Cancer survival
by county and health region in Norway,
2000-2009
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Norsk sammendrag

Variasjoner i kreftoverlevelse på tvers av de 19 fylkene samt de fire helseregionene i Norge ble studert. Dette ble utført for de to siste tidsperiodene med komplette epidemiologiske data, 2000-2004 og 2005-2009. Elleve av tolv krefttyper studert i denne rapporten viste statistisk signifikante (p-verdi < 0.05) eller på grensen til signifikante (p-verdi mellom 0.05 og 0.1) forskjeller i relativ overlevelse på tvers av fylkene. Begge tidsperiodene og begge kjønn sett under ett ga statistisk signifikante forskjeller i relativ overlevelse for non-Hodgkin lymfom og leukemi samt kreft i endetarm, lunge, bryst, ovarier og prostata. Variasjon på tvers av fylker var på grensen til signifikant for malignt melanom og kreft i livmorlegeme, tykktarm og blære. Hvilke fylker som hadde lavest og høyest overlevelse varierte imidlertid over tidsperiodene. Overlevelse økte for de fleste krefttyper fra 2000-2004 til 2005-2009. Denne rapporten beskriver kreftoverlevelse for utvalgte krefttyper i Norge basert på bosted ved diagnosetidspunkt. For å kunne forklare de observerte forskjellene i overlevelse trengs detaljert informasjon om sykdommen og behandlingen til den enkelte pasient, i tillegg til mer demografisk informasjon om pasientene.

Summary

Variations in cancer survival across the 19 counties as well as across the four geographical health regions of Norway were studied. This was performed for the two most recent five year periods with complete epidemiological data, 2000-2004 and 2005-2009. Eleven of the 12 cancers studied in this report showed statistically significant (p-value < 0.05) or borderline significant (p-value between 0.05 and 0.1) differences in relative survival across the counties. Looking at the two time periods and both sexes combined, statistically significant differences in relative survival were found for Non-Hodgkin lymphoma and leukemia and cancers of the rectum, lung, breast, ovary and prostate. The variation across counties was borderline significant for malignant melanoma and cancers of the corpus, colon and bladder. However, which counties that had the lowest and highest survival rates varied somewhat across time periods. Survival increased for most cancer types from 2000-2004 to 2005-2009. This report describes cancer survival for selected cancer types in Norway based on place of residence at the time of diagnosis. In order to investigate the possible reasons for the observed differences in survival, more detailed information concerning the disease and the health care provided is needed, in addition to more demographic information about the patients.
Background

The Norwegian public health service aims to provide efficient and equal health care to all citizens, irrespective of income, age, place of residence, gender or ethnicity. Cancer survival has been shown to vary both regionally (within a country) and internationally (between countries) (Coleman, et al., 2011; Coleman, et al., 2008; Yu, et al., 2005; Yu, et al., 2004; Walters, et al., 2011; Dickman, et al., 1997; Engeland, et al., 1998). To our knowledge, regional differences in cancer survival have not been studied in the Norwegian population. To reduce potential geographical disparities in the quality of cancer care, studies of regional cancer survival are essential.

In 2009, the total number of new cancer cases was 27 520 of which 54% were men and 46% were women (Cancer in Norway 2009). Comparing the two most recent five year time periods where complete data are available (2000-2004 and 2005-2009), a 7% increase in cancer incidence was observed. The increase in incidence may be explained by a combination of several factors, where one is the aging of the population. However, with rising incidence for several cancers it is even more important that the health authorities provide the best possible care for cancer patients. The present report will provide an overview of survival for cancer patients in Norway by county and health region. A similar report has been published in Sweden, and has been an inspiration to some of the work in this report (http://www.socialstyrelsen.se/Lists/Artikelkatalog/Attachments/18274/2011-3-26.pdf).

