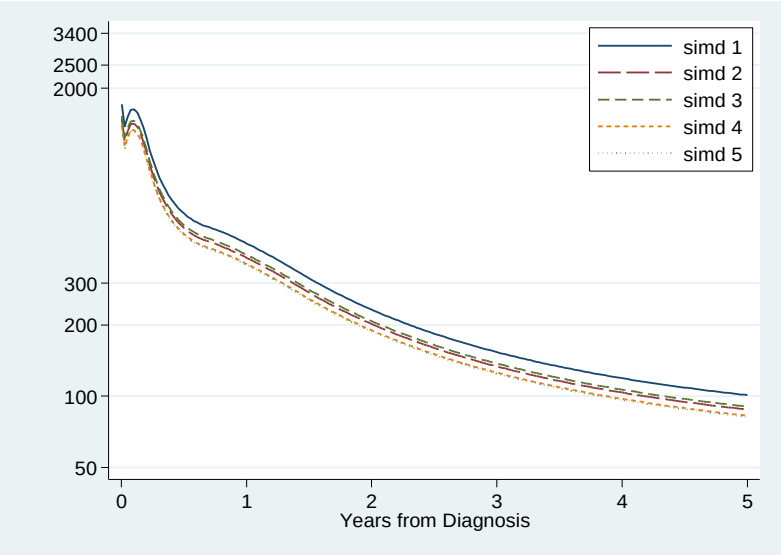



| Unadjusted HR | | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.28 | 1.06 | 1.50 |
| 2 | 1.09 | 0.90 | 1.28 |
| 3 | 1.12 | 0.92 | 1.33 |
| 4 | 1.03 | 0.84 | 1.22 |
| 5 (Least deprived) | 1.00 | | |

***Figure 28: Excess Mortality from Liver cancer by deprivation***

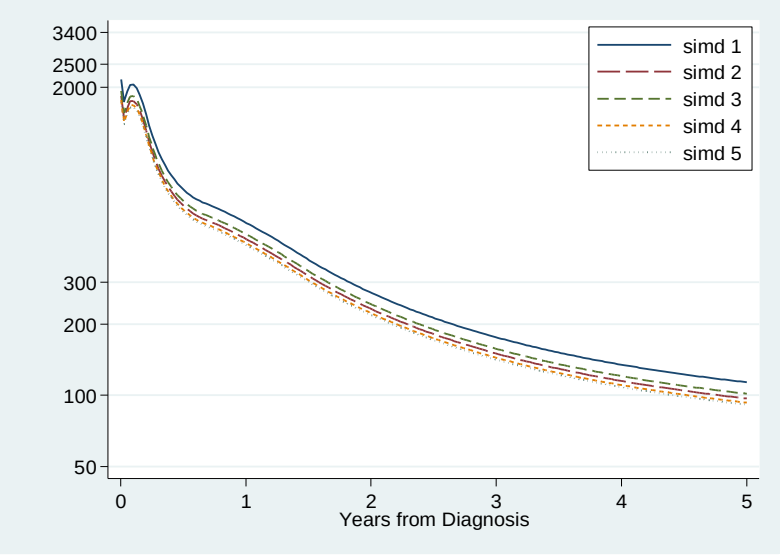
The addition of **sex, age, co-morbidities** (Charlson index of co-morbidity and number of inpatient bed days in the previous five years (not including the six months prior to diagnosis), **metastases within 4 months and histology** have little impact on the amount and pattern of excess mortality over time and associated excess hazard ratios (EHR) when added separately to the model (results are available on request).

The addition of **Grade of differentiation (1-4)** and use of **chemotherapy** to the model alter the amount and pattern of excess mortality over time and associated excess hazard ratios (EHR) when added separately to the model (see Figures 29 and 30 below), although excess hazard ratios for the most deprived category remain significantly different to the least deprived EHR=1.24 (CI 1.03, 1.44) for grade of differentiation and EHR=1.24 (CI 1.03, 1.45) for chemotherapy. Details on all variables added individually to the model are available on request.




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.24 | 1.03 | 1.44 |
| 2 | 1.07 | 0.89 | 1.26 |
| 3 | 1.11 | 0.91 | 1.30 |
| 4 | 1.01 | 0.82 | 1.20 |
| 5 (Least deprived) | 1.00 | | |

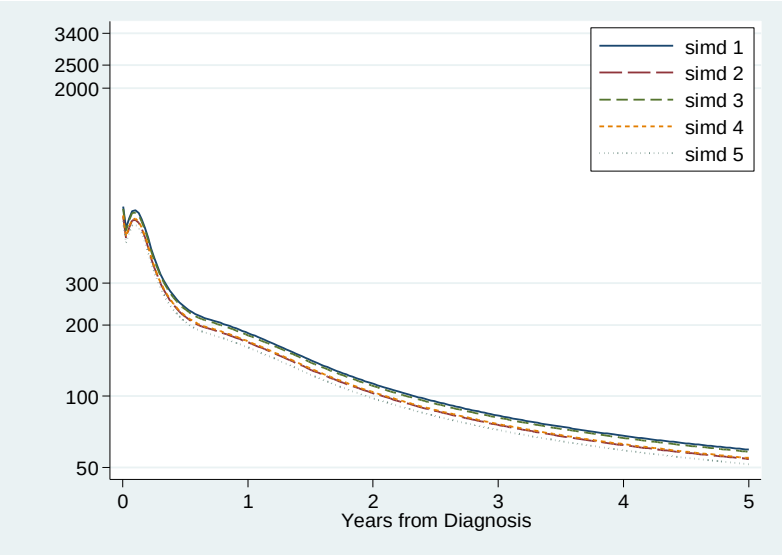
***Figure 29: Excess Mortality from Liver cancer by deprivation (incorporating grade of differentiation)***




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.24 | 1.03 | 1.45 |
| 2 | 1.06 | 0.88 | 1.25 |
| 3 | 1.11 | 0.91 | 1.31 |
| 4 | 1.02 | 0.83 | 1.21 |
| 5 (Least deprived) | 1.00 | | |

***Figure 30: Excess Mortality from Liver cancer by deprivation (incorporating chemotherapy)***

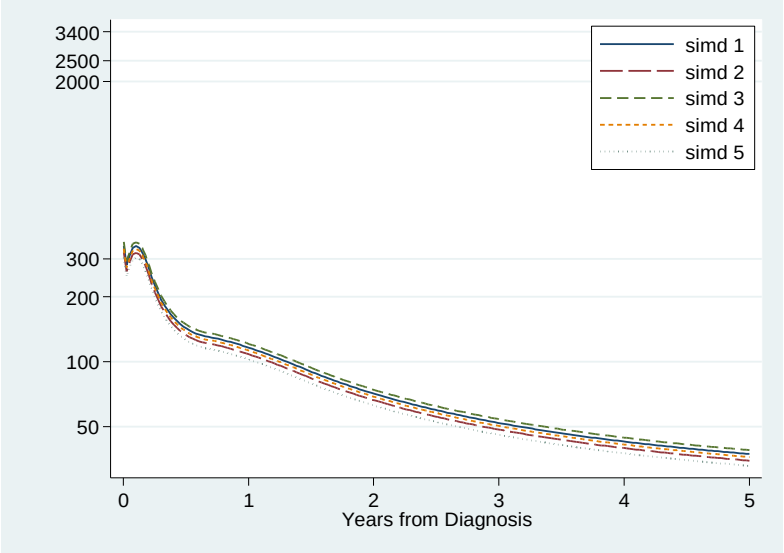
As shown in Figure 31, a larger drop in excess mortality is observed with the inclusion of the use of surgery variable separately in the model, which also reduces the EHR to 1.15 (CI 0.96, 1.35) amongst those in SIMD1. This suggests that any difference between deprivation groups is not statistically significant. However, surgery could be acting as a proxy for other effects such as state of health. If someone is fit enough to undergo surgery then it could be that it is their current state of health that is more influential than the effect of the surgery.




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.15 | 0.96 | 1.35 |
| 2 | 1.05 | 0.87 | 1.23 |
| 3 | 1.13 | 0.92 | 1.33 |
| 4 | 1.06 | 0.86 | 1.26 |
| 5 (Least deprived) | 1.00 | | |

***Figure 31: Excess Mortality from Liver cancer by deprivation (incorporating surgery)***

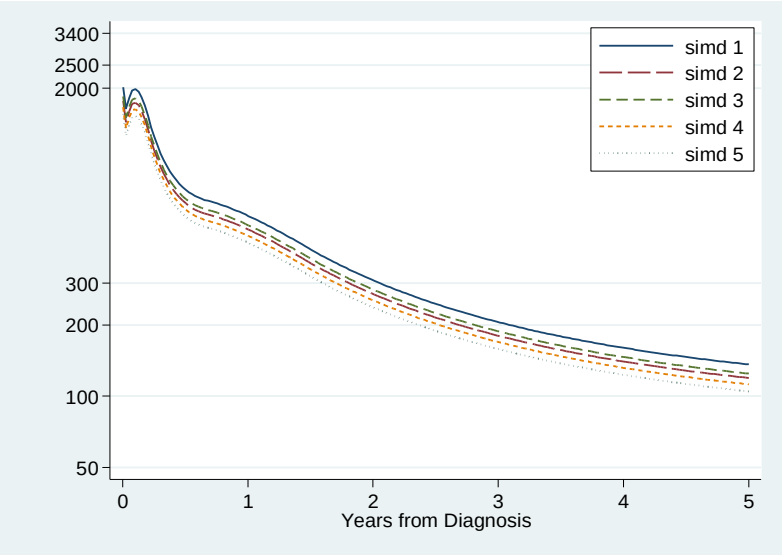
A multivariate model including all the factors previously mentioned together produces the lowest excess mortality rates and also reduces the mortality by deprivation group suggesting that factors included in the model explain some but not all of the variation by deprivation (See Figure 32).




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.13 | 0.94 | 1.33 |
| 2 | 1.06 | 0.87 | 1.24 |
| 3 | 1.18 | 0.97 | 1.40 |
| 4 | 1.10 | 0.89 | 1.30 |
| 5 (Least deprived) | 1.00 | | |

***Figure 32: Excess Mortality from Liver cancer by deprivation (incorporating all previously mentioned variables in the model)***

There is a complication with adding treatment factors to the model because treatments may be used for curative or palliative purposes. For this reason, the full model without treatment characteristics is presented in Figure 33 below.




