Published November 2022

Public Health Scotland

Scottish Routes from Diagnosis: Comorbidities

MACMILLAN CANCER SUPPORT

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Acknowledgements

The analysis presented in this report uses data shared by patients and collected by the NHS as part of their care and support.

Thank you to the Macmillan-ISD Steering Group and to the Scottish Routes from Diagnosis Clinical Advisory Group for clinical and research support and advice in relation to the Scottish Routes from Diagnosis project.

Background

Scottish Routes from Diagnosis (SRfD) was a project between Public Health Scotland (formerly ISD) and Macmillan, which investigated survivorship outcomes and experiences of residents of Scotland with the four most common types of cancer found in Scotland: breast, prostate, colorectal and lung, using national datasets from 2007 and 2012. The project developed survivorship Outcome Groups (OGs), which capture the survivorship experiences in four different groups and allows comparisons across as well as within cancer types. Reporting patient factors, pathways, and outcomes using these outcome groups allows for investigation into the very different experiences people can have following a cancer diagnosis, both within a particular cancer type and across different types. These outcome groups also allow for examination of similar experiences across as well as within common cancer types.

For a full explanation of the Outcome Groups and methodology of SRfD, please refer to the context and methodology publication. The technical notes, limitations and assumptions covering methods specific to this chapter are presented in the technical appendix.

Please note that this publication is based on data relating to cancer prior to the COVID-19 pandemic. Consequently, caution may be required in generalising these results to more recent time periods.

Cancer and Comorbidities

Identifying the extent, severity and patterns of comorbidities for people diagnosed with cancer is key to understanding the experiences of people living with cancer in Scotland. Comorbidities can influence pathways for people living with cancer in many complex ways and at various time points: the conditions and drugs used to treat comorbidities can affect both the development of cancer, shape the treatment of those diagnosed with cancer, and health conditions can arise as a consequence of cancer and treatments. Cancer and comorbidities can share common risk factors that may be biological or environmental. They can be related to lifestyles, such as high body mass index, low physical activity, smoking or pathological pathways, whereby one condition increases the risk of another (Sarfati, 2016).

The definition of comorbidity used in this report is the co-existence of other health conditions with an index condition that is the specific focus of attention (here the index condition being the cohort cancer diagnosis). Multimorbidity is distinct from this: it is the co-existence of several conditions where none are considered an index condition that is the specific focus of attention (MacMahon, 2018). Although the terms are not synonymous, they provide two different perspectives through which to consider a person with more than one condition at the same time. In the first section of this report, summary measures of multimorbidity are used to ascertain common characteristics of people with multiple conditions prior to cancer diagnosis.

Structure of report

The report is structured as follows and aims to answer the following questions in relation to the four 2012 cancer cohorts (breast, colorectal (CRC), lung and prostate cancer):

1. **Comorbidity prior to cancer diagnosis** – How many comorbidities do people have prior to cancer diagnosis? What are the most common comorbidities prior to cancer diagnosis? What is the extent and severity of multimorbidity at the time of cancer diagnosis? What are the common sociodemographic characteristics of people with comorbidities?
2. **The impact of comorbidities on cancer diagnosis** - What impact do comorbidities prior to diagnosis have on cancer stage and grade at diagnosis?
3. **The impact of comorbidities on cancer treatment** – How does cancer treatment differ for people with comorbidities? What are the most common conditions presenting close to diagnosis?
4. **Comorbidities as a consequence of cancer and treatment** - What conditions are most common following cancer diagnosis and treatment? When in the patient pathway are they most likely to occur?
5. **Conclusions**

For information on the data sources and methods used please see the technical appendix. All of the analyses below are for the four 2012 cohorts.

Comorbidity prior to cancer diagnosis

This section firstly explores the extent and severity of comorbidity prior to cancer diagnosis and then ascertains which groups of people are more likely to be at risk of multimorbidity.

The conditions relevant to cancer were identified from a literature review and after consulting with the Clinical Advisory Group (CAG) for the SRfD project. The list includes

all QOF long-term conditions[1], commonly used to ascertain multimorbidity (Brilleman 2012), and other chronic conditions relevant to cancer. Information taken from hospital admissions and day cases (SMR01) and contributory causes of death taken from death records (NRS) was used to ascertain the prevalence of the health conditions covering the period of five years prior to cancer diagnosis and up to five years after diagnosis. Some conditions identified by the CAG were not included in the analyses because the number of admissions for these conditions were too few to be reported. Overall, 25 conditions were identified (please see tables 1A-D in the data appendix and the technical appendix for further information). Sepsis and pneumonia are included in the analyses of age standardised rates and admissions but not included in the list of chronic conditions for multimorbidity analyses as they could not be considered to be chronic but are still relevant to cancer treatment. The conditions do not include other cancers - for further information on other or multiple cancer diagnoses please see the multiple cancer chapter.

It is important to note that the figures will be an undercount of the conditions as not all conditions will require hospital admissions. Furthermore, some conditions are more likely to require hospital admissions than others and therefore the degree of accuracy in capturing the prevalence of the condition varies by the conditions themselves. For further information, please see the technical appendix.

Most common comorbidities

The most common conditions prior to index cancer diagnosis were relatively similar across the cohorts, although there was some variation in the order of prevalence of the conditions by cohort (Figure 1). **The most prevalent condition for all cohorts was hypertension**, with almost 1 in 10 in all cohorts. Hypertension is easily and systematically diagnosed but asymptomatic in most cases, therefore the high admission rates do not necessarily relate to severity or the experience for the patient, as it is likely to be a secondary diagnosis. **Coronary Heart Disease (CHD) was prevalent in all cohorts** ranging from 1 in 20 (5%) for the **breast** cancer cohort and up to 15% for **lung** cancer. **Diseases of the respiratory system were common for lung cancer patients** with 16% with Chronic Obstructive Pulmonary Disease (COPD), and 13% with asthma. The crude and age standardised rates of all specific conditions is shown in Table 1A-D in the data appendix.

[1] https://www.isdscotland.org/Health-Topics/General-Practice/Quality-And-Outcomes-Framework/Information-for-users-of-QOF-register-and-prevalence-data.asp

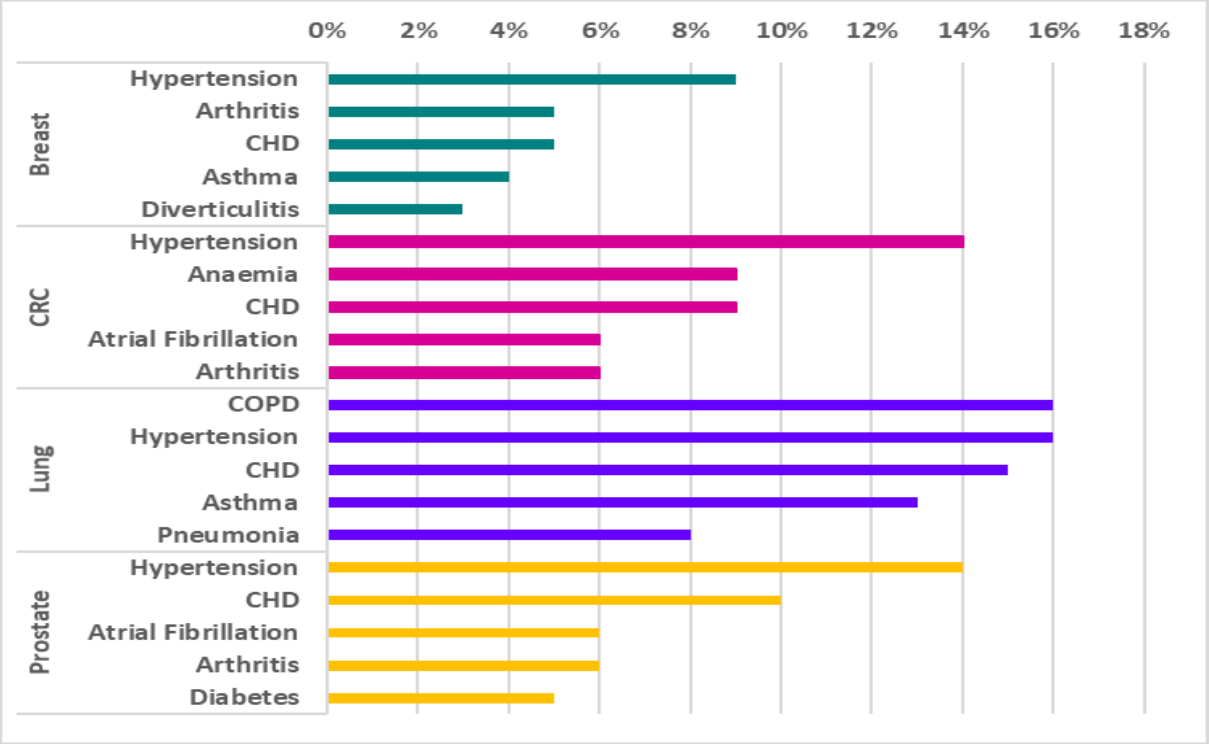

Figure 1: Top 5 chronic conditions (percentage of cohort) in the five years prior to cancer diagnosis by cohort

Multimorbidity prior to cancer diagnosis

NICE guidelines for treatment of people with multimorbidity, state 'multimorbidity matters because it is associated with reduced quality of life, higher mortality, polypharmacy[2] and high treatment burden, higher rates of adverse drug events, and much greater health services use (including unplanned or emergency care)' (NICE guidelines, 2016). There is not a single standard way of identifying people with multimorbidity, the sources used in research vary from self-reporting, primary care records, prescriptions and hospital records. There is also not a definitive list of chronic conditions to be included, the variation in the number of conditions included ranges from 4 to 102 conditions (Diederichs, 2011). In practice, NICE recommend that health professionals identify patients with multimorbidity as patients with 10 or more drug prescriptions.

Count of chronic conditions

Figure 2 shows the overall proportions of the cohorts with the number of chronic health conditions in the five years prior to the cancer diagnosis.

[2] Polypharmacy is the use of multiple medicines. It can be appropriate or inappropriate and the key healthcare aim for the individual patient is to ensure the safe and effective use of their multiple medicines. Polypharmacy becomes inappropriate when the medication risks begin to outweigh benefits for an individual patient (Scottish Government Polypharmacy Model of Care Group, 2018).

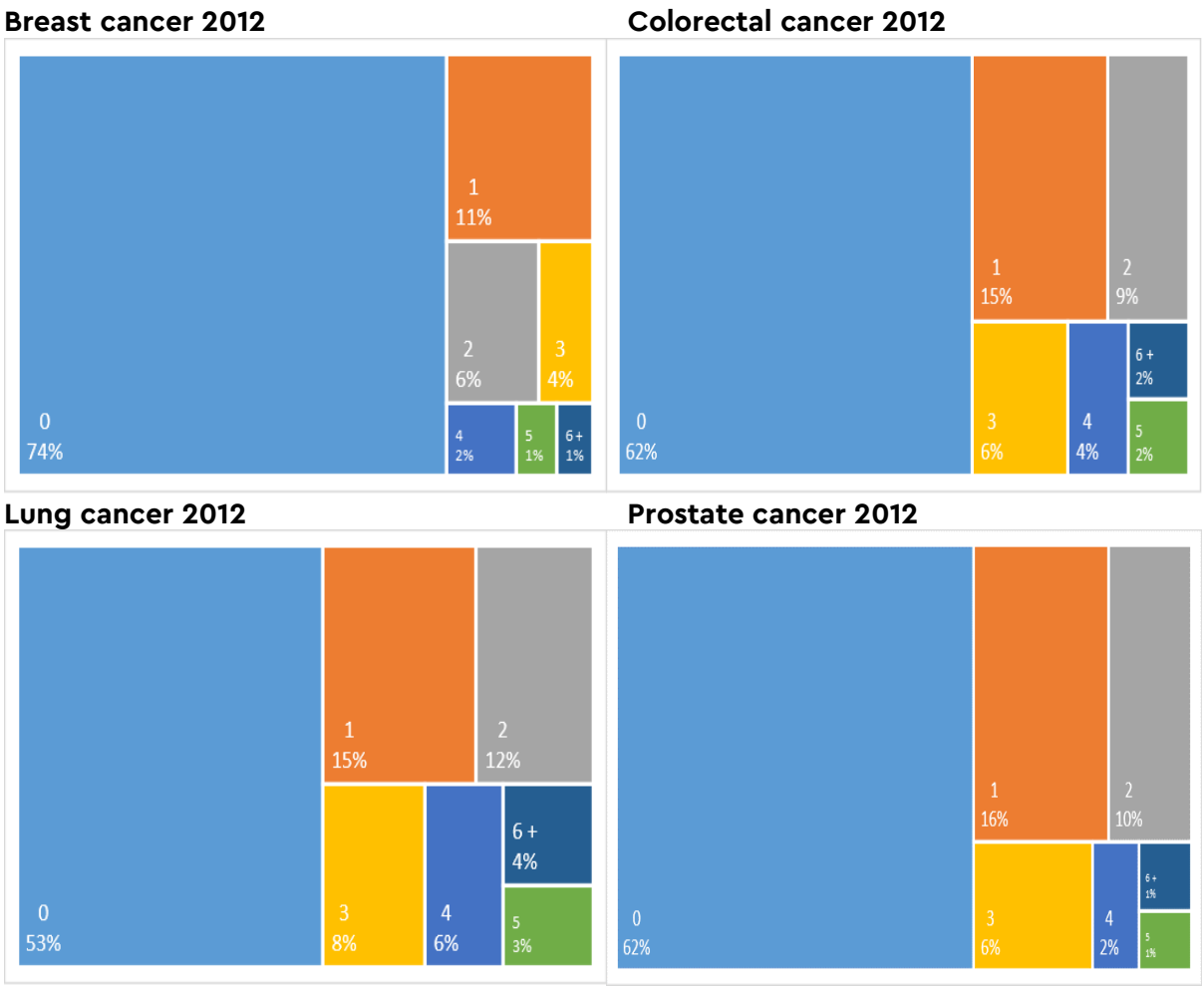

Figure 2: Number of chronic conditions in the five years prior to cancer diagnosis by cohort

At least one quarter of people in all cohorts had a diagnosis of one or more of the chronic conditions prior to the cancer diagnosis. This ranged from 26% for **breast** cancer to almost half of **lung** cancer patients (47%).

It was more common to have two or more conditions (multimorbidity) than to have just one other condition prior to the cancer diagnosis for all cohorts. Although the reference conditions differ, this reflects findings for the Scottish population generally, as, of people with at least one health condition, more than half had multimorbidity (Barnett, 2012). The **lung** cancer cohort had the highest rate of multimorbidity at the time of cancer diagnosis: just **under a third (32%) already had multimorbidity** prior to cancer diagnosis with two or more conditions**,** and one fifth (20%) of the lung cancer cohort had three or more conditions.

The proportions of people with multimorbidity at the time of their cancer diagnosis in the 2012 **colorectal** and **prostate** cancer cohorts were relatively similar. **Just over one**

fifth had two or more conditions (23% for colorectal and 21% for prostate cancer) and just over one in ten had three or more conditions in the five years prior (14% for colorectal and 11% for prostate cancer).

Around one quarter (26%) of women in the 2012 **breast** cancer cohort had at least one other condition prior to the cancer diagnosis, **14% had two or more conditions** and 8% had three or more conditions. The 2012 **breast** cancer cohort had the lowest proportion of multimorbidity.

Count of prescriptions

The count of prescriptions is a measure from primary care only, whereas the Charlson Comorbidity Index (CCI) (see page 9 below) and count of chronic conditions is specific to hospital admissions only and likely to capture only severe cases of the conditions. The measure also relates to the treatment burden of conditions for the patient. In the following section the number of unique British National Formulary (BNF) codes appearing in the individual's prescription drug data were counted. Each code represents one sub-heading within the BNF and includes drugs that are in the same class. Repeated prescriptions of the same or very similar medications were only counted once. In order to avoid the time period in which prescriptions might be administered for the cancer, the period covered is the 18 months to 6 months prior to diagnosis. It is important to note that the prescriptions are only a count of those within the community and will not capture prescriptions for people staying in hospital (for further information please see technical appendix data sources), therefore people with high numbers of admissions or bed days might appear to have lower numbers of drugs prescribed.