Outline of the report

This report contains an overall summary of the incidence rates and five-year survival rates for the total Norwegian population, the four health care regions and the 19 counties in Norway. Figures for the incidence rate and survival rates for the two time periods 2000-2004 and 2005-2009 are given. The report has considered the 12 most common cancer sites in Norway, where the results for each site are presented in separate sections. All statistics were calculated separately for males and females. Due to a relatively small cancer population in Norway, the figures are given for all age-groups combined. Incidence rates and five-year relative survival rates are presented graphically in this report.
### Definitions

<table>
<thead>
<tr>
<th>Definition*</th>
<th>Example (Colon cancer for females in Norway)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Incidence</strong>&lt;br&gt;The number of new cases (of disease) in a defined population within a specific period of time.</td>
<td>The incidence of colon cancer for females was 1319 new cases in 2009.</td>
</tr>
<tr>
<td><strong>Incidence rate</strong>&lt;br&gt;The number of new cases that arise in a population (incidence) divided by the number of people who are at risk of getting cancer in the same period. The rate is expressed per 100 000 person-years. Person-years is a measurement that combines persons and time (in years) as the denominator in rates.</td>
<td>The incidence rate was 55.9 in the period 2005-2009, meaning that on average 55.9 females out of 100 000 under risk were diagnosed with colon cancer each year during this period.</td>
</tr>
<tr>
<td><strong>Age-specific rate</strong>&lt;br&gt;A rate calculated on stratifying by age, often based on a five-year interval.</td>
<td>The age-specific incidence rate for age 50-54 was 30.8 in the period 2005-2009, meaning that on average 30.8 females aged 50-54 out of 100 000 under risk in the same age group were diagnosed with colon cancer each year during this period.</td>
</tr>
<tr>
<td><strong>Age-standardised incidence rate</strong>&lt;br&gt;Age-standardised (or age-adjusted) incidence rates are summary rates which would have been observed, given the schedule of age-specific rates, in a population with the age composition of a given standard population. The world standard population is used in this report (Doll, et al., 1966).</td>
<td>The age-standardised incidence rate was 23.3 in the period 2005-2009, meaning that if the Norwegian population had the same age composition as the reference population (a constructed world population in 1966) on average 23.3 persons out of 100 000 under risk would be diagnosed with colon cancer each year.</td>
</tr>
<tr>
<td><strong>Relative survival</strong>&lt;br&gt;The observed survival in a patient group divided by the expected survival of a comparable group in the general population with respect to key factors affecting survival such as age, sex and calendar year of investigation. Relative survival is thus a measure of the excess mortality experienced by the patients regardless of whether the excess mortality may be directly or indirectly attributable to the disease under investigation. A key advantage is that it does not require cause of death information.</td>
<td>The five-year relative survival was 62.2 % in 2005-2009, meaning that in comparison with the general population, 62.2 % of females with colon cancer will survive at least five years.</td>
</tr>
</tbody>
</table>

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Material

Geographical regions
In this report the place of residence was registered at the time of diagnosis of the patient. If a patient moved during his or her illness, this was not taken into account. The four geographical health care regions and the corresponding counties are given in Table 1.

Table 1. The four geographical health care regions and the corresponding counties.

<table>
<thead>
<tr>
<th>Health Region</th>
<th>Corresponding counties</th>
</tr>
</thead>
<tbody>
<tr>
<td>South-eastern Regional Health Authority</td>
<td>Østfold, Akershus, Oslo, Hedmark, Oppland, Buskerud, Vestfold, Telemark, Aust-Agder, Vest-Agder</td>
</tr>
<tr>
<td>Western Norway Regional Health Authority</td>
<td>Rogaland, Hordaland, Sogn og Fjordane</td>
</tr>
<tr>
<td>Central Norway Regional Health Authority</td>
<td>Møre og Romsdal, Sør-Trøndelag, Nord-Trøndelag</td>
</tr>
<tr>
<td>Northern Norway Regional Health Authority</td>
<td>Nordland, Troms, Finnmark</td>
</tr>
</tbody>
</table>

Cancer Sites
The 12 most common anatomical cancer sites for the Norwegian population were included in this report (Table 2).

Table 2. The 12 most common cancer sites for the Norwegian population.

<table>
<thead>
<tr>
<th>ICD10 code</th>
<th>Cancer site</th>
</tr>
</thead>
<tbody>
<tr>
<td>C18</td>
<td>Colon</td>
</tr>
<tr>
<td>C19-21</td>
<td>Rectum, rectosigmoid and anus</td>
</tr>
<tr>
<td>C33-34</td>
<td>Lung and trachea</td>
</tr>
<tr>
<td>C43</td>
<td>Melanoma of the skin</td>
</tr>
<tr>
<td>C50</td>
<td>Breast (for females)</td>
</tr>
<tr>
<td>C54</td>
<td>Corpus uteri</td>
</tr>
<tr>
<td>C56</td>
<td>Ovary</td>
</tr>
<tr>
<td>C61</td>
<td>Prostate</td>
</tr>
<tr>
<td>C66-68</td>
<td>Bladder, ureter and urethra</td>
</tr>
<tr>
<td>C70-22 + D32-33</td>
<td>Central nervous system</td>
</tr>
<tr>
<td>C82-85 + D96</td>
<td>Non-Hodgkin lymphoma</td>
</tr>
<tr>
<td>C91-95 + D45-47</td>
<td>Leukemia</td>
</tr>
</tbody>
</table>