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.30 | 1.08 | 1.52 |
| 2 | 1.14 | 0.94 | 1.34 |
| 3 | 1.19 | 0.97 | 1.40 |
| 4 | 1.07 | 0.87 | 1.27 |
| 5 (Least deprived) | 1.00 | | |

***Figure 33: Excess Mortality from Liver cancer by deprivation (incorporating all previously mentioned variables in the model except treatment characteristics)***

A comparison of Excess Hazard Ratios (EHR) or excess risk of primary liver cancer death (i.e. the hazard of death on top of the expected hazard of death, therefore related to primary liver cancer) for an unadjusted five year model (shown in dark green in Figure 34 below) shows a statistically significant EHR for SIMD1 when compared to those in the least deprived area. When adjustment is made for the patient, tumour and treatment characteristics previously described, the EHR reduces but remains significantly different between those in the most and least deprived groups. The factors that have been added to the model explain some of the excess mortality seen in primary liver cancer but perhaps do not account for the differences by deprivation (for example, no smoking factors are included).

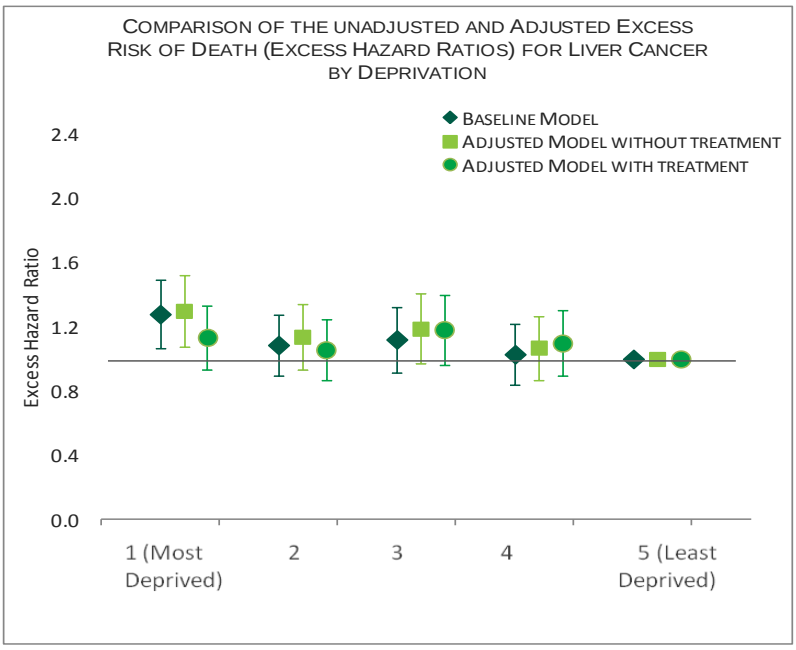



***Figure 34: A comparison of unadjusted and adjusted model Excess Hazard Ratios (showing with and without treatment) for Primary Liver Cancer***

## Lung Cancer

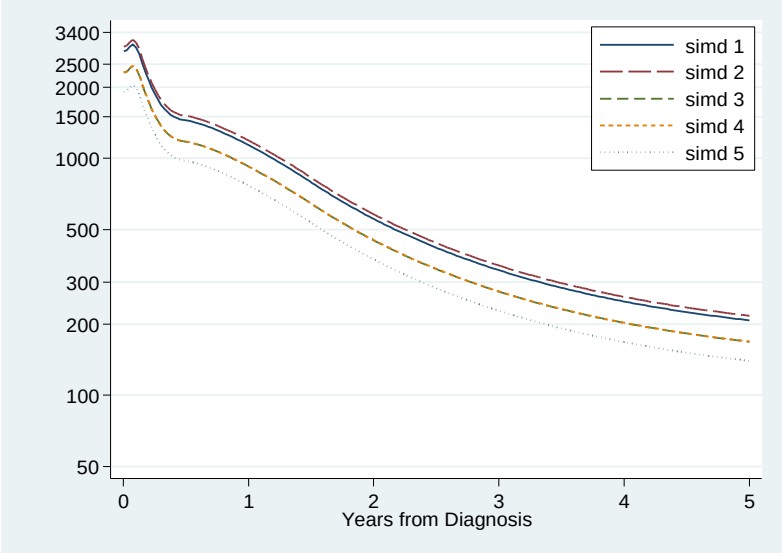
As shown in Table 2, age standardised net survival from lung cancer in men is estimated to be 27% (CI 24%-31%) at one year following diagnosis in the most deprived quintile compared with 34% (CI 28%-39%) in the least deprived quintile, but this difference is not statistically significant. There are also no statistically significant differences seen at five years net survival in men. For women, the differences in the estimates of age standardised net survival between the least and most deprived quintiles is not statistically significant at either one or five years. A linear test for trend across the deprivation quintiles was statistically significant ($p<0.05$) for men at one year survival only.

**Excess Mortality**

It is likely that much of the difference in survival may be related to differences in patient and tumour characteristics at the time of diagnosis (for example, existing co-morbidities, smoking status or stage at presentation) and subsequent treatment. Consequently, the excess hazard of death - the measure of mortality due to lung cancer over and above expected mortality - has been calculated over time and presented below, factoring in some of these aspects. These are: age, sex, Charlson Index of co-morbidity, inpatient bed days, grade of differentiation, stage, clinical extent, small cell/non small cell, use of surgery, radiotherapy and chemotherapy. Further information on the details of the variables used and how they are grouped can be found in Appendix C.

A baseline model of excess mortality is shown below (Figure 35) and suggests a difference in excess mortality between those in the least and most deprived groups, which increases with increasing deprivation. There is an initial increase in excess mortality in the first few weeks following diagnosis, which then decreases sharply in all deprivation groups. This continues to fall, although less sharply, up to five years after diagnosis and seems unlikely to level off beyond that. Deprivation groups SIMD

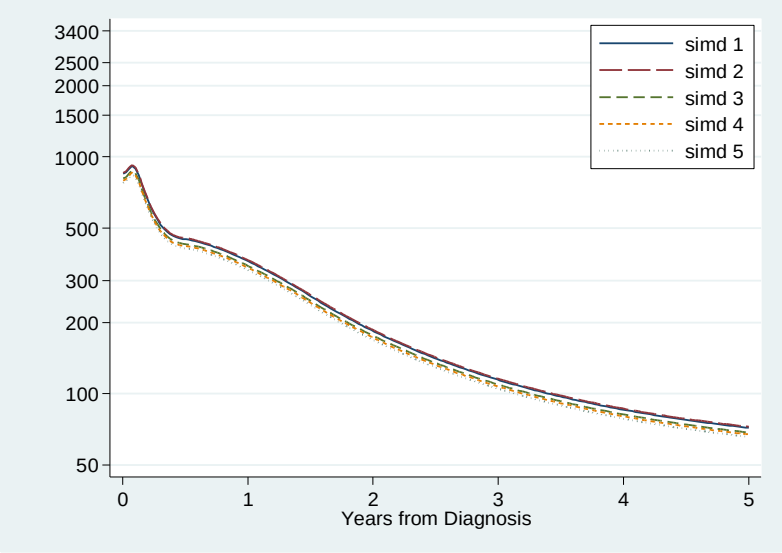
1-2 appear statistically significantly different compared with the least deprived group when looking at Excess Hazard Ratios (EHR) throughout the first five years after diagnosis.




| Unadjusted HR | | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.08 | 1.03 | 1.13 |
| 2 | 1.09 | 1.04 | 1.15 |
| 3 | 1.04 | 0.98 | 1.09 |
| 4 | 1.04 | 0.98 | 1.10 |
| 5 (Least deprived) | 1.00 | | |

***Figure 35: Excess Mortality from lung cancer by deprivation.***

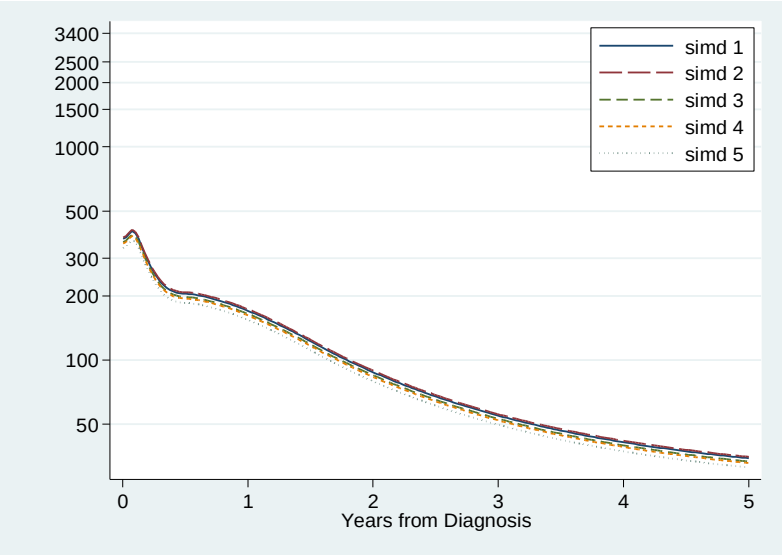
The addition of **sex, age, co-morbidities** (Charlson index of co-morbidity and number of inpatient bed days in the previous five years (not including the six months prior to diagnosis) and whether **small cell** (or non-small cell) all alter the amount and pattern of excess mortality over time and associated excess hazard ratios (HR) very little when added separately to the model (results are available on request).




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.09 | 1.04 | 1.14 |
| 2 | 1.10 | 1.05 | 1.16 |
| 3 | 1.04 | 0.99 | 1.10 |
| 4 | 1.02 | 0.97 | 1.08 |
| 5 (Least deprived) | 1.00 | | |

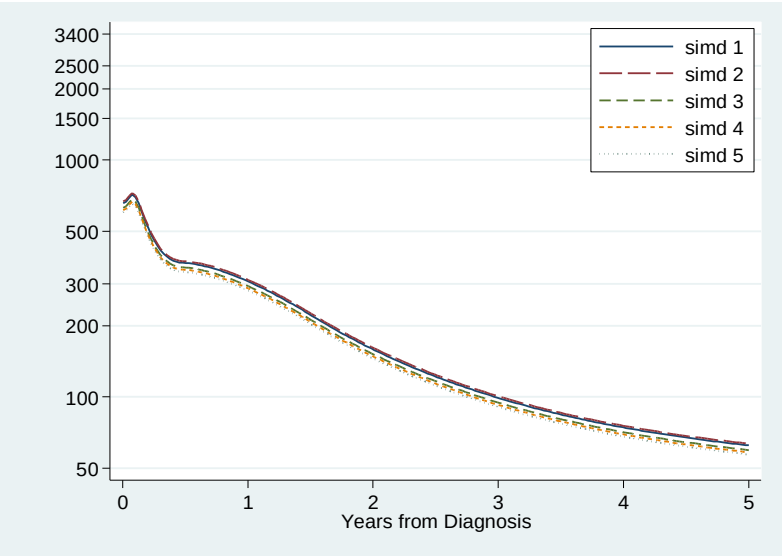
***Figure 36: Excess Mortality from lung cancer by deprivation (<u>incorporating grade of differentiation</u>)***

Larger drops in excess mortality are seen when adding grade of differentiation (Figure 36), clinical extent (Figure 38) and, in particular, stage at presentation (Figure 37), separately to the model.