The distribution of drugs prescribed to the **lung** cancer cohort was markedly different to the other cohorts (Figure 3). **Just under a third (31%) had less than 5 prescriptions while just over a third (34%) had 10 or more prescriptions in the period prior to cancer diagnosis** (Table 2). The **breast** cohort had the fewest drugs prescribed in the time period prior to cancer diagnosis: **more than half (53%) of the cohort had less than 5 prescriptions during this time period; fewer than one in five (18%) had 10 or more prescriptions.** The distribution of number of drugs was similar for the **CRC** and **prostate** cohorts in the 18 months to 6 months prior to cancer diagnosis. **One in five of the CRC cohort (20%) and just under one in six (16%) of the prostate cohort were in the multimorbidity group** with 10 or more prescriptions.

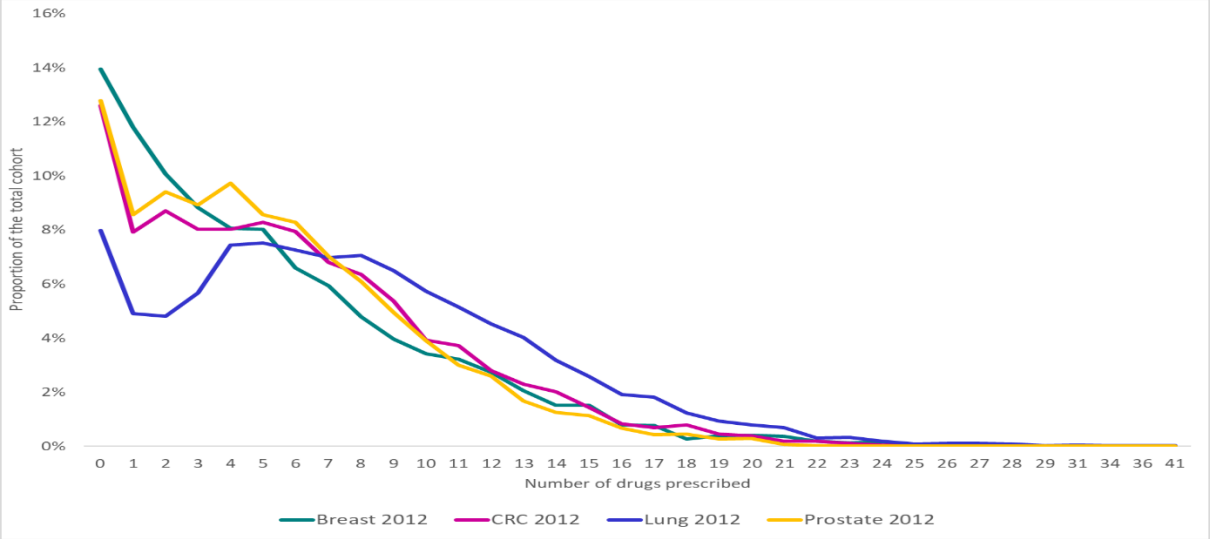

Figure 3: Proportion of cohort with number of drugs prescribed 18 months – 6 months prior to cancer diagnosis

Charlson Comorbidity Index

Secondary care data (SMR01) was used to ascertain the prevalence of the 17 health conditions included in the Charlson Comorbidity Index (CCI). The CCI conditions are weighted, with the purpose of identifying risk of death (for further information see technical appendix). This measure is included as a measure of the severity of comorbidity.

The **majority of people in each cancer cohort had no CCI comorbidities** at the time of their cancer diagnosis (a zero or no CCI score) (Table 3A-D). A **higher proportion of people with lung cancer had severe comorbidities** (defined as a CCI score of 3 or more) at the time of diagnosis than the other cohorts: more than one in ten (12%) people diagnosed with **lung** cancer compared to 8% with **CRC**, 6% of people with **prostate** cancer and less than 1 in 20 (4%) of women with **breast** cancer.

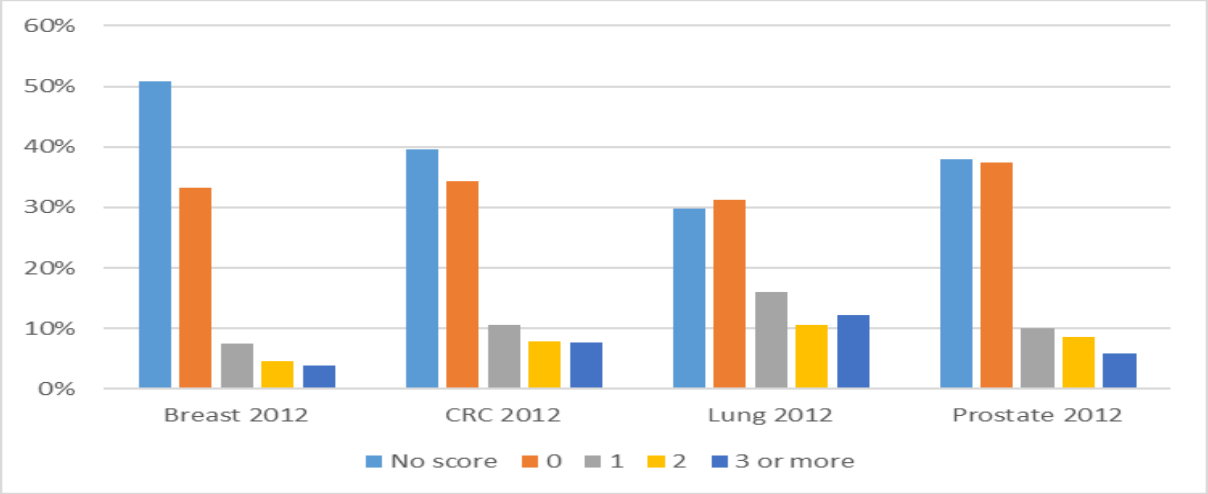

Figure 4: Charlson Comorbidity Index group prior to cancer diagnosis by cohort, 2012

Socio-demographic characteristics

In the following section, the above measures of multimorbidity (count of conditions and count of prescriptions) and severity of comorbidity are considered in relation to sociodemographic characteristics.

Age

Older age is associated with an increased risk of cancer and most other chronic conditions (Sarfati, 2016). With an ageing population multimorbidity is also becoming increasingly common. The analyses below use the age at cancer diagnosis. The following section combines the two measures of multimorbidity – count of chronic conditions and drug prescriptions – to determine evidence of multimorbidity. Combining both measures captures the primary and secondary care settings, as the count of chronic conditions are for hospital admissions and the count of prescriptions are for community prescriptions only (and will not capture prescriptions for people staying in hospital). A higher proportion of younger people were found to have multimorbidity from the count of drugs than the count of chronic conditions, but a similar or higher proportion of older people have multimorbidity with the count of conditions.

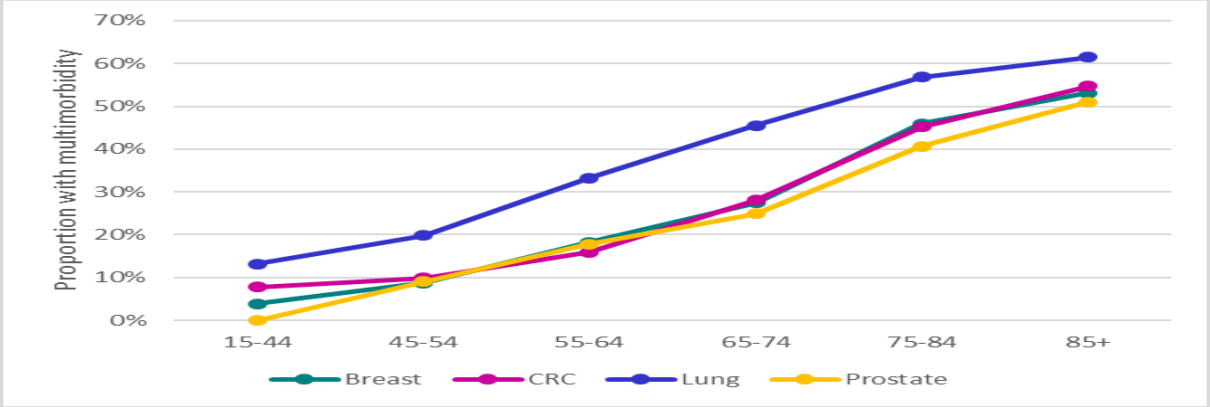

Figure 5: Proportion of cohort with evidence of multimorbidity prior to cancer diagnosis by age group and cohort, 2012

Figure 5 shows a strong linear relationship between age and multimorbidity for all cancer cohorts. The rate of multimorbidity by age group was relatively similar for the **CRC, breast and prostate** cohorts, with a slightly lower rate from age 65 for the **prostate** cohort. A higher proportion of those diagnosed with **lung** cancer had multimorbidity at all age groups. **The rate of multimorbidity for those with lung cancer for each age group was equivalent or higher than the rate of multimorbidity of people 10 years older within the other cancer cohorts.** The differences for **lung** cancer are likely to relate to a number of interrelated factors including smoking and deprivation.

Severity of comorbidity

The **average age was highest in those with severe comorbidities** (CCI score of 3 or more) **and relatively similar across the cancer cohorts** (74 for breast and lung, 75 for prostate and 77 years old for colorectal cancer) (Table 3A-3D). The **association between age and comorbidity was most marked in the 2012 breast cancer cohort** as the difference in average age between those with no CCI score and those with severe comorbidities is 14 years compared to 10 years for **CRC**, 6 years for **prostate** and 5 years for **lung** cancer.

Sex

Tables 4A and 4B shows the age standardised rates of each condition by sex for the **lung** and **CRC** cohorts. Males had significantly higher age standardised rates of cerebrovascular conditions, including CHD, Peripheral vascular disease (PVD) and atrial fibrillation ($p<0.001$), for the **CRC** and **lung cancer** cohorts and females had significantly higher rates of arthritis and osteoporosis ($p<0.001$).

Multimorbidity

In the general Scottish population women have been found to be more likely to suffer from multimorbidity than males (Barnett, 2012). The following section compares the male and female overall rates of multimorbidity (in which there is evidence of

multimorbidity from more than one diagnosis or 10 or more drug prescriptions) and severity of comorbidities prior to diagnosis for **lung** and **colorectal** cancer.

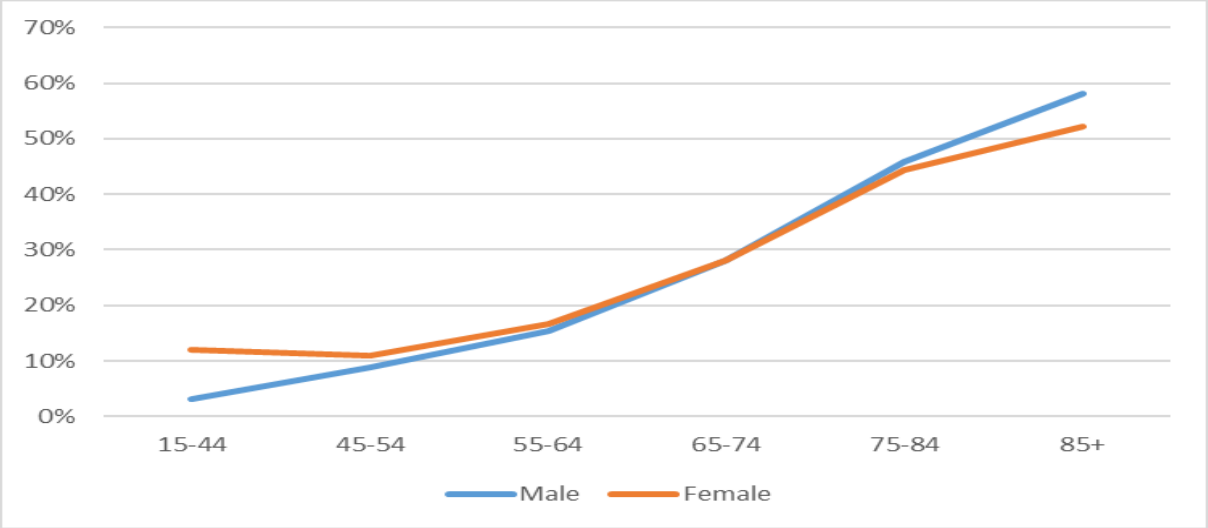

Figure 6: Proportion of people diagnosed with CRC with multimorbidity by sex and age group, 2012

The rate of multimorbidity was similar for males and females aged over 45 to 84 for the **CRC** cohort (Figure 6). **Younger females were more likely to have multimorbidity than younger males** (3% of males diagnosed with **CRC** compared to 12% of females) and older males (over 85) were more likely to have multimorbidity than older females (58% compared to 52%).

Females diagnosed with **lung** cancer were more likely than males to have multimorbidity (Figure 7) for all age groups except age groups 45-54 and 75-84, in which the rate is very similar.

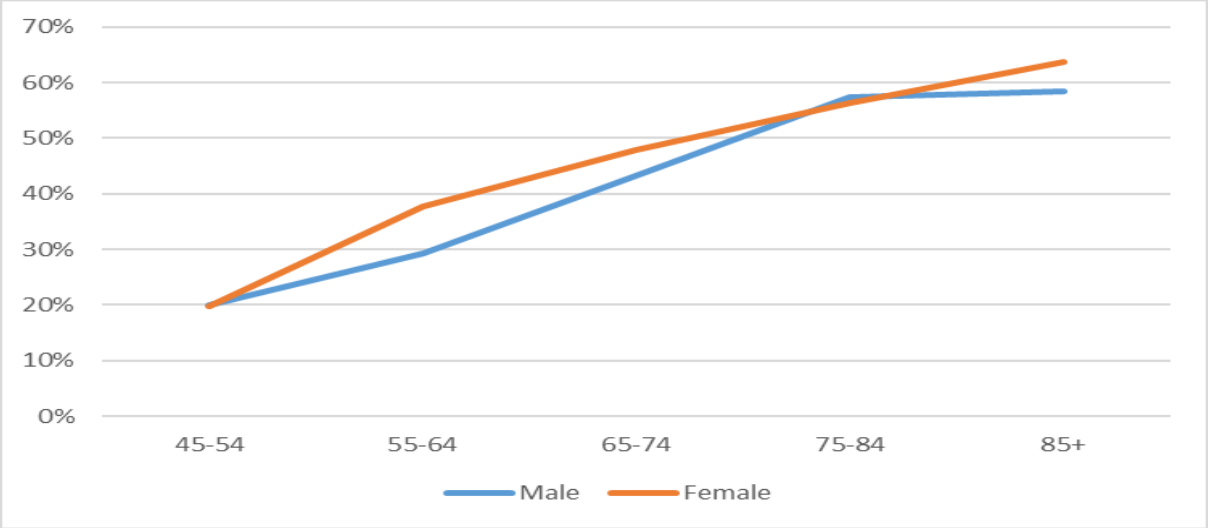

Figure 7: Proportion of people diagnosed with Lung cancer with multimorbidity by sex and age group, 2012[3]

Severity of comorbidity

The **colorectal** cohort had a higher proportion of males overall (54%, p<0.025) in 2012. There was **a higher proportion of males in all CCI groups, with the difference most marked in the severe comorbidities group** (59%) (Table 3B). Overall, the split between the sexes for **lung** cancer was even for those with no or zero CCI score, however **a higher proportion of people with severe comorbidities were male** (55%) (Table 3C).

Deprivation

Studies have found comorbidities are more common in those of lower socio-economic status (SES). However, for cancer the picture is complex as higher rates of some conditions in those with higher SES, such as breast cancer, have been related to health seeking behaviours, such as uptake of screening and greater likelihood of receiving a diagnosis (MacMahon, 2018). Additionally, the direction of the relationship between SES and multimorbidity is complex as multimorbidity can cause a reduction in SES as a consequence of factors such as reduced earning capacity (MacMahon, 2018).

Barnett found that 29% of people with multimorbidity in Scotland are under the age of 65 years of age and are more likely to come from the most deprived communities, and that in Scotland's most socioeconomically deprived areas, multimorbidity happens 10 to 15 years earlier than the least deprived areas (Barnett, 2012). Consequently, in the following analyses age groups are considered separately in order to ascertain if this is also reflected in the cancer context. The Scottish Index of Multiple Deprivation (SIMD) quintiles are used to measure deprivation in the following analyses (see technical appendix).

