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CANCER RESEARCH UK

10-year cancer survival by stage for patients diagnosed in the East of England, 2007 to 2017

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Contents

Main points

Five-year net survival estimates by stage at diagnosis were calculated and compared between patients diagnosed in a geographical area with good historic stage completeness (the East of England) and England overall; using the complete approach of producing net survival estimates. Estimates for patients diagnosed in the East of England were largely similar to patients in England overall, suggesting the East of England data were representative enough to explore further.

Ten-year net survival estimates by stage at diagnosis were subsequently calculated for the East of England using the period approach to more accurately reflect the survival experience for those more recently diagnosed.

Non age-standardised results are presented because small numbers in age/stage/site combinations make some 10-year age-standardised estimates unfeasible. Estimates were also produced by sex (where appropriate) and age (under and over 65 years).

Ten-year net survival estimates by stage for breast, colorectal, lung, prostate, kidney, melanoma, ovarian and uterine cancers were generally lower than 5-year net survival, though there was notable variation by site and stage.

Melanoma, breast and prostate cancer survival estimates for stage 1 remained high for all time periods, whereas 10-year survival estimates for kidney and lung cancer are lower than 1 and 5 year survival estimates at each stage of diagnosis.

The relative difference between 5 and 10 year survival estimates generally increased by later stage at diagnosis.

Differences between 10 year survival by stage highlight the need for continued efforts to achieve diagnosis at earlier stages

Introduction

Cancer survival by stage estimates show how mortality outcomes differ according to the stage of disease when a patient is diagnosed with cancer. They demonstrate the benefits of an earlier stage diagnosis (for example, stage 1 and 2) compared with the poorer outcome of a later stage diagnosis; given there is generally a wider range of treatment options available for earlier stage disease.

Currently published net survival estimates by stage for England are available for 1 and 5-year survival (1). Due to historic incompleteness of staging data, it is currently not possible to estimate survival by stage reliably for England over a longer time period (10 years). However, there is evidence for several cancer types where net survival by stage continues to decrease beyond 5 years post diagnosis (2,3) and so 5-year survival may be deemed inadequate as a marker of statistical cure, which is achieved when the patient and background population mortality risk become similar (4). The estimation of the time point at which statistical cure is achieved (cure point) is difficult (4) but, as it is a longer-term estimate, 10-year survival may better reflect the proportion of patients likely to be ‘cured’ than 5-year survival while also potentially allowing the identification of site-stage combinations where 5-year and 10-year survival are very similar, suggesting that by 5 years a ‘cure point’ may have been reached. Hence, longer-term survival information could be useful for both patients and health professionals. 10-year survival by stage information is also of use for developing and influencing cancer policy, with site-specific 10-year survival by stage estimates having the potential to inform how interventions aiming to cause stage shift could contribute to improving cancer survival and helping with the prioritisation of Early Diagnosis related activity. It will also help to consider the effects of achieving the ‘3 in 4’ patients diagnosed at stage 1 and 2 ambition set by the Government in the 2019 NHS Long Term plan (5) and longer-term follow up should this ambition be realised.

While the historic incompleteness of staging data currently prevents the production of 10-year survival estimates for England, the former East of England cancer registry focussed on capturing stage data for patients diagnosed in the region. East of England data was used to produce 5-year survival estimates by stage published on CRUK’s website until England estimates were able to be produced. Building on this previous precedent, this project aimed to produce useable site-specific net survival by stage estimates for sites with complete 5-year net survival by stage data published by PHE (1) in advance of nationwide estimates being possible. A further aim was to investigate the usefulness and feasibility of producing nationwide 10-year net survival estimates.

Methods

Data

This project utilised cancer registration data from the National Disease Registration Service, Public Health England for English residents diagnosed for the first time with a primary tumour at one of the cancer sites of interest (Table 1) from 2007 to 2017. Patients were excluded based on criteria previously published (6). Excluded records include those with incomplete data, ineligible combinations of site and morphology such as lymphoma, leukaemia or myeloma in a solid organ, sex-site incompatibility, non-malignant tumour behaviour, age<15 or age>99 at diagnosis, vital status unknown, sex unknown, invalid dates or sequence of dates or death certificate only registrations. Details of the cancer registry catchment area for the patient were also extracted and used to include only those patients from the former Eastern Cancer Registration and Information Centre cancer registry where required.