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.10 | 1.05 | 1.16 |
| 2 | 1.12 | 1.07 | 1.18 |
| 3 | 1.07 | 1.01 | 1.12 |
| 4 | 1.05 | 0.99 | 1.11 |
| 5 (Least deprived) | 1.00 | | |

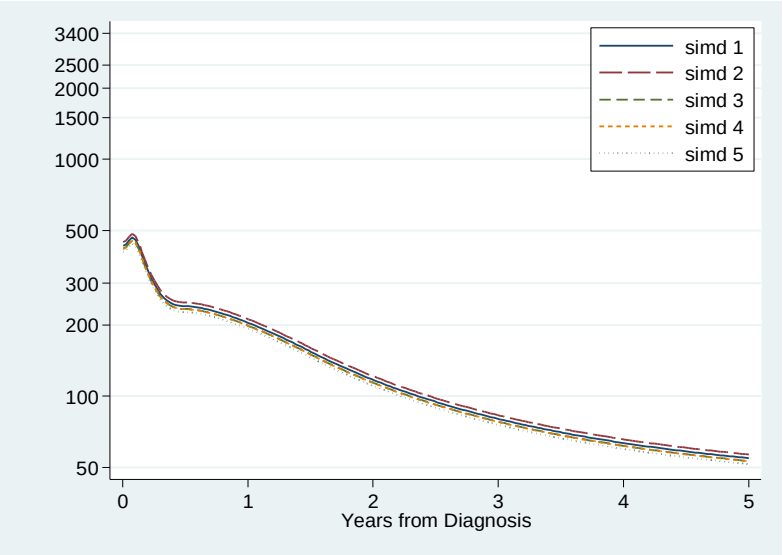
***Figure 37: Excess Mortality from lung cancer by deprivation (incorporating stage)***




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.09 | 1.04 | 1.15 |
| 2 | 1.11 | 1.06 | 1.17 |
| 3 | 1.04 | 0.99 | 1.10 |
| 4 | 1.02 | 0.96 | 1.08 |
| 5 (Least deprived) | 1.00 | | |

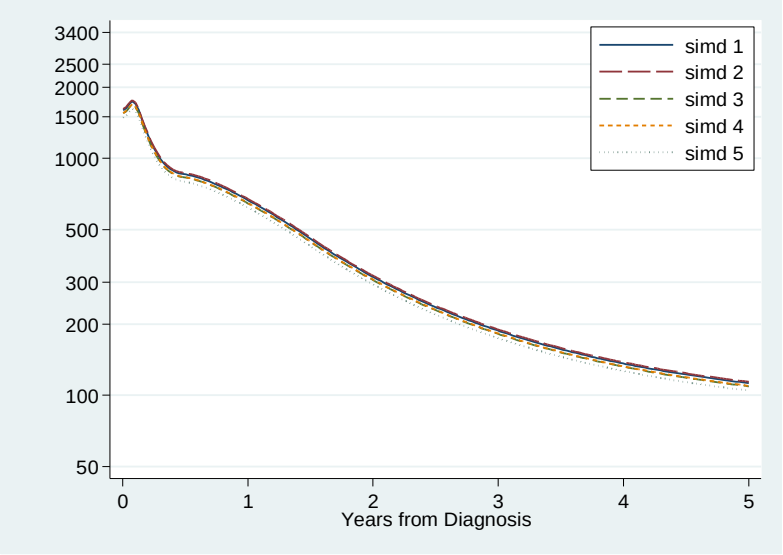
***Figure 38: Excess Mortality from lung cancer by deprivation (incorporating clinical extent)***

In terms of treatments, it was the use of surgery that seemed to have the greatest impact on improving survival (see Figure 39). The other treatments explored were radiotherapy and chemotherapy (Figures 40 and 41) which had some impact on excess mortality.



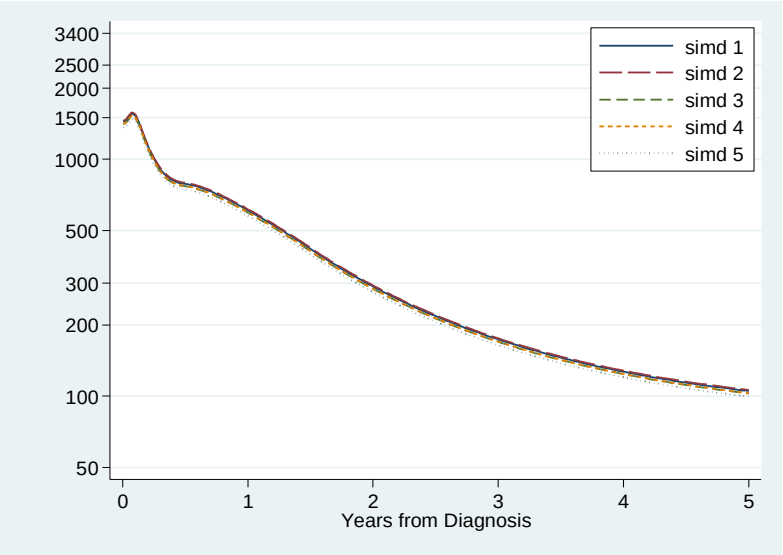

| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.06 | 1.01 | 1.11 |
| 2 | 1.10 | 1.04 | 1.15 |
| 3 | 1.03 | 0.98 | 1.09 |
| 4 | 1.03 | 0.97 | 1.09 |
| 5 (Least deprived) | 1.00 | | |

***Figure 39: Excess Mortality from lung cancer by deprivation (incorporating surgery)***



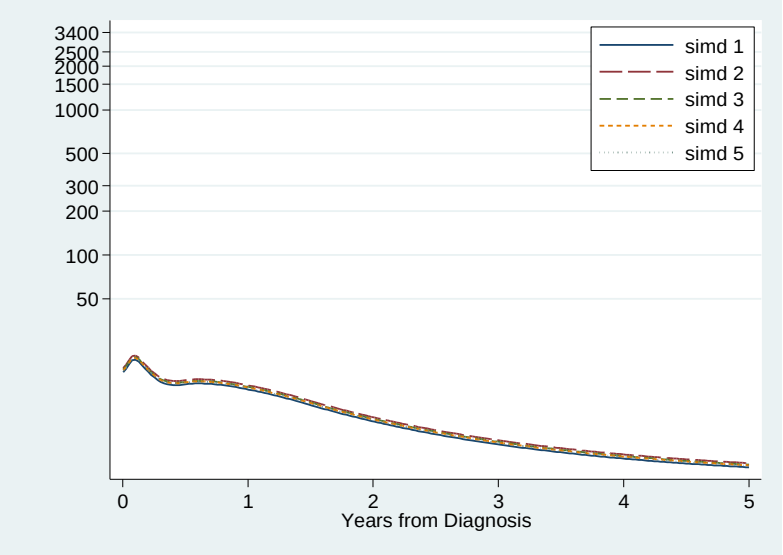

| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.08 | 1.02 | 1.13 |
| 2 | 1.09 | 1.03 | 1.14 |
| 3 | 1.04 | 0.99 | 1.10 |
| 4 | 1.05 | 0.99 | 1.11 |
| 5 (Least deprived) | 1.00 | | |

***Figure 40: Excess Mortality from lung cancer by deprivation (incorporating radiotherapy)***




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.06 | 1.01 | 1.11 |
| 2 | 1.07 | 1.01 | 1.12 |
| 3 | 1.03 | 0.98 | 1.09 |
| 4 | 1.03 | 0.98 | 1.09 |
| 5 (Least deprived) | 1.00 | | |

***Figure 41: Excess Mortality from lung cancer by deprivation (incorporating chemotherapy)***



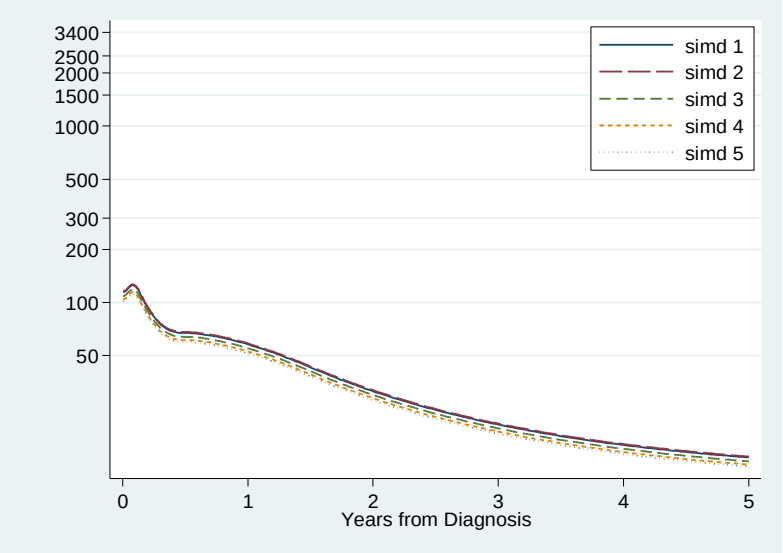

| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 0.98 | 0.93 | 1.02 |
| 2 | 1.04 | 0.99 | 1.09 |
| 3 | 1.02 | 0.96 | 1.07 |
| 4 | 1.01 | 0.95 | 1.06 |
| 5 (Least deprived) | 1.00 | | |

***Figure 42: Excess Mortality from lung cancer by deprivation (incorporating all previously mentioned variables in the model)***

A multivariate model including all the factors previously mentioned in the model together produces the lowest excess mortality rates and the difference between deprivation groups has narrowed to such an extent that there is no longer a significant difference in excess mortality between the most and least deprived groups. The results are shown in Figure 42.

There are some complications with adding treatment factors to the model. For example, radiotherapy may be used with curative or palliative intent and therefore with the current treatment simply recorded as Yes/No/NK, it can be difficult to identify which is indicative of a more favourable outcome for the purposes of statistical modelling. As a result, the full model without treatment

characteristics is presented in Figure 43 below. As shown below, in the model without the treatments, there is still a significant difference between the least and most deprived quintiles.