[3] Please note that age group 15-44 has been removed due to low numbers

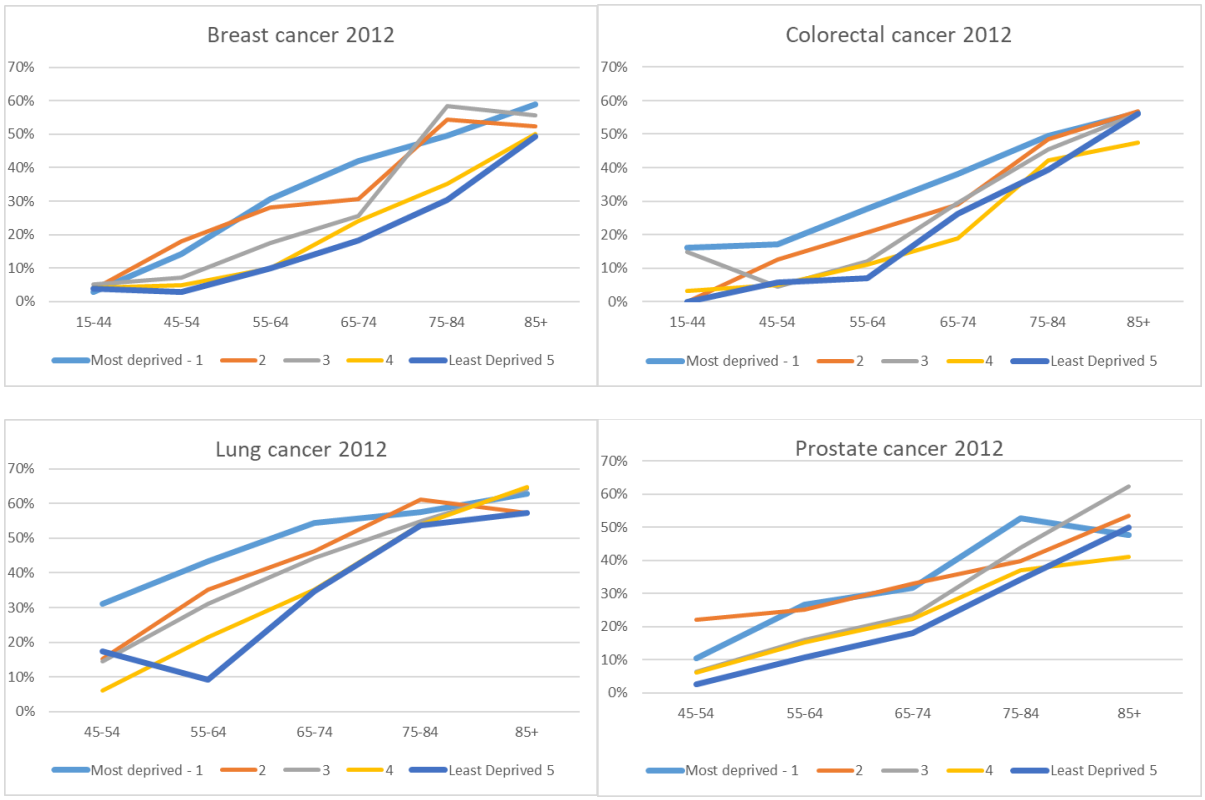

Figure 8: Proportion of age groups with multimorbidity by SIMD[4]

The proportion of people with **multimorbidity was highest for those living in the most deprived areas** across all four cohorts. The **majority of people diagnosed with lung cancer in the most deprived quintile already had multimorbidity** at the time of the cancer diagnosis (52%).

Although age has a very strong association with multimorbidity, there was a **substantial excess of multimorbidity prior to cancer diagnosis in young and middle-aged adults living in the most deprived areas** for each of the four cancer cohorts. For the **breast cohort** the prevalence of multimorbidity for 75-84 year olds in the least deprived quintile is equivalent to 55-64 year olds in the most deprived areas (around 30%). The prevalence of multimorbidity for 45-54 years olds living in the most deprived quintile was equivalent to those aged 65-74 in the least deprived quintile (around a third) for the **lung** cohort. Similar trends occurred for all cohorts, as the **prevalence of multimorbidity in the least deprived areas was equivalent to the prevalence around ten years earlier in the most deprived areas.**

The population age structure varied by SIMD quintile and as strong associations have been shown above between age and multimorbidity, the analyses below include age and sex standardisation and trends by deprivation and age group. The trends in age

[4] Please note that age group 15-44 has been removed due to low numbers for lung and prostate cancer.

standardised rates for the cancer cohorts differ in direction and magnitude by SIMD and measures of multimorbidity (Figure 9)[5].

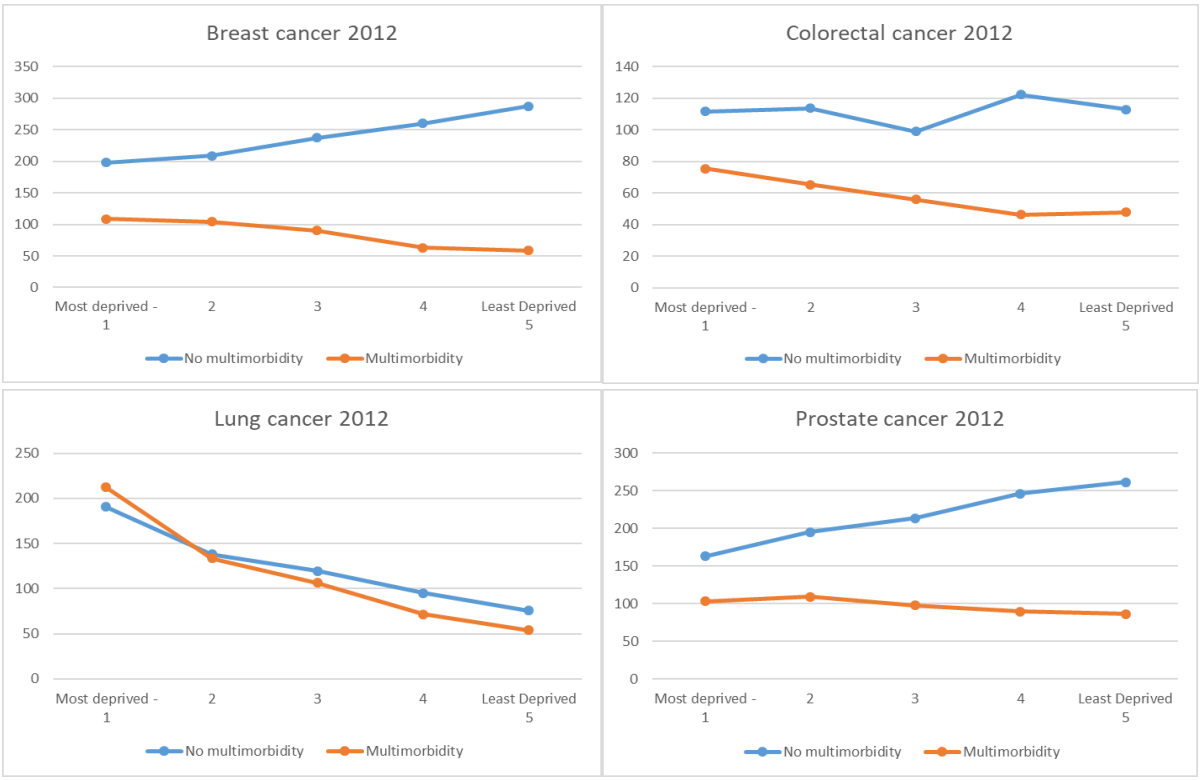

Figure 9: Age standardised rates of cohort cancer by SIMD and multimorbidity per 100,000 population

There was a strong and consistent association between SIMD and multimorbidity for the age standardised rates of **lung** cancer, likely related to differences in smoking prevalence (ISD (2019). The **standardised rate of lung cancer was around two times higher for those living in the most deprived quintile compared to the least deprived for those with no evidence of multimorbidity**. The **social gradient for lung cancer diagnosis was greater for those with multimorbidity**, as people living in the **most deprived areas with evidence of multimorbidity had a four times higher age standardised rate** than the least deprived quintile.

For women with **no evidence of multimorbidity, the truncated rates** of **breast** cancer in 2012 **increased as deprivation decreased** (the age standardised rate for women in the least deprived decile was 45% higher than the most deprived). This reflects the overall trend across the whole **breast** cohort and has been related to reproductive history and uptake of screening within deprivation quintiles (ISD (2019), Tweed (2018), NCRAS (2016)). However, the opposite trend occurred for those **with evidence of**

[5] Please note that the higher age standardised rates of cancer for all SIMD quintiles and cohorts (with the exception of the lung cancer most deprived quintile) are due to the higher proportion of people with no multimorbidity than multimorbidity.

multimorbidity: the rate of breast cancer increased as deprivation increased (the difference between the most and least deprived is 46% and statistically significant (p< 0.001).

Similar to the **breast** cohort, the truncated rates of **prostate** cancer **increased as deprivation decreased for males with no evidence of multimorbidity** (p <0.001). This corresponds to the overall trends and National Statistics trends for Scotland (ISD (2019)) and is consistent with other publications (Tweed (2018), NCRAS (2016)). For those with evidence of multimorbidity, there was no statistically significant difference between the age standardised rates in the most and least deprived quintiles.

The overall trends showed no strong evidence of a statistically significant trend in rates of **colorectal** cancer by deprivation in 2012. This is reflected for those with no evidence of multimorbidity, however age standardised rates increased with deprivation for those with evidence of multimorbidity (p<0.001).

Impact of comorbidities on stage and grade of cancer

The relationship between comorbidity and the timing of presentation, stage, grade and morphology of cancer is complex. Cancer and many health conditions share common risk factors that can be biological or environmental; they can be related to lifestyles and behaviours or pathological pathways, whereby one condition increased the risk of another. Comorbidities can influence the timing of cancer diagnosis, as on the one hand, comorbidity may result in increased contact with health services and greater opportunity for early diagnosis, while on the other, the comorbidity might distract from symptoms and result in a delayed diagnosis. The extent to which these two mechanisms influences the stage of diagnosis has been found to vary depending on the cancer type, comorbidity and the health service context (Sarfati, 2016). In the following section the relationship between the severity of comorbidity (CCI) and cancer stage, grade is explored.

Method of detection

The **proportion of people with cancer detected as an incidental finding increased with severity of comorbidity for all four 2012 cohorts** (Table 3A-3D). More than 1 in 10 with severe comorbidities had their cancer detected as an incidental finding for **breast** (13%), **lung** (12%) and **prostate** cancer (17%) compared to between 2 and 6% for those with no CCI score. The difference was much smaller for **CRC** with 4% of those with severe comorbidities detected incidentally compared to 2% of those with no CCI score.

Cancer stage and grade

A consistent finding across all four cohorts is that people with comorbidities are significantly more likely to have unknown staging information about their cancer. As complete staging requires the patient undergo multiple diagnostic procedures, those with comorbidities might be unfit to undergo the investigations or might choose not to

undergo the procedures because of treatment burden. Individuals with unknown cancer stage tend to have survival profiles relatively similar to those diagnosed with stage 4 cancer (Baillargeon, 2011). Brewster (2011) found that patients with breast and colorectal cancer dying within 30 days were less likely to have had their tumour microscopically verified.

The proportion of people with unknown stage at diagnosis increased with CCI score for all cancer cohorts (Figure 10). **Those with severe comorbidities were at least two times more likely to have unknown stage of cancer compared to those with no CCI** (no hospital admissions prior to diagnosis). For those with severe comorbidities this represented a considerable proportion as at least one fifth had unknown stage in all four cohorts (23% for **breast**, 26% for **lung**, 28% for **CRC**, and 42% for **prostate**).

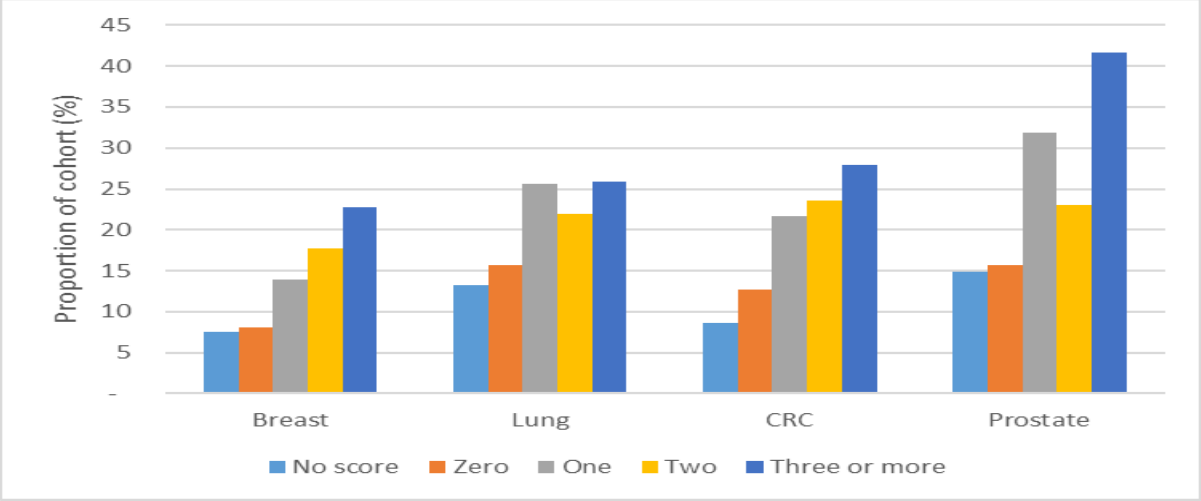

Figure 10: Proportion of cohort with unknown staging information by Charlson Comorbidity Index group

An association between comorbidity and cancer stage at diagnosis is evident for the 2012 **breast** cohort. **One in ten of those with severe comorbidities had stage 4 breast cancer compared to 1 in 20 with no or zero CCI score**. This could be associated with the differences in underlying age profile by comorbidity group and access to screening. The proportion of **breast** cancers detected through screening was 11% in the severe comorbidity group (with an average age older than screening limit of 74) in comparison to 35% for those with no CCI score (average age 60) (Table 3A).

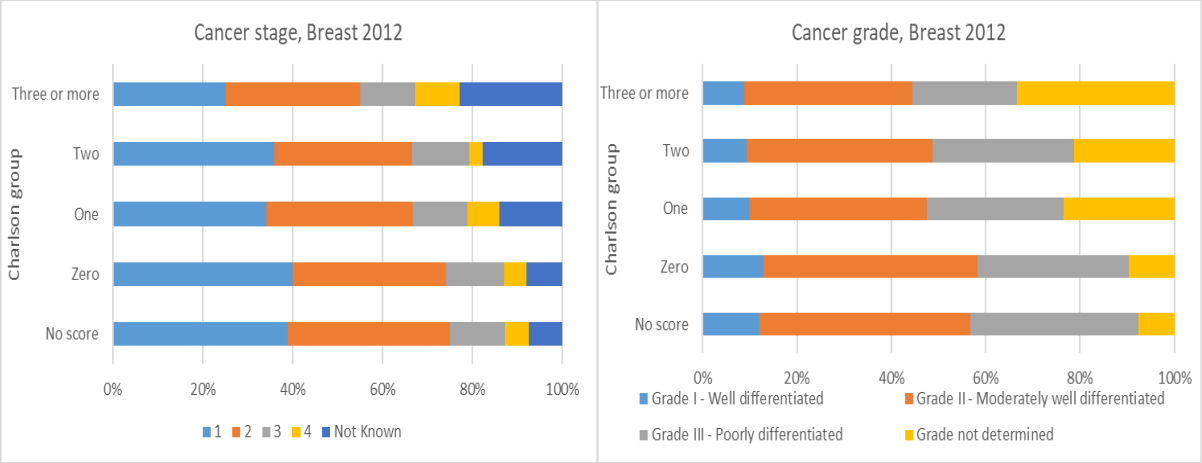

Figure 11: Stage and grade of cancer by Charlson group: breast cancer, 2012

A slightly smaller proportion of women with severe comorbidities had a grade I breast cancer diagnosis (9% compared to 13% with no CCI score).