The Cancer Registry of Norway
Reporting all cancer cases to the Cancer Registry of Norway is statutory, and reporting started as early as in 1952. The present quality (comparability, accuracy, completeness and timeliness) of the data extracted from the Cancer Registry of Norway is considered to be high (Larsen, et al., 2009).
Statistical methods

Incidence
When studying trends and differences in estimated survival rates for geographical regions, it is of interest to study the incidence rates for the same geographical regions. In this report, figures of incidence rates per 100,000 person-years given site, sex and geographical regions are given for the time period 2000-2004 and 2005-2009. The risk of developing cancer is highly affected by age. For comparison of populations in different geographical regions age standardized rates is a standard approach and the world standard population was used in this report (Doll, et al., 1966).

Relative survival
Relative survival is estimated as the ratio of the observed survival of the cancer population to the expected survival of the general population similar to the cancer patients in terms of factors such as age, sex, race and place of residence. In other words, relative survival can be interpreted as the survival from cancer when adjusting for deaths due to other causes. Expected survival was estimated using life tables stratified by age, sex and county, and were estimated using the Ederer II method (Ederer & Heise, 1959) in this report.

To provide up-to-date estimates, relative survival was estimated using the period approach (Brenner & Söderman, 2002) using observation periods 2000-2004 and 2005-2009 for which all patients were included with their follow-up contributions up to five years. Empirical evaluations have shown that the period approach gives better estimates of current survival than the traditional cohort approach (Talbäck & Dickman, 2012). In contrast to the traditional cohort estimates which represent the survival experience of a well defined group of patients diagnosed during a calendar period in the past, period estimates represent the survival that would be observed for a hypothetical cohort of patients who experienced the same interval-specific survival as the patients at risk during the specified calendar period (2000-2004 and 2005-2009 in this report).

In the figures representing relative survival, a reference line was included for both time periods representing the five-year relative survival for the total Norwegian population. The age standardized relative survival rates were calculated using the International Cancer Survival Standard (Corazziari, et al., 2004). Estimating relative survival with and without taking county into account, enabled formally assessing whether county-wise differences were present for the different cancer sites. For this purpose, flexible parametric survival models (Royston-Parmar models) were estimated for each site and both sexes (Lambert & Royston, 2009). Models with and without county as explanatory variable were compared using a likelihood-ratio test.

Comments: The total cancer population in Norway is relatively small and even smaller when considering counties or health regions within the country. The consequence of this is random variation in the estimated relative survival rates and wide confidence intervals for some estimates. Another consequence was that some of the studied subpopulations experienced zero incidence cases, or zero cancer survivors beyond five years. These scenarios resulted in five-year relative survival estimates of zero. This problem was partly dealt with by considering broader five-year time periods. However, for some cancer sites and time periods the population was still too small, and the estimates for these subpopulations were removed from the results.
Results

Variations in cancer survival across the 19 counties of Norway as well as across the four geographical health regions are presented in this report. Relative survival and incidence rates were calculated for each of these regions for the 12 most common types of cancer (defined by anatomical site) for the time periods 2000-2004 and 2005-2009 (Figures 1-12 and Table 3). Eleven of the 12 cancers studied in this report showed significant (p-value < 0.05) or borderline significant (p-value between 0.05 and 0.1) differences across counties (Table 3). Looking at the two time periods and both sexes combined, statistically significant differences were found for Non-Hodgkin lymphoma and leukemia and cancers of the rectum, lung, breast, ovary and prostate. The variation was borderline significant for malignant melanoma and cancers of the corpus, colon and bladder. Relative survival increased for most cancer types from 2000-2004 to 2005-2009. It should be noted that there is high variability and small numbers for some of the counties.

The most significant county-wise differences in relative survival were observed for lung (and trachea) and prostate cancer, which generally have low and high survival rates, respectively. For these two cancer sites, significant county-wise differences were seen for both time periods separately and combined (Figure 3 and 8).