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.13 | 1.07 | 1.18 |
| 2 | 1.14 | 1.08 | 1.20 |
| 3 | 1.07 | 1.01 | 1.13 |
| 4 | 1.03 | 0.97 | 1.08 |
| 5 (Least deprived) | 1.00 | | |

***Figure 43: Excess Mortality from lung cancer by deprivation (incorporating all previously mentioned variables in the model except treatments)***

A comparison of Excess Hazard Ratios (EHR) or excess risk of lung cancer death (i.e. the hazard of death on top of the expected hazard of death, therefore related to lung cancer) for an unadjusted five year model (shown in dark green in Figure 44 below) shows a statistically significant EHR for SIMD 1-2 when compared to the least deprived. When adjustment is made for the series of patient, tumour and treatment characteristics previously described, there is no longer a statistically significant difference between those in most and least deprived quintiles (shown in light green). However, without the effects of treatments, a statistically significant difference remains for SIMD 1-3 when compared to the least deprived (shown in mid green in Figure 44). The assumption that those living in more deprived communities will present with more advanced disease is not borne out across all studies[20].

[20] Brewster DH, Thomson CS, Hole DJ, Black RJ, Stroner PL, Gillis CR. Relation between socioeconomic status and tumour stage in patients with breast, colorectal, ovarian, and lung cancer: results from four national, population based studies. *BMJ*. 2001 Apr 7;322(7290):830-1.

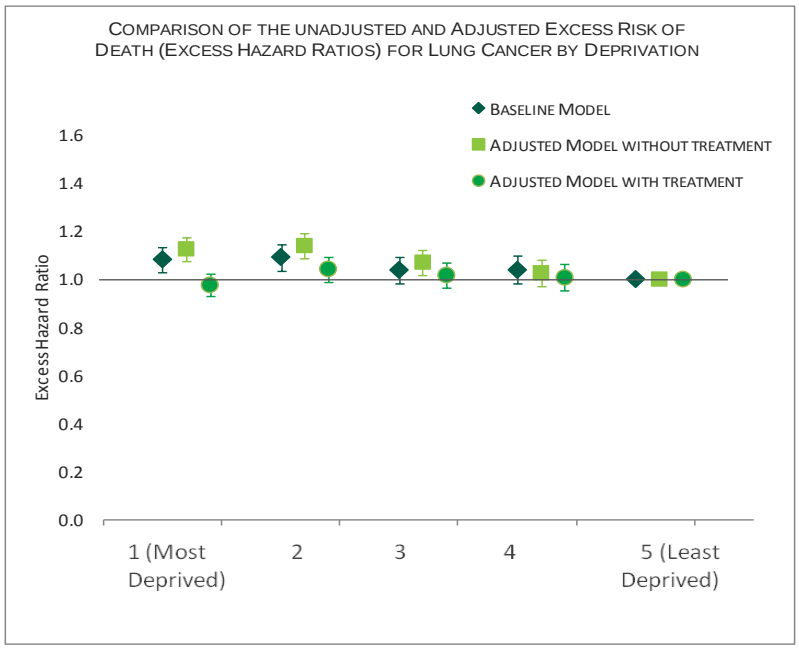



***Figure 44: A comparison of unadjusted and adjusted model Excess Hazard Ratios (showing with and without treatment) for Lung Cancer***

## Malignant Melanoma of Skin

As shown in Table 2, age standardised net survival from malignant melanoma of the skin in men is estimated to be **92% (CI 87%-98%)** at one year in the most deprived quintile compared with **97% (CI 94%-100%)** in the least deprived quintile resulting in a **5%** difference in survival (although not statistically significant). There is also no statistically significant difference seen at five years net survival in men.

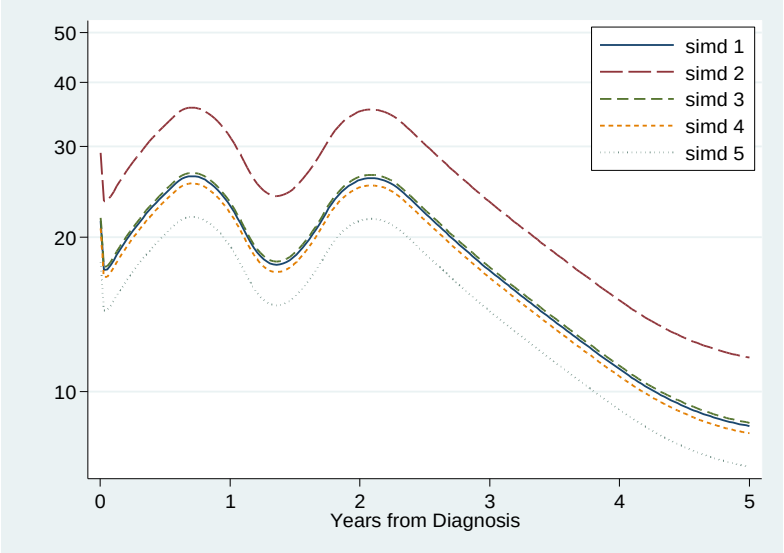
For women, the differences in the estimates of age standardised net survival between the least and most deprived quintiles are also not statistically significant at either one or five years. A linear test for trend for survival across the deprivation quintiles was, however, statistically significant for men at one year ($p < 0.05$).

**Excess Mortality**

It is likely that much of the difference in survival may be related to differences in patient and tumour characteristics at the time of diagnosis (for example existing co-morbidities or Breslow thickness at presentation) and subsequent treatment. Consequently, the excess hazard of death - the measure of mortality due to malignant melanoma of the skin over and above expected mortality - has been calculated over time and presented below, factoring in some of these aspects. These variables are: age, sex, Charlson Index of co-morbidity, number of inpatient bed days, metastases within 4 months, tumour morphology, subsite, Clarks level and Breslow thickness. Further information on the details of the variables used and how they are grouped can be found in Appendix C.

A baseline model of excess mortality is shown below (Figure 45) and suggests a sizable difference in excess mortality between those in the least and most deprived groups which appears to show SIMD 2 (second most deprived group) as having the highest excess mortality and a statistically significant

Excess Hazard Ratio (EHR) of 1.63 (CI 1.03-2.24) when compared to the least deprived group. There is a decrease in excess mortality following diagnosis across all deprivation groups followed by a rise at around nine months, another fall and then a rise again at two years.

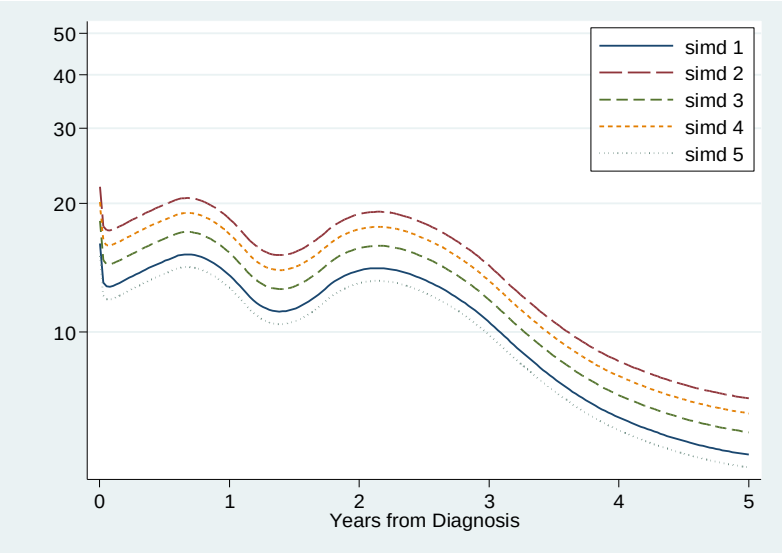



| Unadjusted HR | | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.20 | 0.62 | 1.78 |
| 2 | 1.63 | 1.03 | 2.24 |
| 3 | 1.22 | 0.73 | 1.70 |
| 4 | 1.16 | 0.71 | 1.61 |
| 5 (Least deprived) | 1.00 | | |

***Figure 45: Excess Mortality from malignant melanoma of the skin by deprivation***

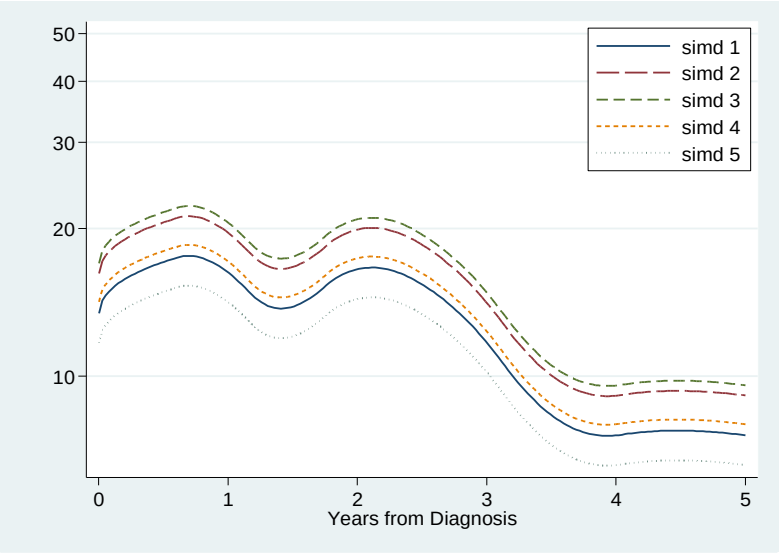
The addition of **age, sex** and **co-morbidities** (Charlson index of co-morbidity and number of inpatient bed days in the previous five years (not including the six months prior to diagnosis) have little impact on the amount and pattern of excess mortality over time and associated excess hazard ratios (EHR) when added separately to the model (available on request).