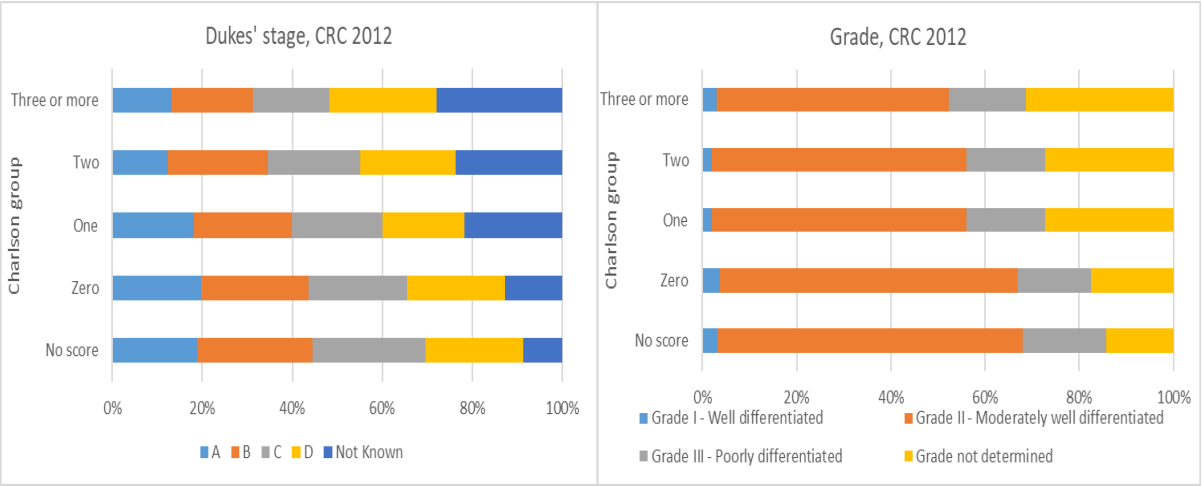

Figure 12: Stage and grade of cancer by Charlson group: CRC, 2012

There was some evidence of an association between comorbidity and stage of diagnosis for **CRC** in 2012. Around 45% of those with no or zero CCI score had Dukes' stage A or B compared to 31% of those with a severe comorbidity. Generally, comorbidity does not appear to be associated with grade at diagnosis for colorectal cancer; similar proportions were diagnosed with lower risk grade I tumours (around 3%) and high risk grade III cancer (around 16%). A higher proportion of those with no or zero CCI score were diagnosed with grade II (moderately well differentiated or intermediate risk), around 64% compared to 49% with a CCI score of three or more.

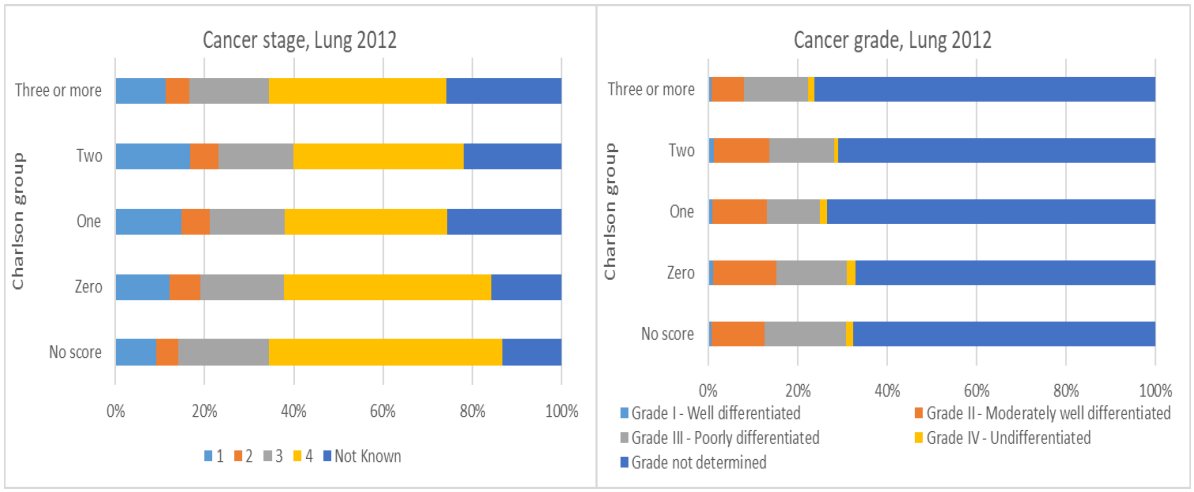

Figure 13: Stage and grade of cancer by Charlson group: Lung cancer, 2012

The proportion of people diagnosed with stage 4 **lung** cancer was greater for those with no or zero CCI score (around 50%) than those with any Charlson condition (36% for those with a CCI score of one, 38% for a score of two and 40% for a CCI of three or more). The higher proportions for those with no hospital admissions (no CCI) relative to those with a CCI score might be due to increased contact with healthcare services leading to an earlier diagnosis. Similarly, earlier diagnosis of lung cancer was found for patients with a previous cancer registration within one year[6].

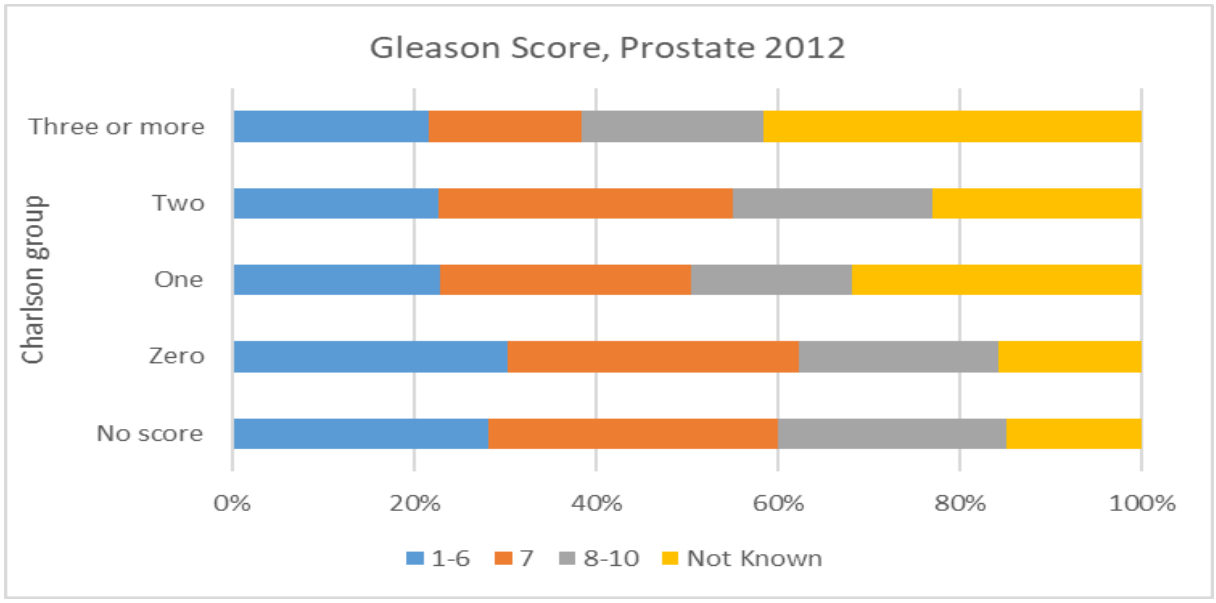

Figure 14: Gleason Score by Charlson group: prostate cancer, 2012

[6] See Multiple Cancer diagnosis and survival poster https://www.macmillan.org.uk/_images/mulitiple-cancer-diagnoses-and-survival_tcm9-341782.pdf)

With the exception of the greater proportion of unknown Gleason score for those with a positive CCI score, the overall distributions of Gleason score were relatively similar[7] for **prostate** cancer. A slightly higher proportion of those with no or zero CCI score (around 30%) had a low risk Gleason score (1-6) compared to around 23% of those with a CCI score of one or greater.

Impact of comorbidities on treatment

Treatment intent

The SRfD mortality chapter shows that those diagnosed at advanced stage, and older age groups are more likely to have palliative/non-curative treatment intent. As evidenced above, comorbidity is associated with older age and, to some extent stage of cancer, therefore the relationship between comorbidity and treatment decisions is related to interactions between all of these interrelated factors.

In this section the treatment intent is explored in relation to the severity of comorbidity (CCI score) prior to cancer diagnosis and the types of therapeutic treatment are briefly considered. The following analyses do not adjust for stage at diagnosis, therefore differences in the distributions of stage at diagnosis for people with comorbidities is also likely to have an impact on treatment decisions. With such considerable proportions of those with severe comorbidities having unknown information about the stage of cancer (at least 23%), the treatment decisions might also relate strongly to the comorbidities prior to cancer diagnosis. For further information about palliative care, please see the SRfD mortality chapter.

The **cancer treatment intent at diagnosis of more than half of all people with severe comorbidities was palliative/non-curative for all four cohorts** (Figure 15). For **breast** cancer the comparison between those with no comorbidities and severe comorbidity was particularly stark as less than 15% with no CCI or zero CCI had palliative intent compared to 52% of those with severe comorbidity.

[7] Cancer stage information for prostate cancer was only collected nationally in Scotland from 2013 onwards; therefore, this information is not available for the cohort years investigated in this analysis. As the vast majority of prostate cancers are adenocarcinoma, we have not presented morphology information.

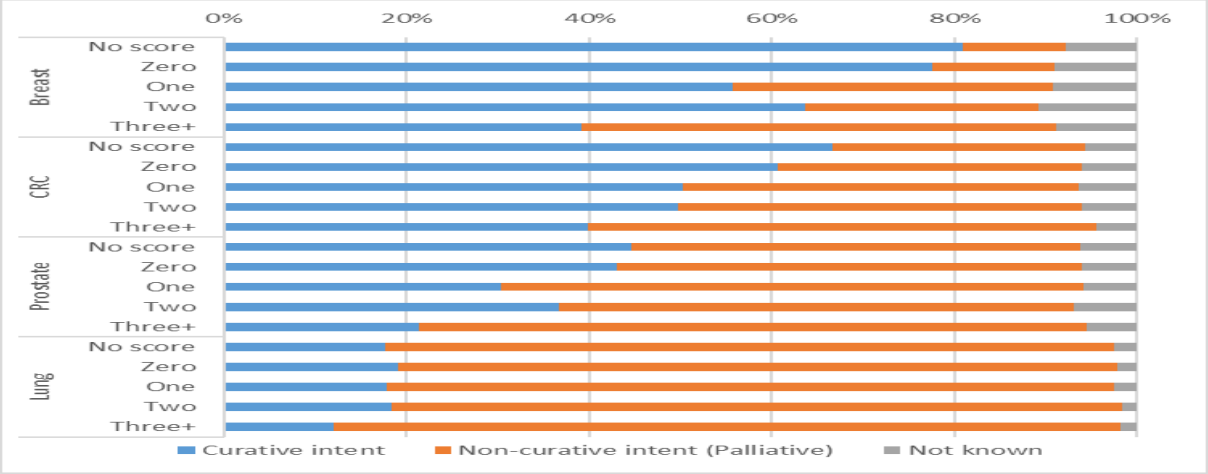

Figure 15: Treatment intent by cohort and CCI, 2012

Treatment type

The treatment pathways of people who undergo curative treatment also vary for people with comorbidities. The reasons for this are complex and likely due to many factors, including differences in demographics, cancer stage and treatment burden. Generally, those with comorbidity receive less treatment than those without after controlling for differences in tumour stage (Sarfati, 2016). Possible explanations for this include concern that the other health conditions will increase the toxicity or side effects of treatment, treatments may be less effective in these groups, and the life expectancy of these patients is insufficient to justify the use of potentially toxic agents (Sarfati, 2016). The impact of comorbidities on treatment vary considerably depending on the specific comorbidity. For example, not all cancer treatments are suitable for people with heart conditions - chemotherapy drugs can damage the heart causing heart failure and might be deemed too high risk. It should be emphasised that the following analyses do not adjust for age or tumour characteristics at diagnosis, therefore differences in the distributions of age and stage at diagnosis for people with comorbidities could also have an impact on treatment types.

Please note that the treatment charts below show the proportions of people receiving any of the treatment options. For surgery and SACT the patient might have received both or other treatments alongside this option.

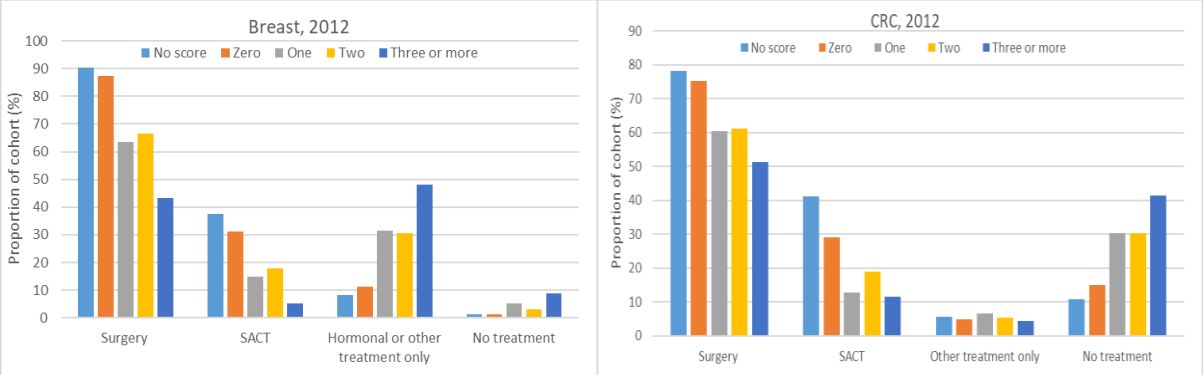

Figure 16: Treatment type by Charlson Comorbidity Index group, Breast cancer and CRC, 2012

People with any Charlson comorbidity prior to cancer diagnosis were considerably less likely to receive chemotherapy within their cancer treatment for breast, colorectal and lung cancer than those without comorbidities (Figure 16 and 17). Such differences were more obvious for those with **breast** cancer as more than a third with no CCI score had SACT within their treatment compared to less than a fifth with a CCI score of 1 or 2 and 5% of those with severe comorbidities. As mentioned above, this might relate to the different age profile and greater likelihood of having advanced stage cancer. A similar gradient was evident for **CRC** as 41% of those with no CCI score received SACT compared to just 11% of those with severe comorbidities. Just over a third of people with **lung** cancer and no CCI score received SACT compared to around 12% for those with any Charlson comorbidity.

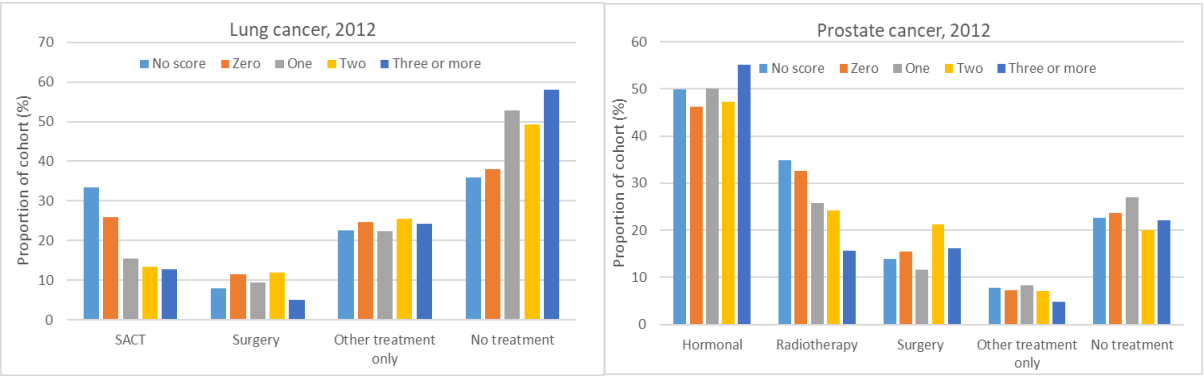

Figure 17: Treatment type by Charlson Comorbidity Index group, Lung and Prostate cancer, *2012*

People with any Charlson comorbidity were also less likely to have surgery within their cancer treatment pathway than those without any comorbidities for breast and CRC. For **breast** cancer, just 43% of people with severe comorbidities received surgery compared to 90% of people with no CCI score. The difference was also evident for **CRC**, as 51% of those with severe comorbidities had surgery compared to 78% of those

with no CCI score. For **prostate** and **lung** cancer there was not a clear relationship between surgery and CCI score.