For females with lung cancer, five-year relative survival rates ranged from 8.9 - 19.8 % in 2000-2004 (counties Rogaland, Sogn og Fjordane and Vestfold were the three lowest and counties Møre og Romsdal, Aust-Agder and Hordaland were the three highest) and 9.5 – 23.0 % in 2005-2009 (counties Sogn og Fjordane, Buskerud, and Østfold were the three lowest and counties Hordaland, Sør-Trøndelag and Finnmark were the three highest). For males with lung cancer, five-year relative survival rates for ranged from 5.0 – 15.6 % in 2000-2004 (counties Finnmark, Østfold and Rogaland were the three lowest and counties Aust-Agder, Sogn og Fjordane and Nord-Trøndelag were the three highest) and 7.9 – 17.2 % in 2005-2009 (counties Sogn og Fjordane, Finnmark and Hedmark were the three lowest and counties Troms, Møre og Romsdal and Nordland were the three highest).

For prostate cancer (only males), five-year relative survival rates ranged from 71.0 – 84.0 % in 2000-2004 (counties Oppland, Telemark and Østfold were the three lowest and counties Hordaland, Aust-Agder and Vest-Agder were the three highest) and 80.0 – 91.0 % in 2005-2009 (counties Østfold, Nord-Trøndelag and Telemark were the three lowest and counties Møre og Romsdal, Oslo, and Aust-Agder were the three highest).

Significant county-wise differences in relative survival for both time periods were also observed for leukemia (Figure 12). For cancer of the breast (Figure 5) and rectum (Figure 2) significant county-wise differences in relative survival were observed for the first time period (2000-2004) and when the two time periods were combined (2000-2009). For non-Hodgkin lymphoma (Figure 11), on the other hand, significant county-wise differences in relative survival were only found when combining the two time periods.
Discussion

The results presented in this report should be regarded as explorative, as no adjustments of the relative survival estimates other than age have been performed. The observed geographical differences in relative survival could thus be explained by many different host- or tumour related factors aside from differing quality of cancer care (Black, et al., 1998). Host-related factors include the socioeconomic status, age at diagnosis and sex of the patient, as well as determinants related to the patient’s lifestyle. Tumour-related factors involve clinical aspects of the tumour, including topography, morphology, degree of differentiation, and the extent of disease. Although this report does not provide explanations for the observed geographical differences, it is important to acknowledge that there exist disparities in cancer survival, which future studies will aim to explain.

At the Cancer Registry of Norway, clinical registries for some types of cancers have been established. These registries include detailed information on diagnostic measures, therapy, and follow-up, and will be valuable for shedding light on potential geographical differences in patient populations or cancer care given. In addition, other registries may be utilized to attain information about factors such as educational level and country of birth.

Although the observed geographical differences cannot be explained based on this descriptive report, the changes in early detection of prostate and breast cancer should be mentioned. Part of the county-wise differences in relative survival observed for prostate and breast cancer can probably be explained by geographical and temporal disparities in prostate-specific antigen (PSA) testing and mammography screening practices, respectively. For prostate cancer, PSA testing increases the number of detected cancer cases which may artificially improve the relative survival in counties where PSA testing is widely used. The mammographic screening programme was introduced gradually by county in Norway, and became nationwide in 2005, which agrees with the county-wise relative survival differences observed for breast cancer in the 2000-2004 period. As with prostate cancer, the lead time caused by early detection through mammographic screening will artificially improve relative survival estimates (so-called lead time bias).

To conclude, this report describes the differences in relative survival for the 12 most common types of cancers in Norway between the 19 counties and the 4 health regions, and could be considered a useful first step in revealing possible inequalities in the provision of cancer care in Norway.
Table 3. Statistical significance (p-values) of regional differences for different cancer sites and time periods. The p-values were calculated using likelihood ratio tests comparing statistical models of relative survival with and without county as a factor variable. p-values < 0.05 were regarded as statistically significant (bold).