Adding **metastases within 4 months** (of diagnosis) **and Breslow thickness** to the model does have some impact on excess mortality and reduces the gap observed in deprivation but differences do remain (see Figures 46 and 47 respectively)




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.07 | 0.58 | 1.56 |
| 2 | 1.45 | 0.93 | 1.97 |
| 3 | 1.21 | 0.76 | 1.66 |
| 4 | 1.34 | 0.85 | 1.83 |
| 5 (Least deprived) | 1.00 | | |

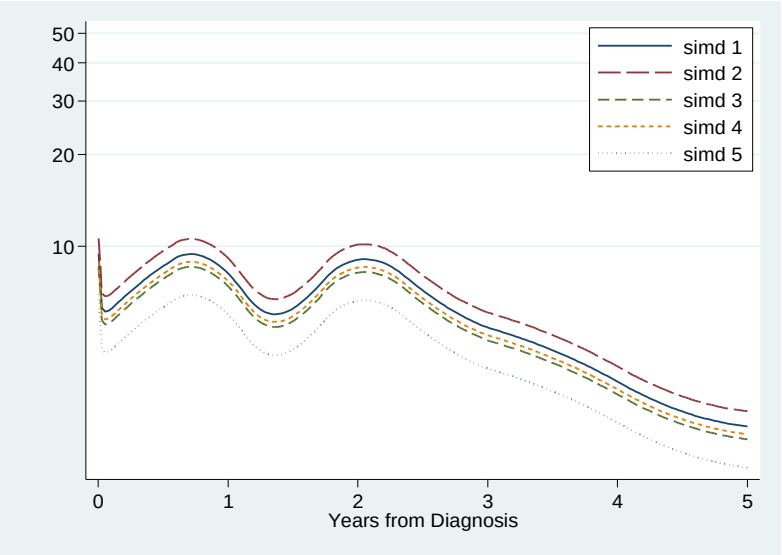
***Figure 46: Excess Mortality from malignant melanoma of the skin by deprivation (incorporating metastases within 4 months)***




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.15 | 0.54 | 1.75 |
| 2 | 1.39 | 0.81 | 1.96 |
| 3 | 1.45 | 0.87 | 2.03 |
| 4 | 1.21 | 0.71 | 1.71 |
| 5 (Least deprived) | 1.00 | | |

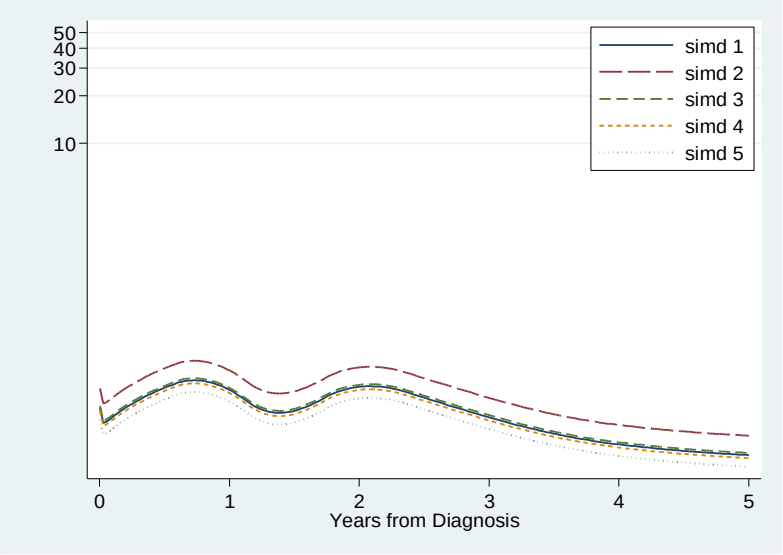
***Figure 47: Excess Mortality from malignant melanoma of the skin by deprivation (incorporating Breslow thickness)***

The univariate addition of **subsite** to the model did reduce some of the excess mortality and associated hazard ratios (available on request), but not to the same extent as tumour **morphology** (Figure 48).




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.36 | 0.80 | 1.92 |
| 2 | 1.53 | 0.99 | 2.07 |
| 3 | 1.24 | 0.78 | 1.69 |
| 4 | 1.28 | 0.81 | 1.75 |
| 5 (Least deprived) | 1.00 | | |

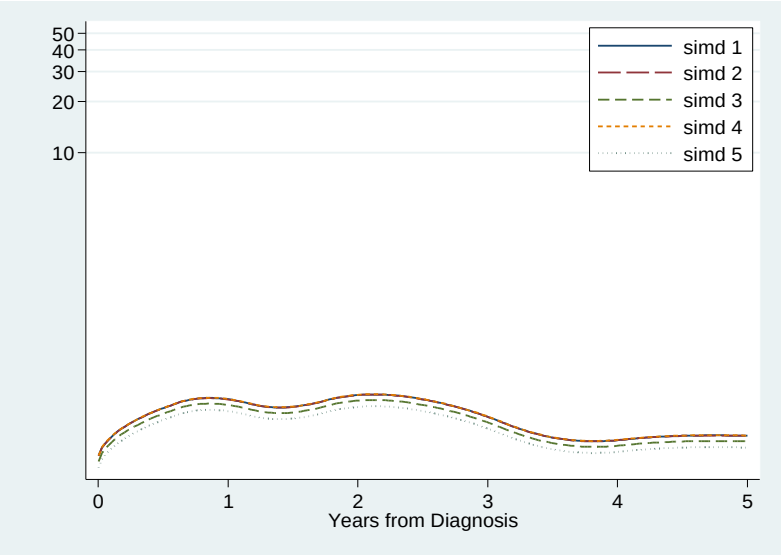
***Figure 48: Excess Mortality from malignant melanoma of the skin by deprivation (incorporating tumour morphology)***




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.18 | 0.70 | 1.67 |
| 2 | 1.57 | 1.03 | 2.11 |
| 3 | 1.22 | 0.78 | 1.66 |
| 4 | 1.13 | 0.73 | 1.54 |
| 5 (Least deprived) | 1.00 | | |

***Figure 49: Excess Mortality from malignant melanoma of the skin by deprivation (incorporating Clarks level)***

As shown in Figure 49, Clarks level at diagnosis has a greater impact on excess mortality than any other single factor. The difference between the deprivation groups also decreases, although the EHR for SIMD2 remains statistically significant.




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.17 | 0.70 | 1.64 |
| 2 | 1.17 | 0.75 | 1.59 |
| 3 | 1.09 | 0.70 | 1.47 |
| 4 | 1.18 | 0.75 | 1.60 |
| 5 (Least deprived) | 1.00 | | |

***Figure 50: Excess Mortality from malignant melanoma of the skin by deprivation (incorporating all previously mentioned variables in the model)***

A multivariate model incorporating all the factors previously mentioned produces the lowest excess mortality rates and also reduces the mortality by deprivation group. There is very little variation in survival by deprivation remaining, which suggests that the factors included in the model appear to explain any previously observed variation by deprivation. An EHR of 1.17 (CI 0.75-1.59) for SIMD2 compared with the least deprived group corroborates this.

A comparison of Excess Hazard Ratios (EHR) or excess risk of malignant melanoma of the skin death (i.e. the hazard of death on top of the expected hazard of death, therefore related to malignant melanoma of the skin) for an unadjusted five year model (shown in dark green in Figure 51 below) shows a consistently non-significant difference between the most and least deprived quintiles even before taking account of patient and tumour characteristics. The observed marginally statistically significant comparison of SIMD2 to the least deprived quintile is explained away primarily by tumour characteristics.

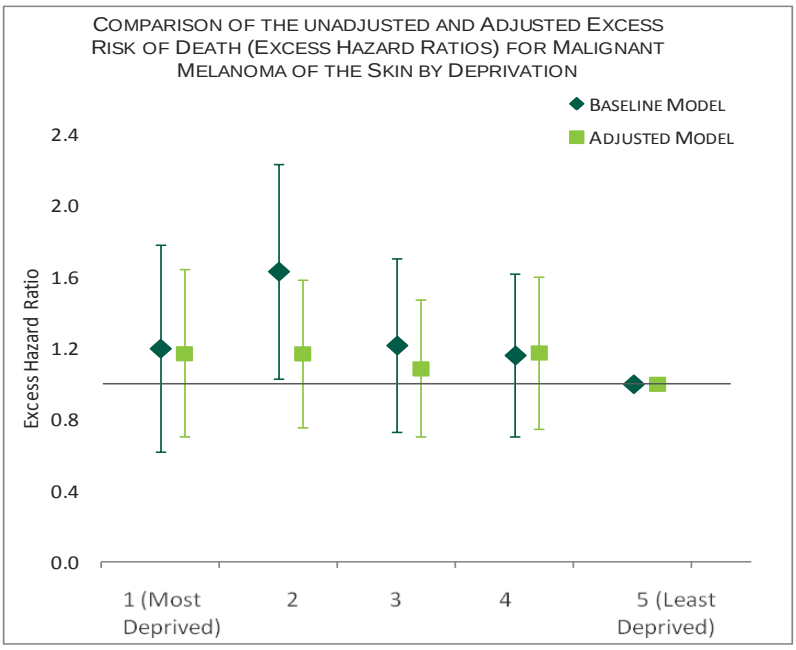



***Figure 51: A comparison of unadjusted and adjusted model Hazard Ratios for Malignant melanoma of the skin***

## Oesophageal Cancer

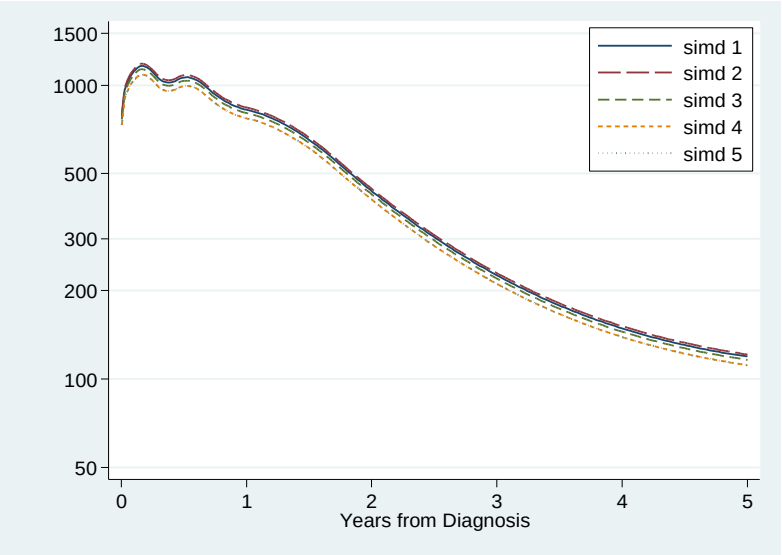
As shown in Table 2, age standardised net survival from oesophageal cancer in men is estimated to be **37% (CI 30%-43%)** at one year following diagnosis in the most deprived quintile compared with **42% (CI 34%-51%)** in the least deprived quintile but this difference is not statistically significant. There is also no statistically significant difference seen at five years net survival in men.

For women, the differences in the estimates of age standardised net survival between the least and most deprived quintiles are also not statistically significant at either one or five years. A linear test for trend across the deprivation quintiles (not shown) resulted in statistical significance ($p < 0.05$) for men at one year survival).

### Excess Mortality

It is likely that much of the difference in survival may be related to differences in patient and tumour characteristics at the time of diagnosis (for example existing co-morbidities, smoking status or grade of differentiation) and subsequent treatment. Consequently, the excess hazard of death - the measure of mortality due to oesophageal cancer over and above expected mortality - has been calculated over time and presented below, factoring in some of these aspects. These aspects are: age, sex, Charlson index of co-morbidity, inpatient bed days, grade of differentiation, metastases within 4 months, subsite, and use of surgery, radiotherapy or chemotherapy. Further information on the details of the variables used and how they are grouped can be found in Appendix C.