The **proportion of the cohort who received no treatment was higher for people with any CCI comorbidity (score of 1 or more) than those with no CCI score or a zero CCI score** for those diagnosed with **breast, colorectal or lung** cancer in 2012. The proportions of those diagnosed with **prostate** cancer and receiving no treatment was relatively similar across the CCI groups (between 20% and 27%), this includes watchful wait and active surveillance (that are not included in the selected treatments). The most marked difference was for those with **CRC** as just 11% of those with no CCI score received no treatment compared to 41% for those with severe comorbidities. Just 1% of women with a diagnosis of **breast** cancer and no or zero CCI score received no treatment in comparison to 9% with severe comorbidities. The proportion receiving no treatment for **lung** cancer was relatively high across the CCI groups, ranging from 36% for those with no CCI score to 58% for those with severe comorbidities.

Specific conditions that might influence or limit treatment

Conditions which might preclude some treatments include COPD, heart conditions (such as CHD, Myocardial infarction (MI) and heart failure), kidney and liver failure and dementia. For example, in the context of **CRC**, Bare (2017) found that COPD was associated with higher rates of in-hospital complications, ICU admission, antibiotic treatment, reinterventions, and mortality. The following section shows the number of inpatient admissions for these conditions through the expected treatment period (6 months prior to 12 months following cancer diagnosis).

Figure 18 shows that the number of admissions peaked around the time of cancer diagnosis for all of the conditions included in the chart, for all cohorts. CHD, COPD and kidney disease admissions remained at a higher-level following cancer diagnosis, while admissions due to dementia and heart failure dropped back to relatively similar levels. For the **breast, CRC** and **prostate** cohort's CHD was the most prevalent condition at diagnosis and for the majority of the expected treatment period. For **lung** cancer, COPD was the most prevalent condition throughout the time period. Admissions for kidney disease were relatively high for people with prostate cancer at the time of the cancer diagnosis.

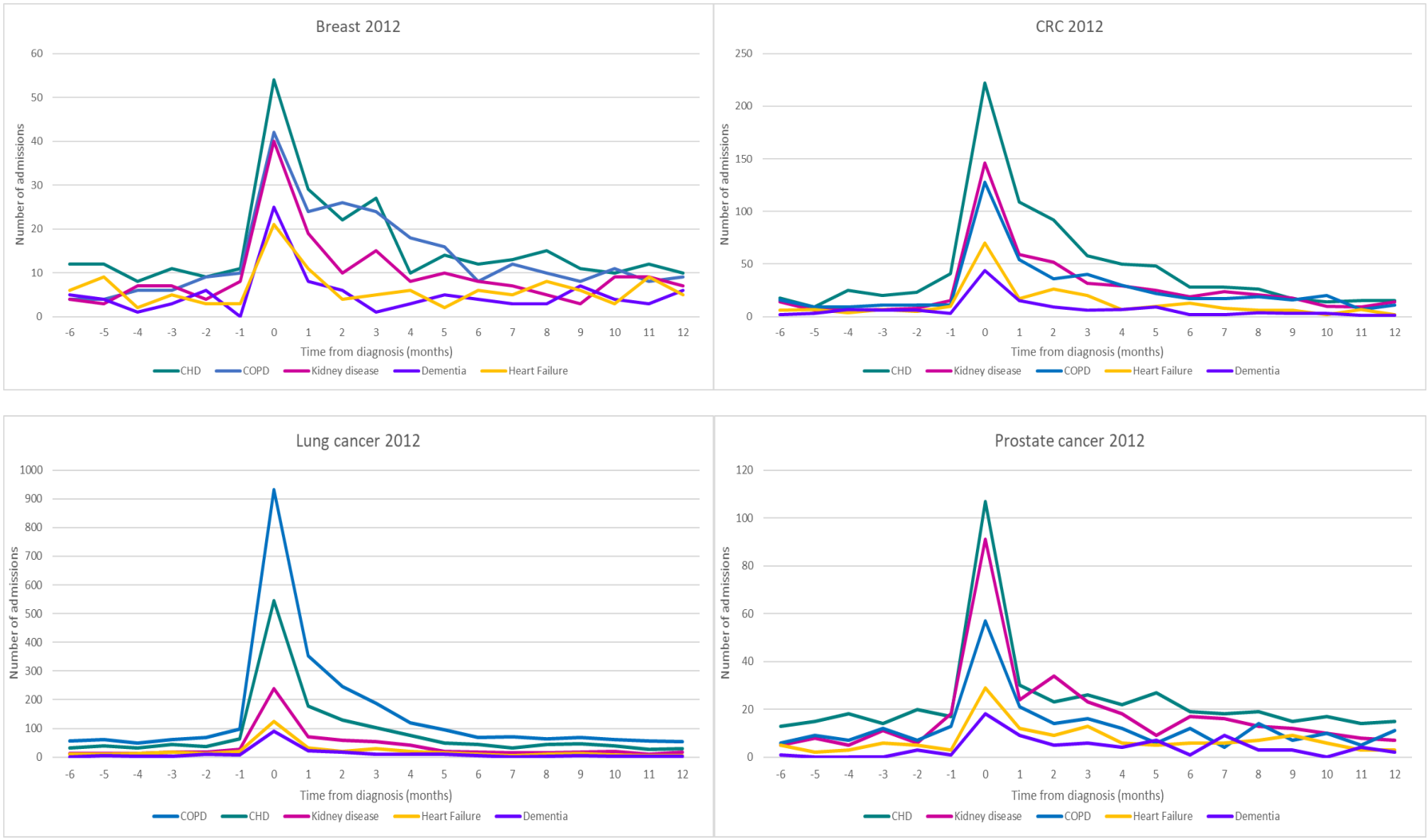

Figure 18: *Number of admissions by condition during expected treatment time (6 months prior to 12 months after diagnosis)*
Please note differences in scale of number of admissions between the four cohort charts.

Comorbidities as a consequence of cancer and treatment

The following section explores specific comorbidities that could be a consequence of cancer and treatment. Although there is variation between cohorts, a number of conditions were considered likely to be related to cancer and cancer treatment. The analyses in the following section compares age standardised rates for the conditions for the overall cohort and those people with limited survival (who died within 12 months of their cancer diagnosis). As the survival profiles across the cohorts vary considerably, the age-sex standardised rates are presented as per 1,000 person years at risk. Cause of death from NRS death data is also included in addition to hospital admissions to determine the age standardised rates of specific conditions.

Infections

Cancer and cancer treatments can increase the risk of infection by limiting the immune system's ability to fight infection. Risk of infection is also related to advanced stage, age and other comorbidities.

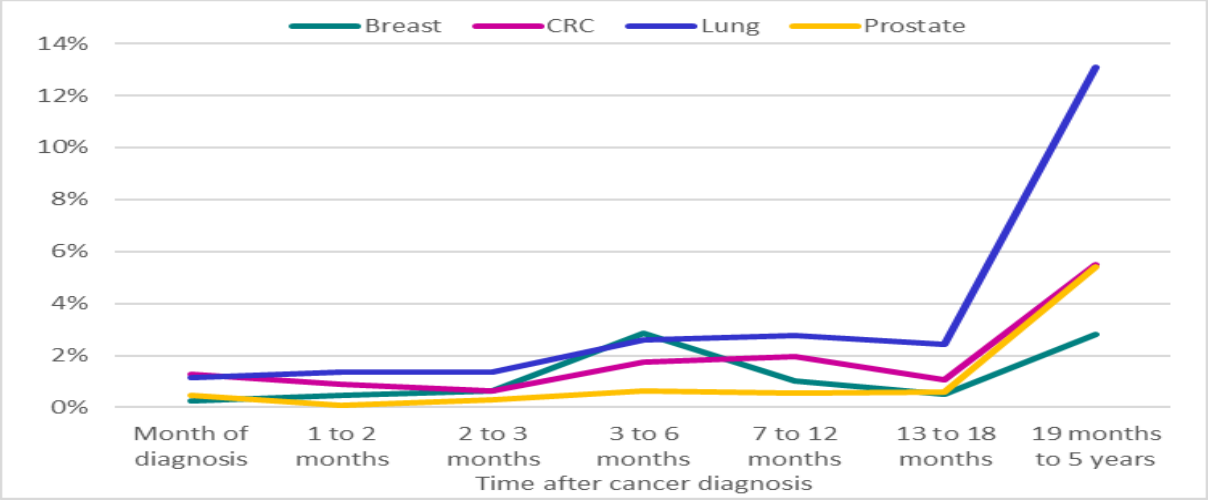

Figure 19: Proportion of cohort alive at the beginning of period with hospital stay or cause of death with sepsis after cancer diagnosis, 2012

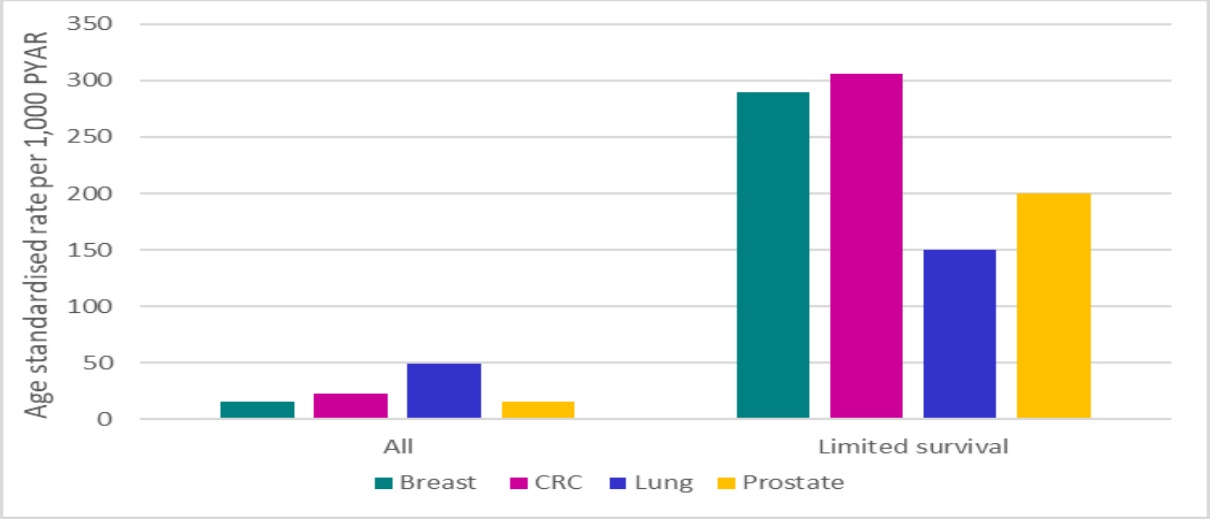

Figure 20: Age standardised rates of sepsis by cohort, 2012

People with cancer are at higher risk of developing sepsis following cancer treatment due to the impact of treatment on the immune system and increased risk of infection from surgery. **Overall, people with lung cancer are more likely to have sepsis after cancer diagnosis** (50 per 1,000 PYAR) than the other cohorts (15-23 per 1,000 PYAR) (Figure 20). However, for those with **limited survival (those who die within 12 months) the rate was considerably higher for people with breast and CRC** with around 300 per 1,000 PYAR compared to 200 for prostate and 150 for lung cancer. The differences in rate of sepsis is likely to relate to different treatment methods by cancer sites as those with breast and colorectal cancer are more likely to receive surgery and chemotherapy as part of their treatment and those with lung cancer were more likely to receive no treatment (Figure 16).

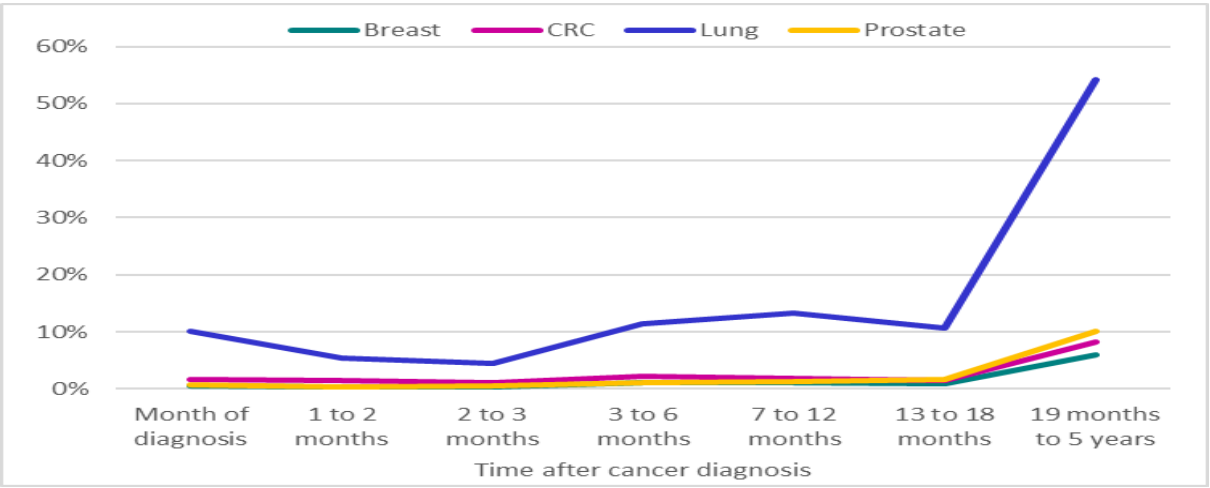

Figure 21: Proportion of cohort alive at the beginning of period with hospital stay or cause of death with pneumonia after cancer diagnosis, 2012

Lung cancer can lead to a higher risk of pneumonia due to changes in the structure of the lungs causing obstructions and weakening of the immune system. Admissions for pneumonia increased around the time of cancer diagnosis (Figure 21). The proportion of the cohort with pneumonia dropped from 10% the month of cancer diagnosis to around 5% for the 1 and 2 months after. From 3-6 months after cancer diagnosis, the proportion increased to 11% and then 13% between 7-12 months from diagnosis. For those with lung cancer who survive after 18 months, 54% had pneumonia between 19 months and five years from lung cancer diagnosis or prior to death.

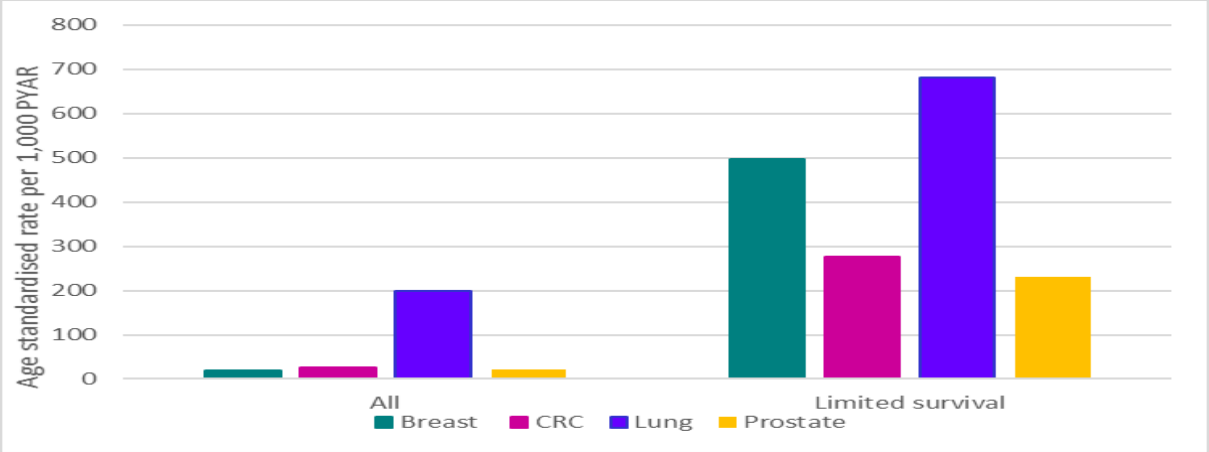

Figure 22: Age standardised rates of pneumonia by cohort, 2012

Women with limited survival following breast cancer had higher rates of pneumonia after cancer diagnosis than CRC and prostate cancer (496 per 1,000 person years at risk compared to 276 for colorectal and 230 for prostate) (Figure 22). Some of the greater risk could be due to metastasis having occurred in the lungs and the high risk of pneumonia associated with lung cancer. Although rare, pneumonia can also be a post-operative complication or related to radiation treatment for breast cancer (Oie, 2013).