Table 1. Cancer sites and ICD10 codes used in calculation of net survival estimates

Cancer site	ICD10 codes
Breast	C50
Colon and rectum	C18-C20
Kidney	C64
Lung	C33-C34
Melanoma	C43
Ovary	C56-C57
Prostate	C61
Uterus	C54-C55

Survival methods

This project used existing survival techniques detailed in the cancer survival Standard Operating Procedure available from United Kingdom and Ireland Association of Cancer Registries (UKIACR) (7). Throughout, we calculated survival using the stns algorithm in Stata SE 16, mirroring the methodology used to produce the National Statistics for cancer survival (1). This algorithm uses the Pohar-Perme estimator which produces a non-biased estimator of net survival (8). Net survival estimates the survival of cancer patients compared with the background mortality that patients would have experienced if they had not been diagnosed with cancer, with this background mortality for the general population derived from lifetables (9). For this analysis, ONS lifetables matched by age, sex, population weighted quintile of the income domain of the index of multiple deprivation, region and year of death were used.

In order to help determine whether the East of England was comparable with England for longer term survival by stage estimates, 5-year net survival estimates by stage were first produced for both England and East of England[1] (as covered by the former Eastern Cancer Registration and Information Centre (ECRIC) cancer registry area). These 5-year net survival estimates were calculated using the complete approach for patients diagnosed from 2013 to 2017 and followed up to 05/01/2019, replicating the methods used in the production of published 5-year net survival by stage (1). 5-year net survival was chosen as it is the longer time period for which stage breakdowns are sufficiently complete for England overall (1). After comparison, the East of England results were sufficiently representative to provide the proof of concept for producing 10-year net survival estimates by stage using the East of England data (Tables B1 and B2). The 10-year estimates were produced using both the complete approach and an additional method called the period approach, which uses more recent data and so may more accurately reflect the survival experience for patients diagnosed more recently. Therefore, aside from the comparison tables (B1 and B2), all 10-year estimates referred to use the period approach. Detailed descriptions of the 2 approaches are given in appendix A and comparisons of net survival estimates are presented in Appendix C.

Age-standardisation is usually applied to survival estimates to allow comparisons between populations with different age distributions. However, many of the 10-year net survival estimates for individual age bands met criteria necessitating suppression. These criteria are either small numbers of patients left in the cohort at 10 years, small numbers of deaths in the years around 10 years or the standard error being too wide around the estimate. Hence, most age-standardised results were not robust enough to be published and therefore non-standardised results are reported instead. The 5-year net survival estimates for England and the East of England region are provided, both age-standardised and non-age-standardised for comparison (Appendix B) and indicate that the England and East of England results remain similar for non-standardised results and that the non-standardised results are generally similar to the age-standardised estimates.

To further assess the impact of producing non age-standardised results, the cohorts were split into 2 age groups (15 to 64 years and over 65) with survival estimates by stage produced for each site by the 2 age groups.

Stage at diagnosis

Cancer stage at diagnosis is most commonly classified using the TNM system as stage 1 to 4 as a measure of how large and how far the primary tumour has grown and spread. Some cancers of the ovary and the uterus are staged using FIGO, an alternative staging system. However, these FIGO stages can be uniquely matched to TNM stages and TNM staging data is used to supplement stage data where FIGO is not available. Cancers may be unstageable if their morphology does not have a staging system or stage may be unknown or missing if the

[1] The East of England region includes the counties of Essex, Hertfordshire, Bedfordshire, Cambridgeshire, Norfolk and Suffolk.

cancer was not able to be staged or stage was not recorded. In order to produce survival estimates by stage accurately, it is important to have high stage completeness. The percentage of patients in East of England with unstageable or unknown or missing stage varied from 6.1% for breast cancer to 12.2% for females with colorectal cancer.

Results

Patient characteristics

Figure 1 shows the variation in stage distribution by site included in the calculation of 10-year net survival estimates.