A baseline model of excess mortality is shown below (Figure 52) but there is no statistically significant difference in excess mortality between those in the least and most deprived groups. At around nine months, a decrease in excess mortality begins and continues across the groups over time from diagnosis. None of these results show statistically significant differences.

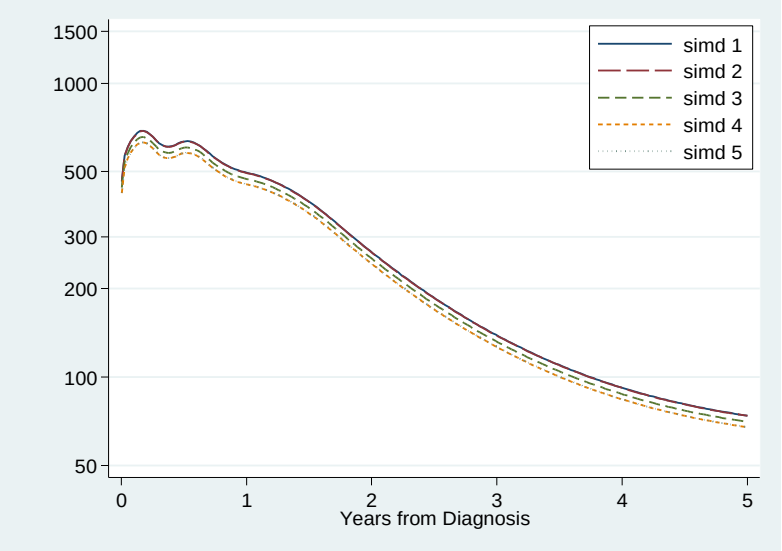



| Unadjusted HR | | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.07 | 0.95 | 1.19 |
| 2 | 1.09 | 0.97 | 1.21 |
| 3 | 1.04 | 0.92 | 1.16 |
| 4 | 1.00 | 0.88 | 1.12 |
| 5 (Least deprived | 1.00 | | |

***Figure 52: Excess Mortality from oesophageal cancer by deprivation***

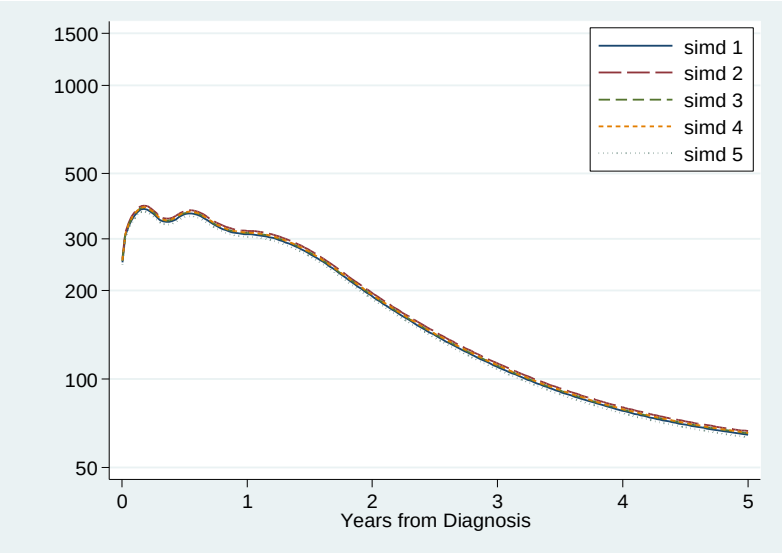
The addition of **sex, age, co-morbidities** (Charlson index of co-morbidity and number of inpatient bed days in the previous five years (not including the six months prior to diagnosis), **metastases within 4 months** and **subsite** have little impact on the amount and pattern of excess mortality over time and associated excess hazard ratios (EHR) when added separately to the model (available on request).

The addition of **grade of differentiation** to the model (shown in Figure 53) reduced excess mortality and associated hazard ratios by a small amount, but again the pattern and difference between deprivation groups looks very similar.




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.09 | 0.97 | 1.22 |
| 2 | 1.09 | 0.97 | 1.21 |
| 3 | 1.04 | 0.92 | 1.16 |
| 4 | 1.00 | 0.88 | 1.12 |
| 5 (Least deprived) | 1.00 | | |

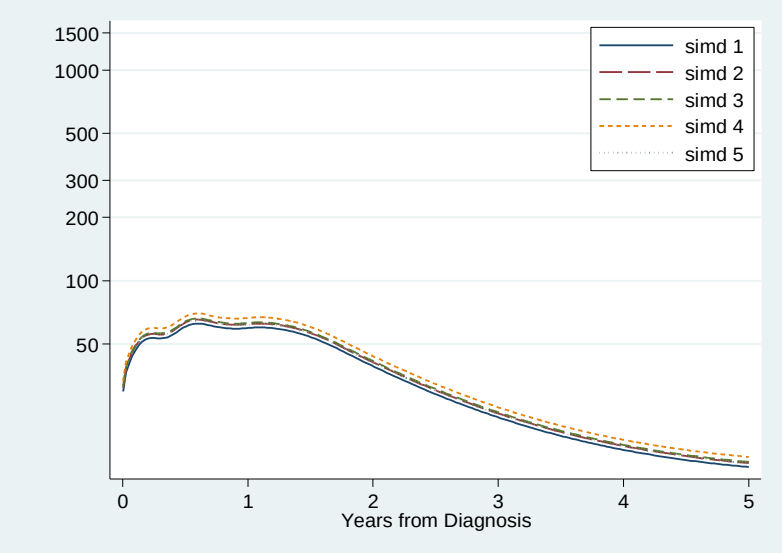
***Figure 53: Excess Mortality from oesophageal cancer by deprivation (incorporating grade of differentiation)***




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.02 | 0.91 | 1.14 |
| 2 | 1.05 | 0.93 | 1.16 |
| 3 | 1.03 | 0.91 | 1.15 |
| 4 | 1.04 | 0.91 | 1.16 |
| 5 (Least deprived) | 1.00 | | |

***Figure 54: Excess Mortality from oesophageal cancer by deprivation (incorporating surgery)***

Out of all the treatment variables, it is only **surgery** that has an impact on excess mortality although inclusion of variables on use of **radiotherapy** and **chemotherapy** reduce the EHR somewhat (results are available on request).

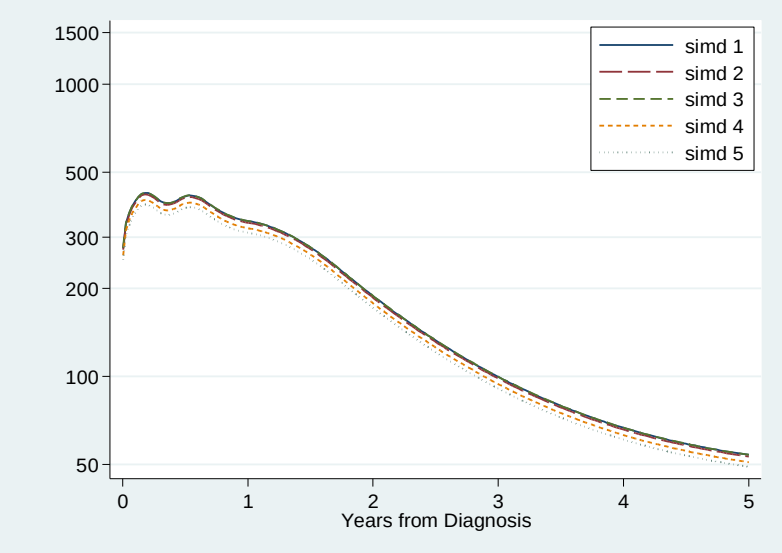



| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 0.96 | 0.85 | 1.07 |
| 2 | 1.01 | 0.89 | 1.12 |
| 3 | 1.02 | 0.90 | 1.13 |
| 4 | 1.08 | 0.95 | 1.20 |
| 5 (Least deprived) | 1.00 | | |

***Figure 55: Excess Mortality from oesophageal cancer by deprivation (incorporating all previously mentioned variables in the model)***

Multivariate model including all the factors previously mentioned in the model together produces the lowest excess mortality rates and very little difference by deprivation group can be seen. The EHR reduce to 0.96 (CI 0.85-1.07) for the most deprived group compared with the least deprived group which is not statistically significant (see Figure 55).

There is a complication with adding treatment factors to the model because treatments may be used for curative or palliative purposes. For this reason, the full model <u>without treatment characteristics</u> is presented in Figure 56 below.




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.10 | 0.97 | 1.22 |
| 2 | 1.08 | 0.96 | 1.20 |
| 3 | 1.10 | 0.97 | 1.22 |
| 4 | 1.04 | 0.91 | 1.16 |
| 5 (Least deprived) | 1.00 | | |

***Figure 56: Excess Mortality from oesophageal cancer by deprivation (<u>incorporating all previously mentioned variables in the model except treatments</u>)***

A comparison of Excess Hazard Ratios (EHR) or excess risk of oesophageal cancer death (i.e. the hazard of death on top of the expected hazard of death, therefore related to oesophageal cancer) for an unadjusted five year model (shown in dark green in Figure 57 below) shows a non-statistically significant EHR when compared to the least deprived. Adjustment for the patient, tumour and treatment characteristics as previously described reduce the EHR in most cases, and there are no statistically significant differences between SIMD groups.