Kidney disease

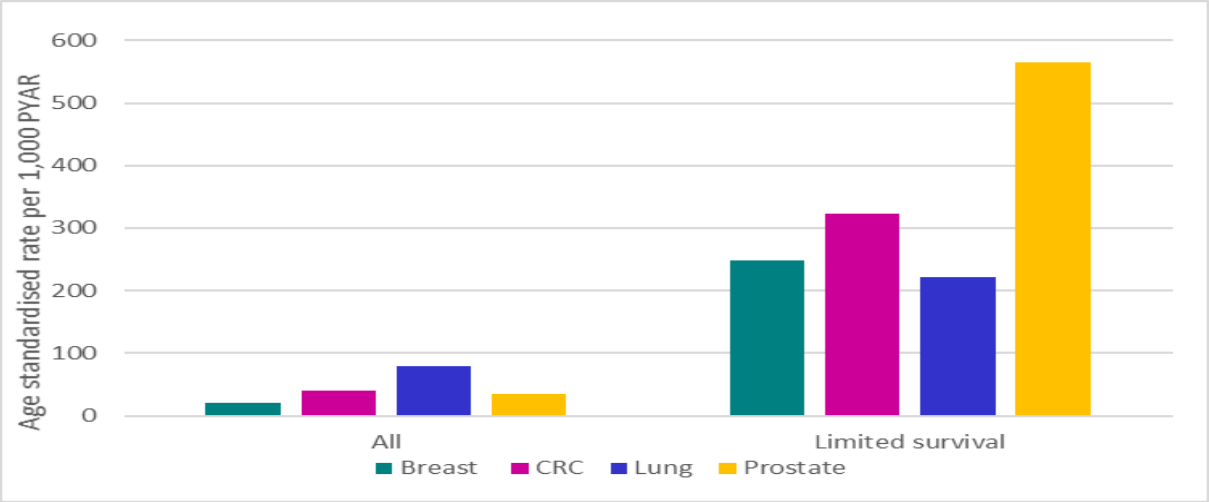

Figure 23: Age standardised rates of kidney disease by cohort and outcome group, 2012

Kidney failure is a common complication of cancer and other long-term conditions such as diabetes and hypertension. The overall rate of **kidney disease after cancer diagnosis was highest for the lung** cancer cohort (79 per 1,000 PYAR) and strongly related to mortality for all cohorts. For those with **limited survival**, people with **prostate cancer had the highest rate of kidney disease** (566 per 1,000 person years at risk).

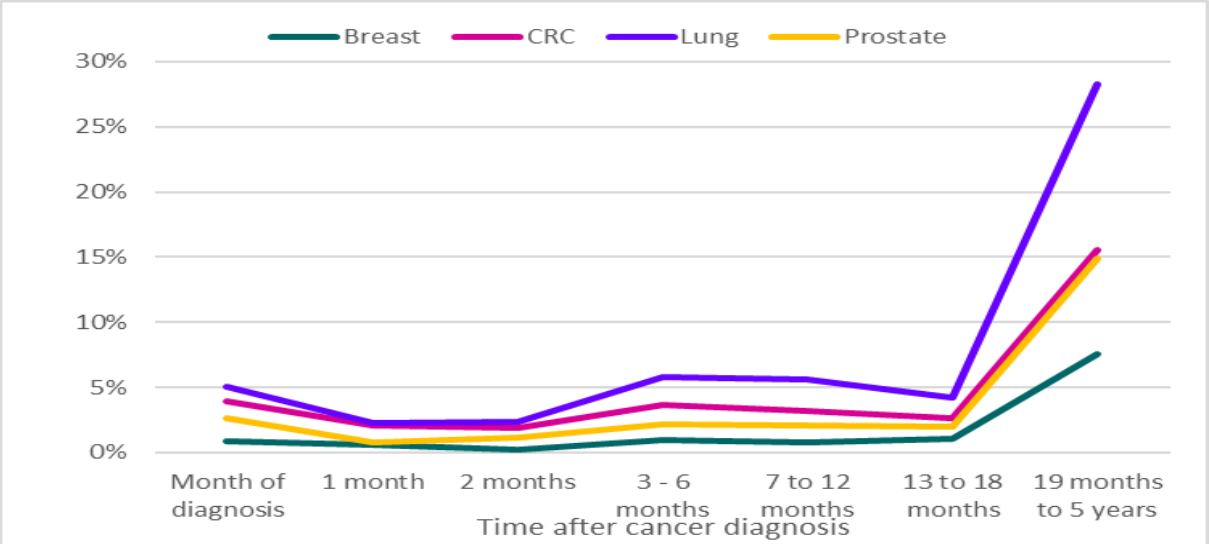

Figure 24: Proportion of cohort alive at the beginning of period with hospital stay or cause of death with kidney disease after cancer diagnosis, 2012

After hypertension, **kidney disease was the most common hospital admission diagnosis in the time period from 19 months to 5 years in the breast and CRC** cohorts with 8% and 16%, respectively (Figure 24). The proportion is even higher for **lung** cancer with

more than a quarter (28%) of those who survived more than 18 months having a diagnosis of kidney disease within the time period.

Conclusions

The analyses have identified that the majority of people with a health condition prior to cancer diagnosis already have more than one other condition too. In order to meet the complex needs of people with multiple conditions and cancer, care should be person-centred and medical professionals' skills should be integrated across specialties (Whitty, 2020). Although it is widely established that comorbidities are associated with age, the analyses show that younger people from deprived areas also are more likely to have multimorbidity prior to cancer diagnosis and need a more general approach to their care.

The proportion of people with cancer detected as an incidental finding increased with severity of comorbidity for all four 2012 cohorts. A consistent finding across all four cohorts is that people with comorbidities are significantly more likely to have unknown staging information about their cancer. For those with severe comorbidities this represented a considerable proportion as at least one fifth had unknown stage in all four cohorts. An association between comorbidity and cancer stage at diagnosis is evident for the breast and colorectal cohort.

People with comorbidities prior to breast, colorectal or lung cancer are considerably more likely to receive no treatment. They are considerably less likely to receive chemotherapy and surgery within their cancer treatment for breast, colorectal and lung cancer than those without comorbidities. In order to understand the relationship between comorbidities and cancer treatment further analysis is needed to adjust for cancer stage and grade at diagnosis. The different distributions of cancer stage and grade could have an impact on treatment decisions.

Further Information

Further information on the Scottish Routes from Diagnosis project, or other work resulting from our partnership, can be found on the Macmillan or the Public Health Scotland websites or by contacting us at phs.macmillan@phs.scot or HealthData@macmillan.org.uk.

Data Appendix

Table 1A – Crude and age standardised rates (truncated at 45 years) of chronic health conditions 5 years prior to cancer diagnosis, Breast cancer, 2012

Conditions	Total cases	% of cohort	Crude rate	Lower CI	Upper CI	Age standardised rate (per 1,000 PYAR)	Lower CI	Upper CI
Anaemia	121	3%	**6.5**	4.5	5.4	**5.0**	4.2	6.0
Arthritis	241	5%	**12.7**	9.8	11.2	**10.4**	9.1	11.8
Asthma	169	4%	**8.8**	6.5	7.6	**7.5**	6.4	8.8
Atrial Fibrillation	140	3%	**7.7**	5.5	6.5	**5.6**	4.7	6.5
Bladder dysfunction	41	1%	**2.7**	1.4	2.0	**1.7**	1.2	2.3
Cellulitis	60	1%	**3.5**	2.1	2.7	**2.4**	1.8	3.1
CHD	215	5%	**11.4**	8.7	10.0	**9.0**	7.8	10.3
COPD	112	3%	**6.3**	4.3	5.2	**4.8**	3.9	5.7
Dementia	47	1%	**4.0**	2.2	3.0	**1.8**	1.3	2.3
Diabetes	154	3%	**8.2**	5.9	7.0	**6.6**	5.6	7.7
Diverticulitis	153	3%	**8.1**	5.9	7.0	**6.4**	5.4	7.5
Dyspepsia	21	0%	**1.8**	0.7	1.2	**1.0**	0.6	1.4
Gastritis & duodenitis	116	3%	**6.6**	4.5	5.5	**5.1**	4.2	6.1
Heart Failure	65	1%	**4.1**	2.5	3.2	**2.6**	2.0	3.3
Hypertension	420	9%	**21.0**	17.3	19.1	**17.6**	15.9	19.4
Interstitial lung conditions	16	0%	**1.4**	0.5	0.9	**0.7**		
Kidney disease	98	2%	**5.4**	3.6	4.5	**3.9**	3.2	4.7
Liver disease	8	0%	**0.9**	0.2	0.4	**0.5**		
Mental health	74	2%	**4.2**	2.6	3.4	**3.6**	2.8	4.4
Neuropathy	62	1%	**3.6**	2.1	2.8	**2.8**	2.1	3.6
Osteoporosis	58	1%	**4.1**	2.4	3.2	**2.4**	1.8	3.1
Peripheral Vascular disease	11	0%	**1.8**	0.5	1.0	**0.4**		
Pneumonia	68	2%	**3.9**	2.4	3.1	**2.7**	2.1	3.4
Sepsis	22	0%	**1.5**	0.6	1.0	**1.0**	0.6	1.5
Stroke and TIA	115	3%	**6.3**	4.3	5.2	**4.7**	3.8	5.6

Table 1B – Crude and age standardised rates (truncated at 45 years) of chronic health conditions 5 years prior to cancer diagnosis, CRC, 2012

Conditions	Total cases	% of cohort	Crude rate	Lower CI	Upper CI	Age standardised rate (per 1,000 PYAR)	Lower CI	Upper CI
Anaemia	351	9%	**20.5**	16.6	18.4	**12.8**	11.0	14.8
Arthritis	213	6%	**13.1**	9.9	11.4	**7.9**	6.6	9.3
Asthma	191	5%	**11.6**	8.7	10.1	**7.1**	6.0	8.4
Atrial Fibrillation	233	6%	**14.1**	10.8	12.4	**7.1**	6.1	8.2
Bladder dysfunction	69	2%	**4.6**	2.8	3.6	**2.0**	1.5	2.5
Cellulitis	42	1%	**3.0**	1.6	2.2	**1.7**	1.0	2.6
CHD	357	9%	**21.0**	17.0	18.9	**12.8**	11.1	14.6
COPD	162	4%	**10.0**	7.3	8.6	**5.7**	4.7	6.7
Dementia	51	1%	**4.3**	2.4	3.3	**1.3**	1.0	1.7
Diabetes	230	6%	**13.8**	10.6	12.1	**8.6**	7.2	10.1
Diverticulitis	182	5%	**11.0**	8.2	9.5	**8.7**	6.9	10.6
Dyspepsia	23	1%	**1.9**	0.8	1.3	**1.1**	0.6	1.8
Gastritis & duodenitis	155	4%	**9.5**	6.9	8.2	**7.0**	5.5	8.7
Heart Failure	107	3%	**7.5**	5.1	6.2	**3.4**	2.7	4.1
Hypertension	542	14%	**31.1**	26.2	28.6	**19.0**	17.1	21.0
Interstitial lung conditions	27	1%	**2.2**	1.0	1.5	**1.0**	0.6	1.6
Kidney disease	170	4%	**10.3**	7.6	8.9	**5.7**	4.7	6.9
Liver disease	19	0%	**1.7**	0.6	1.1	**1.2**		
Mental health	39	1%	**2.8**	1.5	2.1	**2.2**	1.4	3.1
Neuropathy	44	1%	**3.1**	1.7	2.3	**2.1**	1.4	3.0
Osteoporosis	47	1%	**3.4**	1.9	2.5	**1.7**	1.0	2.6
Peripheral Vascular disease	26	1%	**2.3**	1.0	1.5	**0.7**	0.5	1.1
Pneumonia	86	2%	**5.6**	3.6	4.5	**2.9**	2.2	3.7
Sepsis	39	1%	**2.8**	1.5	2.1	**1.9**	1.1	2.9
Stroke and TIA	148	4%	**9.2**	6.7	7.9	**4.6**	3.9	5.4

Table 1C – Crude and age standardised rates (truncated at 45 years) of chronic health conditions 5 years prior to cancer diagnosis, Lung cancer, 2012

Conditions	Total cases	% of cohort	Crude rate	Lower CI	Upper CI	Age standardised rate (per 1,000 PYAR)	Lower CI	Upper CI
Anaemia	341	7%	**14.7**	11.8	13.2	**9.3**	7.8	10.9
Arthritis	330	6%	**14.3**	11.5	12.8	**10.1**	8.2	12.3
Asthma	653	13%	**27.3**	23.3	25.2	**20.4**	17.9	23.0
Atrial Fibrillation	351	7%	**15.1**	12.2	13.6	**7.8**	6.9	8.8
Bladder dysfunction	113	2%	**5.3**	3.6	4.4	**2.8**	2.2	3.5
Cellulitis	82	2%	**3.9**	2.5	3.2	**3.6**	2.0	5.7
CHD	762	15%	**31.8**	27.6	29.6	**20.2**	18.3	22.2
COPD	822	16%	**34.0**	29.6	31.8	**23.0**	20.9	25.2
Dementia	80	2%	**3.9**	2.5	3.2	**1.7**	1.3	2.3
Diabetes	327	6%	**14.2**	11.4	12.7	**9.1**	7.7	10.7
Diverticulitis	283	5%	**12.5**	9.9	11.1	**6.9**	6.0	7.9
Dyspepsia	30	1%	**1.7**	0.8	1.2	**1.9**	0.9	3.3
Gastritis & duodenitis	257	5%	**11.3**	8.8	10.0	**9.3**	7.3	11.5
Heart Failure	234	5%	**10.3**	8.0	9.1	**6.0**	4.8	7.3
Hypertension	827	16%	**34.4**	30.0	32.2	**24.0**	21.5	26.8
Interstitial lung conditions	71	1%	**3.5**	2.2	2.8	**1.8**	1.3	2.3
Kidney disease	253	5%	**11.1**	8.7	9.8	**5.9**	5.0	6.8
Liver disease	30	1%	**1.7**	0.8	1.2	**1.0**	0.6	1.5
Mental health	85	2%	**4.1**	2.6	3.3	**3.4**	2.3	4.9
Neuropathy	78	2%	**3.8**	2.4	3.0	**3.8**	2.4	5.5
Osteoporosis	120	2%	**5.8**	4.0	4.8	**2.5**	2.0	3.0
Peripheral Vascular disease	98	2%	**4.9**	3.2	4.0	**2.2**	1.7	2.7
Pneumonia	415	8%	**17.6**	14.5	16.0	**15.0**	12.2	18.1
Sepsis	48	1%	**2.5**	1.4	1.9	**1.4**	0.9	1.9
Stroke and TIA	286	6%	**12.4**	9.8	11.1	**8.7**	7.0	10.5

Table 1D – Crude and age standardised rates (truncated at 45 years) of chronic health conditions 5 years prior to cancer diagnosis, Prostate cancer, 2012