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>C18</td>
<td>Colon</td>
<td>0.20</td>
<td>0.09</td>
<td>0.06</td>
</tr>
<tr>
<td>C19-21</td>
<td>Rectum, rectosigmoid and anus</td>
<td><strong>0.03</strong></td>
<td>0.31</td>
<td><strong>0.03</strong></td>
</tr>
<tr>
<td>C33-34</td>
<td>Lung and trachea</td>
<td>&lt; <strong>0.01</strong></td>
<td>&lt; <strong>0.01</strong></td>
<td>&lt; <strong>0.01</strong></td>
</tr>
<tr>
<td>C43</td>
<td>Melanoma of the skin</td>
<td>0.60</td>
<td>0.08</td>
<td>0.06</td>
</tr>
<tr>
<td>C50</td>
<td>Breast (for females)</td>
<td>&lt; <strong>0.01</strong></td>
<td>0.34</td>
<td>&lt; <strong>0.01</strong></td>
</tr>
<tr>
<td>C54</td>
<td>Corpus uteri</td>
<td>0.02</td>
<td>0.19</td>
<td>0.06</td>
</tr>
<tr>
<td>C56</td>
<td>Ovary</td>
<td>0.20</td>
<td>0.11</td>
<td>0.03</td>
</tr>
<tr>
<td>C61</td>
<td>Prostate</td>
<td>&lt; <strong>0.01</strong></td>
<td>&lt; <strong>0.01</strong></td>
<td>&lt; <strong>0.01</strong></td>
</tr>
<tr>
<td>C66-68</td>
<td>Bladder, ureter and urethra</td>
<td>0.06</td>
<td>0.47</td>
<td>0.07</td>
</tr>
<tr>
<td>C70-22 + D32-33</td>
<td>Central nervous system</td>
<td>0.68</td>
<td>0.27</td>
<td>0.24</td>
</tr>
<tr>
<td>C82-85 + D96</td>
<td>Non-Hodgkin lymphoma</td>
<td>0.18</td>
<td>0.10</td>
<td>&lt; <strong>0.01</strong></td>
</tr>
<tr>
<td>C91-95 + D45-47</td>
<td>Leukemia</td>
<td><strong>0.01</strong></td>
<td><strong>0.02</strong></td>
<td>&lt; <strong>0.01</strong></td>
</tr>
</tbody>
</table>
Figure 1. Colon (C18). Five year relative survival (top) and incidence rates (bottom) for the periods 2000-2004 (light blue for males, orange for females) and 2005-2009 (dark blue for males, red for females).
Figure 2. Rectum, rectosigmoid and anus (C19-21). Five year relative survival (top) and incidence rates (bottom) for the periods 2000-2004 (light blue for males, orange for females) and 2005-2009 (dark blue for males, red for females).
Figure 3. Lung and trachea (C33-34). Five year relative survival (top) and incidence rates (bottom) for the periods 2000-2004 (light blue for males, orange for females) and 2005-2009 (dark blue for males, red for females).
Figure 4. Melanoma of the skin (C43). Five year relative survival (top) and incidence rates (bottom) for the periods 2000-2004 (light blue for males, orange for females) and 2005-2009 (dark blue for males, red for females).
Figure 5. Breast (C50), females. Five year relative survival and incidence rates for the periods 2000-2004 (orange) and 2005-2009 (red).
Figure 6. Corpus uteri (C54). Five year relative survival and incidence rates for the periods 2000-2004 (orange) and 2005-2009 (red).
Figure 7. Ovary (C56). Five year relative survival and incidence rates for the periods 2000-2004 (orange) and 2005-2009 (red).
Figure 8. Prostate (C61). Five year relative survival and incidence rates for the periods 2000-2004 (light blue) and 2005-2009 (dark blue).
Figure 9. Bladder, ureter and urethra (C66-68). Five year relative survival (top) and incidence rates (bottom) for the periods 2000-2004 (light blue for males, orange for females) and 2005-2009 (dark blue for males, red for females).
Figure 10. Central nervous system (C70-72 + D42-43). Five year relative survival (top) and incidence rates (bottom) for the periods 2000-2004 (light blue for males, orange for females) and 2005-2009 (dark blue for males, red for females).
Figure 11. Non-Hodgkin lymphoma (C82-85, C96). Five year relative survival (top) and incidence rates (bottom) for the periods 2000-2004 (light blue for males, orange for females) and 2005-2009 (dark blue for males, red for females).
Figure 12. Leukemia (C91-95 + D45-47). Five year relative survival (top) and incidence rates (bottom) for the periods 2000-2004 (light blue for males, orange for females) and 2005-2009 (dark blue for males, red for females).
References