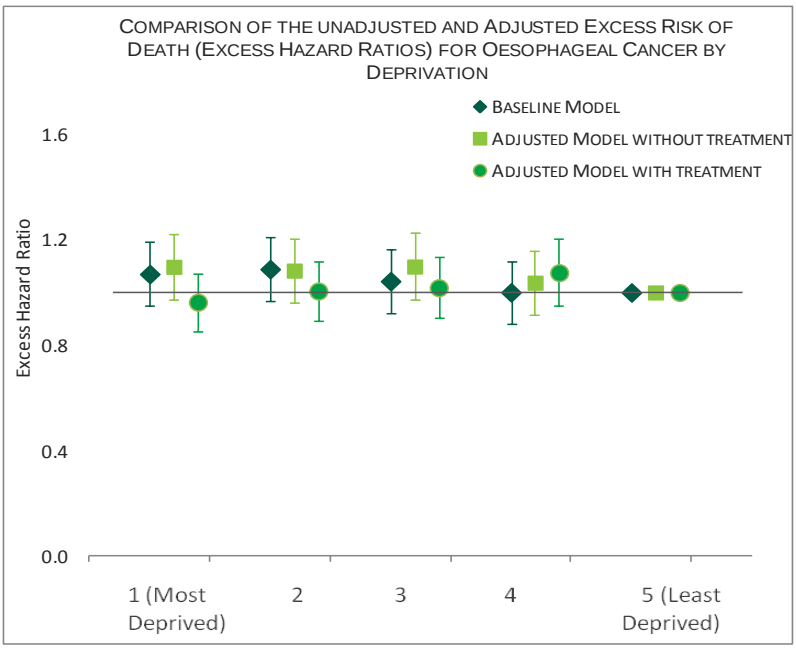



***Figure 57: A comparison of unadjusted and adjusted model Excess Hazard Ratios (showing with and without treatment) for Oesophageal Cancer***

## Prostate Cancer

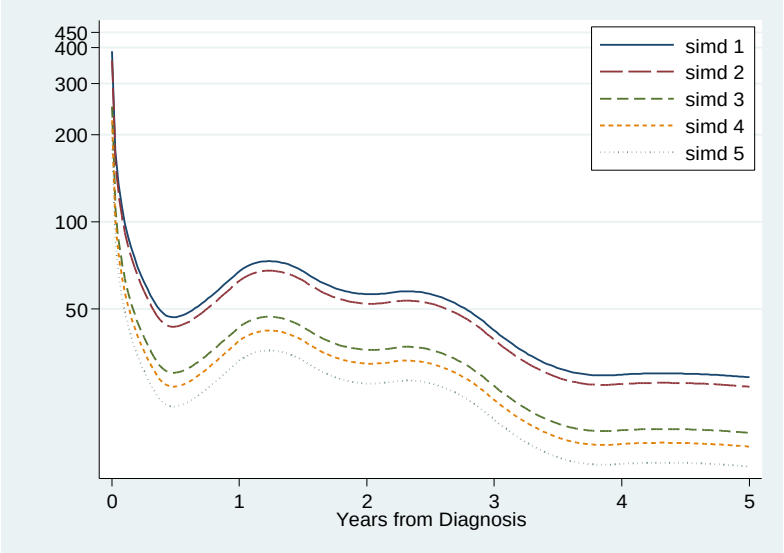
As shown in Table 2, age standardised net survival from prostate cancer is estimated to be **95% (CI 91- 98%)** at one year following diagnosis in the most deprived quintile compared with **97% (CI 95%-99%)** in the least deprived quintile, resulting in a non-statistically significant **2%** difference in survival. There is also no statistically significant difference seen at five years. A linear test for trend across the deprivation quintiles resulted in statistical significance ($p<0.05$) at five years.

### Excess Mortality

It is likely that much of the difference in survival may be related to differences in patient and tumour characteristics at the time of diagnosis (for example existing co-morbidities or stage at presentation) and subsequent treatment. Consequently, the excess hazard of death - the measure of mortality due to prostate cancer over and above expected mortality - has been calculated over time and presented below, factoring in some of these aspects. These are age, Charlson Index of co-morbidity, inpatient bed days, Gleason score, Metastases within 4 months, use of surgery, radiotherapy and hormonal therapy. Further information on the details of the variables used and how they are grouped can be found in Appendix C.

A baseline model of excess mortality is shown below (Figure 58) and there appears to be some evidence of increasing excess mortality with increasing deprivation quintile, although larger differences are observed in SIMD1 and 2 compared to those in the less deprived quintiles. There is an initial drop in excess mortality in the first six months, which then increases to one year. This is followed by a slow decrease in excess mortality to around three and a half years after diagnosis. Thereafter, it remains reasonably constant over time. All deprivation groups appear statistically significantly different compared with the least deprived group when looking at Excess Hazard Ratios

(EHR) throughout the first five years after diagnosis, with the extent in SIMD1 being the largest (EHR=1.98 (CI 1.60-2.36)).

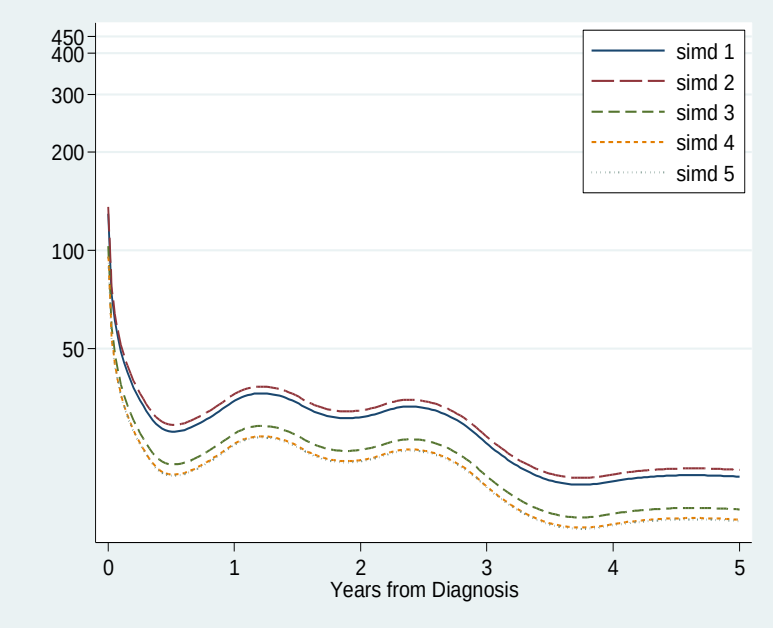



| Unadjusted HR | | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.98 | 1.60 | 2.36 |
| 2 | 1.84 | 1.50 | 2.18 |
| 3 | 1.29 | 1.03 | 1.54 |
| 4 | 1.17 | 0.93 | 1.41 |
| 5 (Least deprived) | 1.00 | | |

***Figure 58: Excess Mortality from prostate cancer by deprivation***

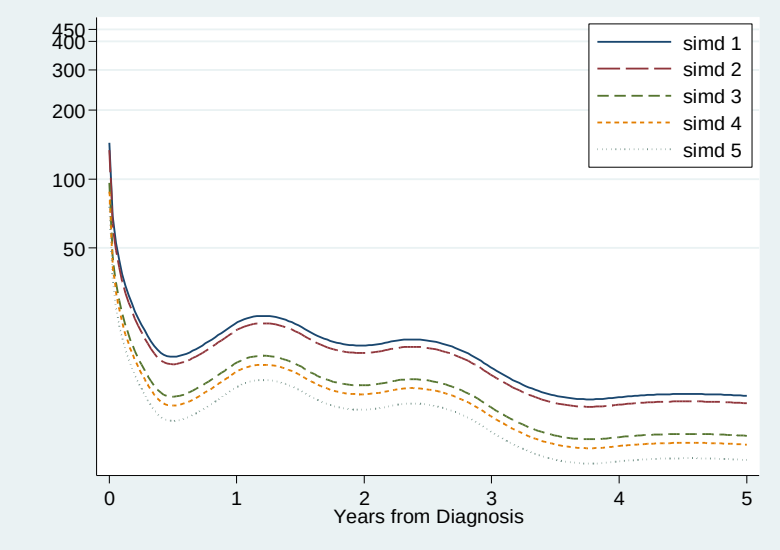
The addition of **age group**, **co-morbidities** (Charlson index of co-morbidity and number of inpatient bed days in the previous five years (not including the six months prior to diagnosis), **Gleason score** and use of **radiotherapy** all alter the amount and pattern of excess mortality over time very little and associated excess hazard ratios (EHR) when added separately to the model (available on request).

The addition of **metastases within 4 months** (Figure 59), use of **surgery** (Figure 60) and not receiving **hormonal therapy** (Figure 61) to the model reduced excess mortality and associated hazard ratios to a greater extent.



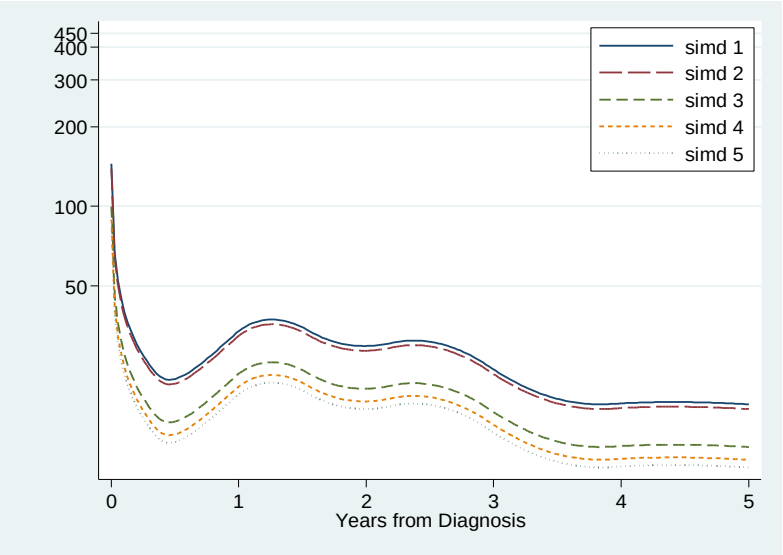

| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.37 | 1.12 | 1.61 |
| 2 | 1.43 | 1.19 | 1.67 |
| 3 | 1.08 | 0.89 | 1.28 |
| 4 | 1.01 | 0.83 | 1.19 |
| 5 (Least deprived) | 1.00 | | |

***Figure 59: Excess Mortality from prostate cancer by deprivation (incorporating metastases within 4 months variable)***




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.91 | 1.55 | 2.26 |
| 2 | 1.77 | 1.45 | 2.09 |
| 3 | 1.28 | 1.03 | 1.53 |
| 4 | 1.17 | 0.94 | 1.40 |
| 5 (Least deprived) | 1.00 | | |

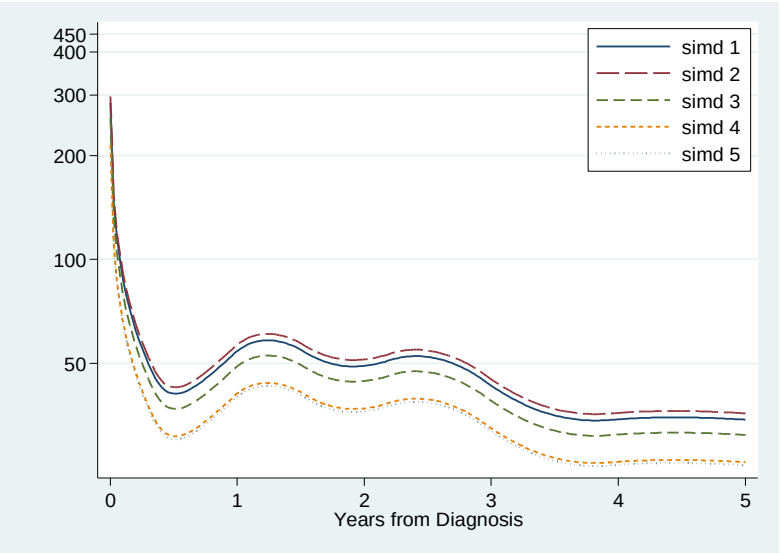
***Figure 60: Excess Mortality from prostate cancer by deprivation (incorporating surgery)***