Conditions	Total cases	% of cohort	Crude rate	Lower CI	Upper CI	Age standardised rate (per 1,000 PYAR)	Lower CI	Upper CI
Anaemia	112	4%	**8.7**	6.0	7.3	**5.1**	4.0	6.3
Arthritis	172	6%	**12.9**	9.5	11.1	**7.6**	6.4	8.9
Asthma	130	4%	**9.9**	7.0	8.4	**6.9**	5.4	8.6
Atrial Fibrillation	177	6%	**13.3**	9.8	11.5	**7.8**	6.6	9.2
Bladder dysfunction	168	5%	**12.6**	9.2	10.8	**9.3**	5.6	13.9
Cellulitis	34	1%	**3.1**	1.5	2.2	**2.2**	1.3	3.3
CHD	317	10%	**22.8**	18.2	20.4	**14.4**	12.6	16.3
COPD	108	3%	**8.4**	5.7	7.0	**4.5**	3.7	5.5
Dementia	19	1%	**2.2**	0.8	1.4	**0.7**		
Diabetes	152	5%	**11.5**	8.3	9.8	**7.1**	5.8	8.6
Diverticulitis	156	5%	**11.8**	8.5	10.1	**7.3**	6.0	8.8
Dyspepsia	14	0%	**1.7**	0.6	1.0	**0.5**		
Gastritis & duodenitis	88	3%	**7.0**	4.6	5.7	**4.3**	3.3	5.4
Heart Failure	76	2%	**6.2**	3.9	4.9	**3.6**	2.7	4.6
Hypertension	424	14%	**30.2**	24.9	27.4	**19.0**	16.9	21.1
Interstitial lung conditions	14	0%	**1.5**	0.5	0.9	**0.9**		
Kidney disease	131	4%	**10.0**	7.1	8.4	**6.1**	4.9	7.4
Liver disease	3	0%	**0.6**	0.0	0.2	**0.1**		
Mental health	20	1%	**2.0**	0.8	1.3	**1.0**	0.6	1.6
Neuropathy	42	1%	**3.7**	2.0	2.7	**2.2**	1.5	3.1
Osteoporosis	9	0%	**1.3**	0.3	0.7	**0.4**		
Peripheral Vascular disease	29	1%	**2.8**	1.3	2.0	**1.3**	0.8	1.9
Pneumonia	59	2%	**4.9**	2.9	3.8	**2.5**	1.9	3.2
Sepsis	26	1%	**2.5**	1.1	1.7	**1.2**	0.7	2.0
Stroke and TIA	129	4%	**9.9**	7.0	8.4	**6.1**	4.9	7.4

Table 2 – Number of drugs prescribed (18 -6 months prior to cancer diagnosis) by cohort and age group, 2012

	Number of drugs prescribed									
	0		1-4		5-9		10 or more		Total	
Age group	Number	%	Number	%	Number	%	Number	%	Number	%
Breast cancer										
All	**623**	**14%**	**1731**	**39%**	**1309**	**29%**	**805**	**18%**	**4468**	**100%**
15-44	102	26%	203	53%	69	18%	11	3%	385	100%
45-54	221	23%	481	51%	168	18%	71	8%	941	100%
55-64	171	16%	494	45%	275	25%	159	14%	1099	100%
65-74	89	9%	338	34%	369	37%	209	21%	1005	100%
75-84	30	4%	159	22%	292	40%	252	34%	733	100%
85+	10	3%	56	18%	136	45%	103	34%	305	100%
CRC										
All	**482**	**13%**	**1250**	**33%**	**1329**	**35%**	**764**	**20%**	**3825**	**100%**
15-44	32	25%	65	50%	23	18%	9	7%	129	100%
45-54	84	28%	142	47%	57	19%	21	7%	304	100%
55-64	162	23%	295	41%	180	25%	74	10%	711	100%
65-74	146	13%	373	33%	410	36%	215	19%	1144	100%
75-84	48	4%	274	25%	466	43%	296	27%	1084	100%
85+	10	2%	101	22%	193	43%	149	33%	453	100%
Lung cancer										
All	**414**	**8%**	**1182**	**23%**	**1830**	**35%**	**1756**	**34%**	**5182**	**100%**
15-54	62	23%	114	41%	63	23%	36	13%	275	100%
55-64	128	14%	295	31%	280	30%	234	25%	937	100%
65-74	141	8%	415	24%	594	34%	605	34%	1755	100%
75-84	64	4%	280	17%	665	40%	672	40%	1681	100%
85+	19	4%	78	15%	228	43%	209	39%	534	100%
Prostate cancer										
All	**397**	**13%**	**1137**	**37%**	**1084**	**35%**	**489**	**16%**	**3107**	**100%**
15-54	34	5%	73	10%	15	2%	10	8%	132	100%
55-64	157	22%	294	42%	183	26%	72	10%	706	100%
65-74	142	11%	506	40%	454	36%	167	13%	1269	100%
75-84	58	8%	201	27%	315	42%	173	23%	747	100%
85+	6	2%	63	25%	117	46%	67	26%	253	100%

Table 3A – Charlson comorbidity Index group by characteristics, Breast cancer, 2012

Characteristic	Breast cancer cases diagnosed in 2012		Charlson Comorbidity Score Group										Chi squared test
			No score		Zero		One		Two		Three or more		
	Count/rate	%/(95% CI)	Count/rate	%/(95% CI)	Count/rate	%/(95% CI)	Count/rate	%/(95% CI)	Count/rate	%/(95% CI)	Count/rate	%/(95% CI)	
Total Cases	4,468		2,273	51	1,485	33	336	8	203	5	171	4	
Patient Category													p < 0.001
Outcome group 1 - Survive with similar acute healthcare burden	1,444	32	768	34	503	34	87	26	58	29	28	16	
Outcome group 2 - Survive with increased acute healthcare burden	926	21	487	21	287	19	77	23	44	22	31	18	
Outcome group 3 - Survive with cancer-related events	1,819	41	927	41	627	42	127	38	73	36	65	38	
Outcome group 4 - Limited survival	279	6	91	4	68	5	45	13	28	14	47	27	
Age													p < 0.001
15-44	385	9	252	11	113	8	9	3	6	3	5	3	
45-54	941	21	607	27	273	18	30	9	23	11	8	5	
55-64	1,099	25	613	27	379	26	47	14	36	18	24	14	
65-74	1,005	22	475	21	352	24	86	26	52	26	40	23	
75-84	733	16	250	11	252	17	112	33	56	28	63	37	
85-99	305	7	76	3	116	8	52	15	30	15	31	18	
Average age at diagnosis (mean)	63.6	(63.2-64.0)	60.2	(59.6-60.7)	64.7	(64.0-65.4)	72.5	(71.1-73.9)	70.8	(69.0-72.7)	74	(72.6-76.4)	
Deprivation (based on SIMD at diagnosis) : Truncated (at 45yrs) EASR													
1 (Most deprived)	306	(284-329)	133	(119-148)	99	(87-113)	35	(28-43)	21	(16-27)	18	(13-23)	
2	312	(291-335)	143	(128-158)	114	(101-127)	27	(21-34)	14	(10-20)	14	(10-19)	
3	327	(306-350)	162	(147-178)	105	(93-118)	29	(23-36)	14	(10-20)	17	(12-22)	
4	323	(301-345)	170	(154-186)	110	(97-123)	19	(14-24)	14	(10-19)	11	(7-15)	
5 (Least deprived)	346	(323-369)	189	(172-206)	117	(104-130)	19	(14-25)	15	(10-20)	6		
Method of detection													p < 0.001
Screening	1,416	32	793	35	500	34	66	20	38	19	19	11	
Incidental finding	139	3	36	2	41	3	14	4	25	12	23	13	
Clinical presentation	2,868	64	1,429	63	928	62	254	76	131	65	126	74	
Other and Not Known	45	1	15	1	16	1	2	1	9	4	3	2	
Stage													p < 0.001
1	1,711	38	885	39	595	40	115	34	73	36	43	25	
2	1,548	35	820	36	506	34	109	32	62	31	51	30	
3	559	13	280	12	191	13	41	12	26	13	21	12	
4	238	5	117	5	74	5	24	7	6	3	17	10	
Not Known	412	9	171	8	119	8	47	14	36	18	39	23	
Grade													p < 0.001
Grade I - Well differentiated	533	12	275	12	191	13	33	10	19	9	15	9	
Grade II - Moderately well differentiated	1,957	44	1,015	45	674	45	127	38	80	39	61	36	
Grade III - Poorly differentiated	1,483	33	809	36	478	32	97	29	61	30	38	22	
Grade not determined	495	11	174	8	142	10	79	24	43	21	57	33	

Table 3B – Charlson comorbidity Index group by characteristics, CRC, 2012

Characteristic	Colorectal cancer cases diagnosed in 2012		Charlson Comorbidity Score Group										Chi squared test
			No score		Zero		One		Two		Three or more		
	Count/rate	%/(95% CI)	Count/rate	%/(95% CI)	Count/rate	%/(95% CI)	Count/rate	%/(95% CI)	Count/rate	%/(95% CI)	Count/rate	%/(95% CI)	
Total Cases	3825		1512	40	1312	34	406	11	301	8	294	8	
Patient Category													p < 0.001
Outcome group 1 - Survive with similar acute healthcare burden	557	15	217	14	218	17	59	15	36	12	27	9	
Outcome group 2 - Survive with increased acute healthcare burden	682	18	310	21	239	18	65	16	40	13	28	10	
Outcome group 3 - Survive with cancer-related events	1,553	41	686	45	523	40	134	33	115	38	95	32	
Outcome group 4 - Limited survival	1,033	27	299	20	332	25	148	36	110	37	144	49	
Age													p < 0.001
15-44	129	3	64	4	55	4	5	1	2	1	3	1	
45-54	304	8	164	11	109	8	16	4	10	3	5	2	
55-64	711	19	373	25	224	17	43	11	52	17	19	6	
65-74	1,144	30	519	34	365	28	106	26	75	25	79	27	
75-84	1,084	28	312	21	381	29	163	40	105	35	123	42	
85-99	453	12	80	5	178	14	73	18	57	19	65	22	
Average age at diagnosis (mean)	70.7	(70.3-71.1)	67.0	(66.4-67.6)	71.0	(70.3-71.7)	75.4	(74.3-76.5)	75.0	(73.8-76.2)	77.1	(76.0-78.3)	
Sex													p = 0.025
Male	2,078	54	846	56	669	51	232	57	159	53	172	59	
Female	1,747	46	666	44	643	49	174	43	142	47	122	41	
Deprivation (based on SIMD at diagnosis) : Truncated (at 45yrs) EASR													
1 (Most deprived)	187	(173-201)	66	(58-75)	65	(57-73)	26	(21-31)	12	(9-16)	19	(14-23)	
2	179	(167-192)	68	(60-76)	61	(54-69)	20	(16-25)	17	(13-21)	13	(10-17)	
3	155	(143-167)	52	(45-59)	55	(48-62)	19	(15-23)	16	(12-20)	14	(10-18)	
4	169	(157-181)	70	(63-78)	60	(53-67)	16	(12-20)	11	(9-15)	12	(9-16)	
5 (Least deprived)	161	(149-173)	68	(60-76)	49	(43-56)	16	(12-20)	13	(10-17)	15	(11-19)	
Method of detection													p < 0.001
Screening	696	18	351	23	237	18	55	14	33	11	20	7	
Incidental finding	92	2	25	2	34	3	9	2	13	4	11	4	
Clinical presentation	3,017	79	1,129	75	1,034	79	341	84	255	85	258	88	
Other and Not Known	20	1	7	0	7	1	1	0	-	-	5	2	
Dukes' stage													p < 0.001
A	693	18	285	19	258	20	74	18	37	12	39	13	
B	909	24	387	26	314	24	88	22	67	22	53	18	
C	861	23	380	25	287	22	82	20	62	21	50	17	
D	825	22	330	22	287	22	74	18	64	21	70	24	
Not Known	537	14	130	9	166	13	88	22	71	24	82	28	
Grade													p < 0.001
Grade I - Well differentiated	125	3	48	3	48	4	14	3	6	2	9	3	
Grade II - Moderately well differentiated	2,343	61	979	65	830	63	226	56	163	54	145	49	
Grade III - Poorly differentiated	630	16	269	18	204	16	59	15	50	17	48	16	
Grade not determined	727	19	216	14	230	18	107	26	82	27	92	31	

Table 3C – Charlson comorbidity Index group by characteristics, Lung cancer, 2012

Characteristic	Lung cancer cases diagnosed in 2012		Charlson Comorbidity Score Group										Chi squared test
			No score		Zero		One		Two		Three or more		
	Count/rate	%/(95% CI)	Count/rate	%/(95% CI)	Count/rate	%/(95% CI)	Count/rate	%/(95% CI)	Count/rate	%/(95% CI)	Count/rate	%/(95% CI)	
Total Cases	5182		1546	30	1621	31	834	16	547	11	634	12	
Patient Category													p < 0.001
Outcome group 1 - Survive with similar acute healthcare burden	179	3	51	3	60	4	26	3	25	5	17	3	
Outcome group 2 - Survive with increased acute healthcare burden	238	5	58	4	74	5	62	7	20	4	24	4	
Outcome group 3 - Survive with cancer-related events	1,398	27	445	29	469	29	225	27	138	25	121	19	
Outcome group 4 - Limited survival	3,367	65	992	64	1,018	63	521	62	364	67	472	74	
Age													p < 0.001
15-44	38	1	18	1	12	1	5	1	1	0	2	0	
45-54	237	5	100	6	87	5	25	3	17	3	8	1	
55-64	937	18	369	24	288	18	131	16	70	13	79	12	
65-74	1,755	34	582	38	525	32	261	31	174	32	213	34	
75-84	1,681	32	376	24	538	33	294	35	219	40	254	40	
85-99	534	10	101	7	171	11	118	14	66	12	78	12	
Average age at diagnosis (mean)	72.4	(72.1-72.7)	69.8	(69.3-70.4)	72.3	(71.8-72.8)	73.9	(73.2-74.5)	74.6	(73.8-75.4)	74.9	(74.2-75.6)	
Sex													p=0.040
Male	2,602	50	769	50	805	50	393	47	288	53	347	55	
Female	2,580	50	777	50	816	50	441	53	259	47	287	45	
Deprivation (based on SIMD at diagnosis) : Truncated (at 45yrs) EASR													
1 (Most deprived)	403	(383-423)	107	(97-118)	123	(112-134)	77	(68-86)	46	(39-53)	50	(43-58)	
2	272	(257-288)	80	(72-89)	84	(76-93)	43	(37-50)	27	(23-32)	37	(31-43)	
3	226	(212-241)	68	(61-76)	66	(58-74)	35	(29-40)	27	(22-32)	31	(25-36)	
4	167	(155-179)	52	(46-59)	55	(48-62)	24	(19-28)	15	(12-19)	21	(17-26)	
5 (Least deprived)	130	(119-141)	38	(32-43)	48	(41-55)	16	(13-21)	14	(11-18)	14	(10-18)	
Method of detection													p < 0.001
Clinical presentation	4,724	91	1,446	94	1,504	93	749	90	473	86	552	87	
Incidental finding	435	8	94	6	113	7	78	9	73	13	77	12	
Other and Not Known	23	0	6	0	4	0	7	1	1	0	5	1	
Stage													p < 0.001
1	622	12	140	9	196	12	123	15	92	17	71	11	
2	313	6	79	5	112	7	54	6	34	6	34	5	
3	963	19	314	20	304	19	140	17	92	17	113	18	
4	2,327	45	809	52	754	47	303	36	209	38	252	40	
Not Known	957	18	204	13	255	16	214	26	120	22	164	26	
Grade													p < 0.001
Grade I - Well differentiated	49	1	12	1	17	1	8	1	7	1	5	1	
Grade II - Moderately well differentiated	629	12	183	12	231	14	101	12	68	12	46	7	
Grade III - Poorly differentiated	804	16	281	18	255	16	99	12	79	14	90	14	
Grade IV - Undifferentiated	85	2	25	2	31	2	14	2	5	1	10	2	
Grade not determined	3,615	70	1,045	68	1,087	67	612	73	388	71	483	76	

Table 3D – Charlson comorbidity Index group by characteristics, Prostate cancer, 2012