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.73 | 1.41 | 2.05 |
| 2 | 1.66 | 1.37 | 1.96 |
| 3 | 1.19 | 0.97 | 1.42 |
| 4 | 1.07 | 0.86 | 1.28 |
| 5 (Least deprived) | 1.00 | | |

***Figure 61: Excess Mortality from prostate cancer by deprivation (incorporating hormonal therapy)***

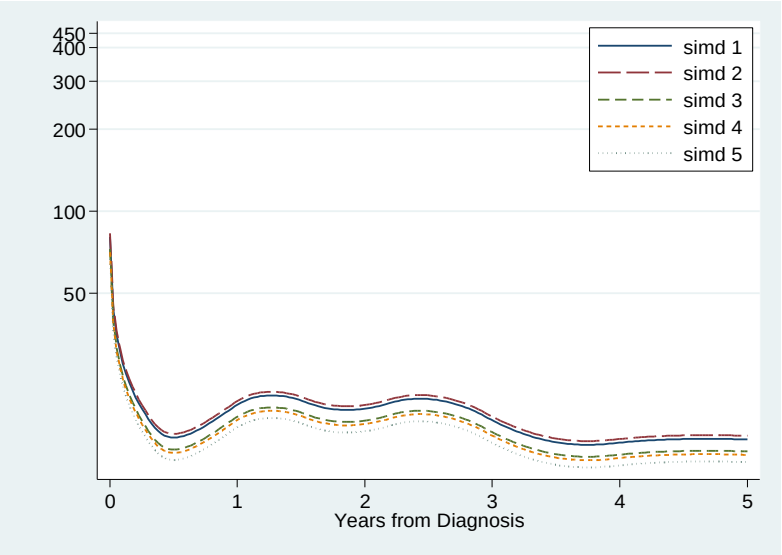
Similar patterns in excess mortality over time are seen in all these models, with SIMD 1 and 2 appearing to have larger excess mortality and statistically significant EHR than other deprivation quintiles. The only univariate model which displays a more gradual increase in excess mortality by deprivation is that including Gleason score which is shown in Figure 62.




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.36 | 1.15 | 1.56 |
| 2 | 1.41 | 1.20 | 1.62 |
| 3 | 1.22 | 1.04 | 1.41 |
| 4 | 1.02 | 0.86 | 1.18 |
| 5 (Least deprived) | 1.00 | | |

***Figure 62: Excess Mortality from prostate cancer by deprivation (incorporating Gleason score)***

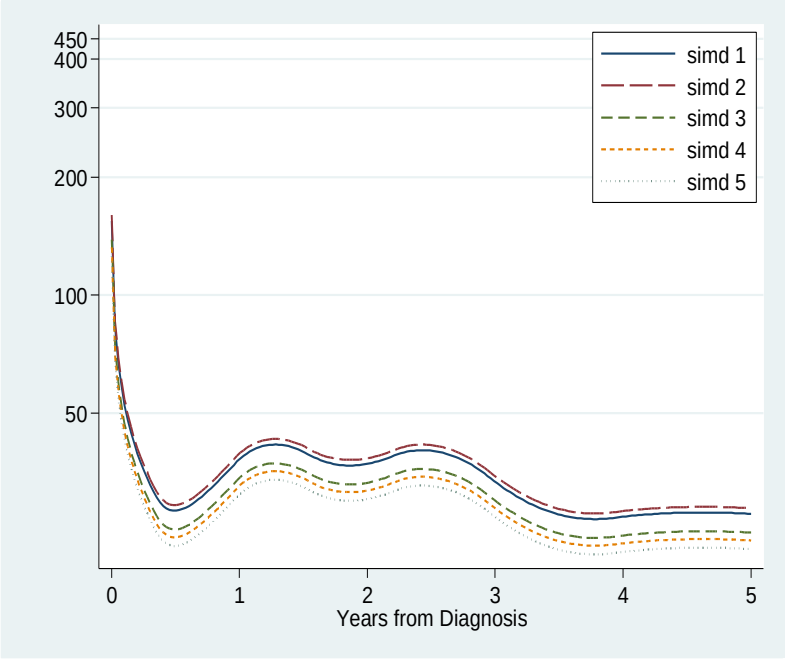
A multivariate model including all the factors previously mentioned in the model together produces the lowest excess mortality rates, with a large amount of the difference across deprivation groups explained by a combination of patient, tumour and treatment characteristics. As a result the EHR for SIMD1 and SIMD2 become only marginally statistically significant (SIMD1 EHR=1.21 (CI 1.02-1.40) and SIMD2 EHR=1.25 (CI 1.06-1.43) when compared to the least deprived group (Figure 63)




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.21 | 1.02 | 1.40 |
| 2 | 1.25 | 1.06 | 1.43 |
| 3 | 1.09 | 0.93 | 1.26 |
| 4 | 1.06 | 0.90 | 1.23 |
| 5 (Least deprived) | 1.00 | | |

***Figure 63: Excess Mortality from prostate cancer by deprivation (incorporating all previously mentioned variables in the model)***

There is a complication with adding treatment factors to the model because treatments may be used for curative or palliative purposes. For this reason, the full model without treatment characteristics is presented in Figure 64 below.




| | Hazard Ratio | 95% CI | |
|---|---|---|---|
| | | LCI | UCI |
| **SIMD (2009)** | | | |
| 1 (Most deprived) | 1.23 | 1.04 | 1.42 |
| 2 | 1.27 | 1.08 | 1.46 |
| 3 | 1.10 | 0.93 | 1.27 |
| 4 | 1.05 | 0.89 | 1.22 |
| 5 (Least deprived) | 1.00 | | |

***Figure 64: Excess Mortality from prostate cancer by deprivation (incorporating all previously mentioned variables in the model except treatments)***

The inclusion of treatment variables in statistical modelling for prostate cancer appear to reduce the HR and excess mortality marginally more than the model which excludes these variables.

A comparison of Excess Hazard Ratios (EHR) or excess risk of prostate cancer death (i.e. the hazard of death on top of the expected hazard of death, therefore related to prostate cancer) for an unadjusted five year model (shown in dark green in Figure 65 below) shows statistically significant EHR for SIMD1-4 when compared with the least deprived. When adjustment is made for the patient, tumour and treatment characteristics previously described, the EHR reduce but remain significantly different to the least deprived. The factors that have been added to the model explain some of the excess mortality seen in prostate cancer but do not account for all the differences by deprivation.

It is likely that this remaining difference is as a result of factors not accounted for (residual confounding or diagnosis through PSA testing which tends to be requested by those living in more affluent areas) or measurement error in those used (e.g. Charlson Index of co-morbidity).

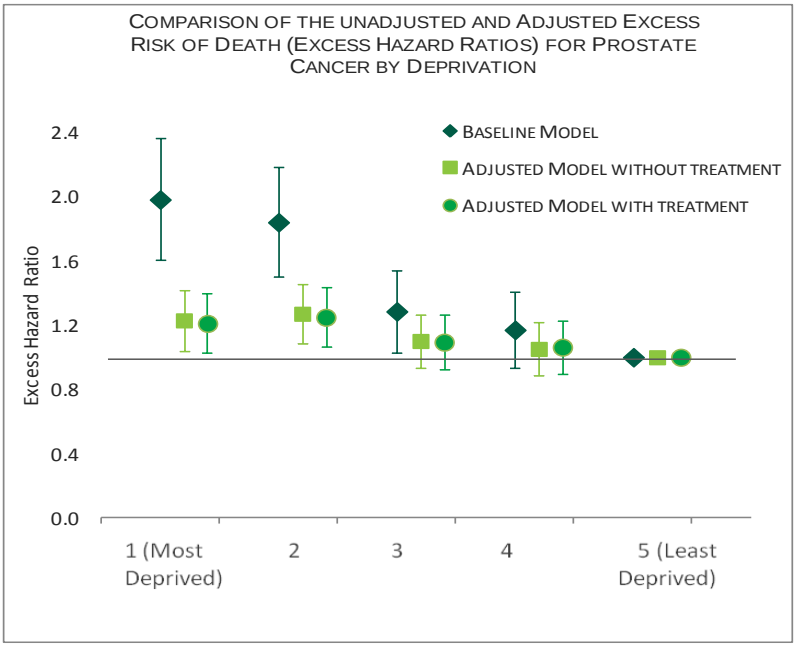



***Figure 65: A comparison of unadjusted and adjusted model Excess Hazard Ratios (showing with and without treatment) for Prostate Cancer***

## Recommendations and Next Steps:

The Macmillan-ISD Scottish Cancer Pathways Partnership recommends that all health and social care partners continue their efforts in:

- Early diagnosis (including the promotion of informed participation in cancer screening programmes)
- Improving the care and management of people with co-morbidities
- Developing ways to increase the reach and action of public health messages
- Engaging communities to better understand the relationships between health and deprivation

Further investigation of survival by cancer type for different geographical areas within Scotland is planned, as is academic publication.

Although lifestyle factors, such as diet, physical activity, and tobacco and alcohol use have been studied extensively in relation to the risk of developing cancer, their impact on survival and other outcomes of a cancer diagnosis have received much less attention, and should be a priority for future research.

Non-specialist two-page briefs on the cancer sites with significant variation and a publicly-aimed one-page brief are also available on the Macmillan Cancer Support website: http://www.macmillan.org.uk/about-us/what-we-do/evidence/research-funding/our-partnerships/information-services-division-scotland.html#271894.

## Glossary

| | |
|---|---|
| CI | Confidence Interval |
| DCO | Death Certificate Only |
| EHR | Excess Hazard Ratio |
| ER | Oestrogen Receptor |
| F | Female |
| ICD-O(2) | 2nd edition of International Classification of Diseases for Oncology |
| ICD-10 | 10th revision of the International Statistical Classification of Diseases |
| ISD | Information Services Division, NHS National Services Scotland |
| HR | Hazard Ratio |
| M | Male |
| PHE | Public Health England |
| PHI | Public Health Intelligence, NHS National Services Scotland |
| SIMD | Scottish Index of Multiple Deprivation (where 1 = most deprived quintile and 5 = least deprived quintile) |
| UKIACR | United Kingdom and Ireland Association of Cancer Registries |

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