Characteristic	Prostate cancer cases diagnosed in 2012		Charlson Comorbidity Score Group										Chi squared test
			No score		Zero		One		Two		Three or more		
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%	
Total Cases	3107		1180	38	1162	37	311	10	269	9	185	6	
Patient Category													p < 0.001
Outcome group 1 - Survive with similar acute healthcare burden	858	28	321	27	368	32	77	25	66	25	26	14	
Outcome group 2 - Survive with increased acute healthcare burden	742	24	299	25	283	24	69	22	57	21	34	18	
Outcome group 3 - Survive with cancer-related events	1,243	40	498	42	434	37	128	41	108	40	75	41	
Outcome group 4 - Limited survival	264	8	62	5	77	7	37	12	38	14	50	27	
Age													p < 0.001
15-54	132	4	70	6	42	4	9	3	10	4	1	1	
55-64	706	23	322	27	274	24	48	15	41	15	21	11	
65-74	1,269	41	488	41	495	43	115	37	108	40	63	34	
75-84	747	24	245	21	263	23	91	29	81	30	67	36	
85-99	253	8	55	5	88	8	48	15	29	11	33	18	
Average age at diagnosis (mean)	70.9	(70.6-71.3)	69.1	(68.5-69.6)	70.8	(70.3-71.3)	74.1	(73.0-75.1)	73.0	(71.9-74.1)	75.8	(74.5-77.1)	
Deprivation (based on SIMD at diagnosis) : Truncated (at 45yrs) EASR													
1 (Most deprived)	266	(242-292)	83	(70-97)	99	(84-115)	41	(31-52)	24	(17-32)	20	(13-28)	
2	304	(280-330)	101	(88-116)	106	(92-121)	37	(29-47)	33	(25-43)	26	(19-34)	
3	312	(287-337)	112	(98-127)	116	(101-131)	31	(23-40)	29	(22-37)	24	(17-32)	
4	336	(311-361)	130	(115-146)	130	(114-146)	28	(21-35)	28	(21-36)	20	(14-27)	
5 (Least deprived)	348	(322-375)	139	(124-156)	132	(117-149)	34	(26-44)	28	(21-37)	14	(9-20)	
Method of detection													p < 0.001
Incidental finding	212	7	29	2	66	6	29	9	57	21	31	17	
Clinical presentation	2,865	92	1,136	96	1,091	94	278	89	211	78	149	81	
Other and Not Known	30	1	15	1	5	0	4	1	1	0	5	3	
Gleason score													p < 0.001
1-6	856	28	332	28	352	30	71	23	61	23	40	22	
7	950	31	375	32	371	32	86	28	87	32	31	17	
8-10	705	23	298	25	256	22	55	18	59	22	37	20	
Not Known	596	19	175	15	183	16	99	32	62	23	77	42	

Table 4A - Age standardised rates of conditions 5 years prior to cancer diagnosis by sex, CRC, 2012

	Males			Females		
Conditions	Age standardised rate (per 1,000 PYAR)	Lower CI	Upper CI	Age standardised rate (per 1,000 PYAR)	Lower CI	Upper CI
Anaemia	**11.4**	9.3	13.7	**14.3**	11.4	17.5
Arthritis	**7.4**	5.6	9.6	**8.4**	6.7	10.4
Asthma	**7.3**	5.8	9.1	**6.9**	5.3	8.8
Atrial Fibrillation	**8.3**	6.8	9.9	**5.9**	4.6	7.4
Bladder dysfunction	**3.2**	2.4	4.2	**0.8**		
Cellulitis	**2.7**	1.4	4.4	**0.7**		
CHD	**15.1**	12.6	17.7	**10.5**	8.3	13.0
COPD	**5.9**	4.7	7.3	**5.4**	4.0	7.1
Dementia	**1.4**	0.9	2.1	**1.2**	0.7	1.7
Diabetes	**9.0**	7.4	10.8	**8.2**	6.1	10.6
Diverticulitis	**6.6**	4.8	8.7	**10.7**	7.8	14.1
Dyspepsia	**0.7**			**1.5**		
Gastritis & duodenitis	**7.1**	5.3	9.2	**6.9**	4.6	9.6
Heart Failure	**4.0**	3.0	5.2	**2.7**	1.9	3.6
Hypertension	**20.4**	17.5	23.4	**17.6**	15.2	20.3
Interstitial lung conditions	**1.4**			**0.6**		
Kidney disease	**5.8**	4.6	7.3	**5.6**	4.0	7.4
Liver disease	**1.4**			**1.0**		
Mental health	**2.5**	1.4	4.0	**1.8**		
Neuropathy	**2.0**			**2.3**	1.3	3.5
Osteoporosis	**0.6**			**2.8**	1.6	4.5
Peripheral Vascular disease	**1.0**			**0.5**		
Pneumonia	**2.8**	2.0	3.7	**3.1**	1.9	4.4
Sepsis	**1.8**	1.1	2.7	**2.0**		
Stroke and TIA	**5.5**	4.4	6.8	**3.7**	2.7	4.8

Table 4B - Age standardised rates of conditions 5 years prior to cancer diagnosis by sex, Lung cancer, 2012

	Males			Females		
Conditions	Age standardised rate (per 1,000 PYAR)	Lower CI	Upper CI	Age standardised rate (per 1,000 PYAR)	Lower CI	Upper CI
Anaemia	**9.0**	6.7	11.6	**9.6**	7.9	11.5
Arthritis	**6.6**	5.3	8.1	**13.7**	10.1	17.8
Asthma	**18.0**	14.9	21.3	**22.8**	19.0	26.9
Atrial Fibrillation	**9.3**	8.0	10.8	**6.3**	5.1	7.6
Bladder dysfunction	**4.4**	3.3	5.7	**1.2**	0.7	1.7
Cellulitis	**2.0**	1.2	3.1	**5.2**	2.3	9.3
CHD	**22.7**	19.7	25.9	**17.7**	15.4	20.1
COPD	**23.2**	19.9	26.7	**22.7**	20.1	25.5
Dementia	**1.7**	1.0	2.7	**1.7**	1.2	2.3
Diabetes	**10.5**	8.1	13.1	**7.8**	6.2	9.6
Diverticulitis	**5.6**	4.5	6.8	**8.3**	6.9	9.8
Dyspepsia	**2.3**			**1.5**		
Gastritis & duodenitis	**10.1**	6.7	14.1	**8.6**	6.8	10.6
Heart Failure	**6.8**	4.8	9.1	**5.2**	4.0	6.5
Hypertension	**24.2**	20.6	28.2	**23.8**	20.3	27.6
Interstitial lung conditions	**2.4**	1.5	3.4	**1.2**	0.7	1.7
Kidney disease	**7.2**	5.9	8.7	**4.5**	3.5	5.6
Liver disease	**1.1**			**0.9**		
Mental health	**3.4**	1.5	5.9	**3.5**	2.3	5.0
Neuropathy	**3.5**	1.7	5.9	**4.1**	2.1	6.8
Osteoporosis	**0.7**			**4.2**	3.4	5.2
Peripheral Vascular disease	**2.5**	1.9	3.2	**1.9**	1.3	2.6
Pneumonia	**16.0**	12.0	20.6	**14.0**	10.3	18.3
Sepsis	**1.1**	0.7	1.6	**1.6**	0.8	2.6
Stroke and TIA	**9.3**	6.5	12.6	**8.0**	6.3	10.0

Table 5 – Age standardised rates of chronic health conditions 5 years after cancer diagnosis, by cohort, 2012

	Breast 2012			CRC 2012			Lung 2012			Prostate 2012		
Comorbidities	Age standardised rates per 1,000 PYR	LCI	UCI	Age standardised rates per 1,000 PYR	LCI	UCI	Age standardised rates per 1,000 PYR	LCI	UCI	Age standardised rates per 1,000 PYR	LCI	UCI
Anaemia	**13.8**	12.1	15.7	**45.4**	41.1	49.8	**64.6**	55.6	74.2	**18.6**	16.2	21.1
Arthritis	**14.5**	12.8	16.3	**12.3**	10.3	14.4	**27.9**	23.0	33.3	**14.9**	10.5	20.0
Asthma	**19.0**	17.1	21.1	**27.0**	23.8	30.5	**187.8**	174.4	201.7	**23.5**	17.4	30.4
Atrial Fibrillation	**14.9**	13.1	16.8	**27.2**	24.4	30.2	**73.5**	66.4	81.0	**23.5**	20.8	26.4
Bladder dysfunction	**2.5**	1.8	3.3	**10.4**	8.3	12.6	**16.0**	12.0	20.5	**24.6**	19.8	30.0
Cellulitis	**12.0**	10.4	13.8	**5.2**	4.0	6.7	**11.4**	8.1	15.1	**4.7**	3.4	6.1
CHD	**19.2**	17.2	21.3	**41.8**	38.1	45.6	**128.2**	118.6	138.2	**35.4**	30.3	41.0
COPD	**13.2**	11.6	14.9	**19.1**	16.8	21.6	**220.5**	206.2	235.2	**17.8**	13.4	22.9
Dementia	**10.5**	9.0	12.1	**8.2**	6.8	9.7	**24.9**	21.2	28.9	**8.7**	7.2	10.5
Diabetes	**16.3**	14.5	18.2	**32.5**	29.1	36.1	**66.4**	59.7	73.4	**23.0**	18.2	28.3
Diverticulitis	**7.8**	6.6	9.1	**41.4**	37.5	45.5	**13.5**	10.9	16.5	**16.4**	12.0	21.5
Dyspepsia	**0.4**			**1.1**			**3.9**			**0.7**		
Gastritis & duodenitis	**6.5**	5.4	7.7	**13.3**	10.9	16.0	**16.9**	12.3	22.2	**7.2**	5.6	9.0
Heart Failure	**9.0**	7.6	10.4	**12.7**	10.9	14.7	**34.4**	29.7	39.3	**12.0**	10.1	14.0
Hypertension	**39.7**	36.8	42.6	**67.6**	62.6	72.8	**122.3**	112.7	132.3	**42.9**	39.2	46.6
Interstitial lung conditions	**2.6**	1.9	3.4	**4.8**	3.6	6.0	**23.3**	19.1	27.9	**3.0**	2.2	4.0
Kidney disease	**20.3**	18.2	22.5	**39.9**	36.2	43.9	**78.7**	70.5	87.4	**34.2**	29.0	39.8
Liver disease	**1.4**	0.9	2.0	**5.0**	3.4	6.9	**4.3**	2.8	6.0	**1.9**	1.2	2.9
Mental health	**4.4**	3.5	5.5	**5.4**	3.8	7.3	**19.3**	14.3	25.0	**2.6**	1.7	3.6
Neuropathy	**4.5**	3.5	5.6	**5.3**	3.9	7.0	**12.3**	8.8	16.3	**3.8**	2.8	5.0
Osteoporosis	**6.3**	5.2	7.5	**4.4**	3.3	5.6	**17.4**	13.9	21.3	**3.5**	0.6	8.9
Peripheral Vascular disease	**0.9**			**3.9**	3.1	4.9	**10.6**	8.5	13.0	**3.1**	2.3	4.0
Pneumonia	**19.7**	17.6	22.0	**26.6**	23.6	29.9	**199.5**	184.3	215.3	**21.5**	19.0	24.1
Sepsis	**15.3**	13.5	17.2	**22.5**	19.4	25.8	**48.8**	41.4	56.8	**16.0**	10.3	22.9
Stroke and TIA	**12.3**	10.7	14.0	**14.4**	12.2	16.6	**53.3**	46.3	60.8	**14.4**	12.4	16.5

Technical Appendix

Data sources

For information about how the four cancer cohorts were defined and the survivorship outcome groups were determined, please see the context and methodology publication.

In the analyses above hospital admissions data (SMR01) and NRS death records are used to derive the prevalence of health conditions.

Counts of drugs are obtained from NHS prescriptions that are prescribed in Scotland and that are dispensed in Scotland and elsewhere in the United Kingdom. All these prescriptions are dispensed by community pharmacies and dispensing doctors. The figures include prescriptions written in hospitals that were dispensed in the community, but exclude prescriptions dispensed within hospitals and prisons. Items which are purchased over the counter are excluded.

Abbreviations

CCI – Charlson Comorbidity Index

SRfD - Scottish Routes from Diagnosis

PHS – Public Health Scotland

PYAR – Person year at risk. i.e. the total number of people alive times the time period. One person for one year = 1 PYAR, 2 people for 6 months each = 1PYAR.

Methods

Age-sex-standardised rates allow for differences in the age/sex structure of populations and allow valid comparisons between geographical areas and through time. They do this by applying the age-specific rates for the area of study to a theoretical European standard population. Age-standardised rates in this publication are usually expressed in terms of rate per 1000 PYAR. The standardised rates presented are truncated (age 45 and over) European age-sex-standardised rates (EASR); as such they differ from national rates published elsewhere.

It should be noted that in follow-up, death is a competing factor with risk of another health condition after cancer diagnosis i.e. those with short survival do not have much time to develop/ be diagnosed with another health condition. The age-standardised rate is converted to a rate **per person year at risk (PYAR);** this allows exploration of the relative risks of developing another condition according to cohort, whilst accounting for differences in survival time.

Chronic Health Conditions

The list of chronic conditions were based on literature review and results from a survey of the Clinical Advisory Group. Sepsis and Pneumonia were also included in the analyses for after cancer diagnosis. Table A shows the ICD codes used for each condition.

Table A: ICD codes for health conditions

Condition	**ICD-10 codes**
Rheumatoid Arthritis and Osteroarthritis	M05, M06, M080, M15-M19, M45, M479
Asthma	J449, J45,J46
Atrial Fibrilation	I48
CHD	I20-I25
COPD	J40-J44
Dementia	F00-F03, F051, G311
Diabetes	E10-E14
Heart Failure	I50
Hypertension	I10-I13, I15
Kidney disease	N17-N19, I120, I131, N039
Liver disease	K70, K711, K720, K721, K729, K73, K74
Mental health	F32, F33, F41
Osteoporosis	M80-M82
Peripheral Vascular disease	I70, I71
Stroke and TIA	G45, I60-I69
Anaemia	D50-D53, D55-D64
Bladder dysfunction	F980, N23, N393, N394, R32, R33, R398
Cellulitis	A184, H050, H601,J340,J383, J387, J391, K122, K610-K612, L03, L983, N482, N499, N61, N730-N732
Diverticulitis	K57
Dyspepsia	K30, R101
Gastritis & duodenitis	K29
Interstitial lung conditions	J80-J82, J84
Mono- and Polyneuropathy	G50-G63
Pneumonia	J100, J110, J12-J18
Sepsis	A021, A227, A267, A327, A40, A41, A427, B377, R572, R651, O85

The Charlson Comorbidity Index (CCI)

The Charlson Comorbidity Index (CCI) is a method of assessing comorbidity through prior hospital records, scoring these based on the reason for the hospital admission. The Charlson score is a validated tool used by healthcare professionals to predict risk of death and the burden of a disease. Starting at zero, a patient's score can increase because of the severity of their illness or illnesses, or because the number of conditions they have increases.

Secondary care data (SMR01) was used to ascertain the prevalence of the 17 conditions of the CCI, with a period of five years as the look back period prior to cancer diagnosis. Each condition has a weight assigned from 1 to 6, derived from the relative risk estimates obtained from a regression model. The CCI score is the sum of weights for all prevalent conditions. The CCI scores were collapsed into five categories: those with no matched inpatient record in the look back period (no score), those with a hospital record but no matching conditions (score of 0), those with a score of 1, a score of 2 and a score equal or greater than 3.

While there are versions of the CCI which exclude the impact of cancer, the approach used in this analysis did not specifically exclude cancer as it was intended to be a measure of general health.

Count of prescriptions

Brilleman (2012) found that the number of prescribed drugs is a powerful predictor of future health service utilization (consultation rate) and mortality, when comparing measures of multimorbidity. In the multimorbidity analyses the number of unique British National Formulary (BNF) codes appearing in the individual's prescription drug data are counted. Each code represents one sub-heading within the BNF and includes drugs that are in the same class. Repeated prescriptions of the same or very similar medications were only counted once. In order to avoid the time period in which prescriptions might be administered for the cancer, the period covered in the above analyses is the 18 months to 6 months prior to diagnosis.

Limitations

It is important to recognise that the efficacy of SMR01 data to derive the prevalence of conditions is likely to differ by the type of condition of interest. For example, sepsis is very likely to result in a hospitalisation while other conditions of interest such as asthma, diabetes, COPD and hypertension might not result in a hospital admission and may be undercounted in the cohorts. Additionally, patients with higher numbers of hospital admissions are more likely to have additional conditions counted although this was not the primary reason for admission. The strengths and limitations of data sources are discussed further in context and methodology publication.

Counts of prescriptions is obtained from NHS prescriptions that are dispensed by community pharmacies and dispensing doctors. It is important to note that the count of prescriptions does not include those dispensed in hospital and, therefore, those in the cohort with higher numbers of hospital admissions and longer hospital stays will not have their prescriptions included in the analyses but might be more likely to have other health conditions.

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