Figure 1. Proportion of patients in each site included in production of 10-year East of England net survival estimates by stage at diagnosis (diagnosed 2007 to 2017)

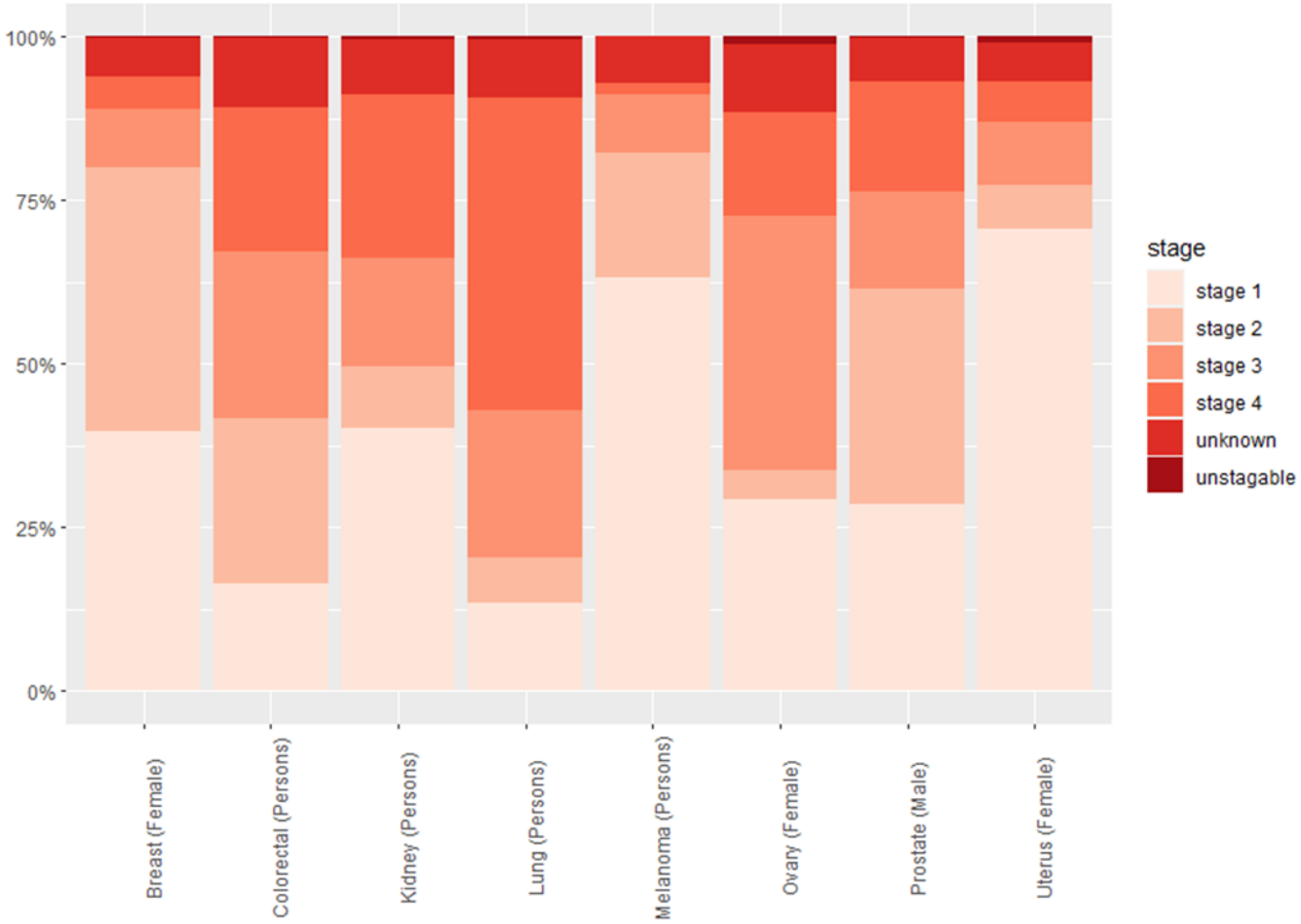
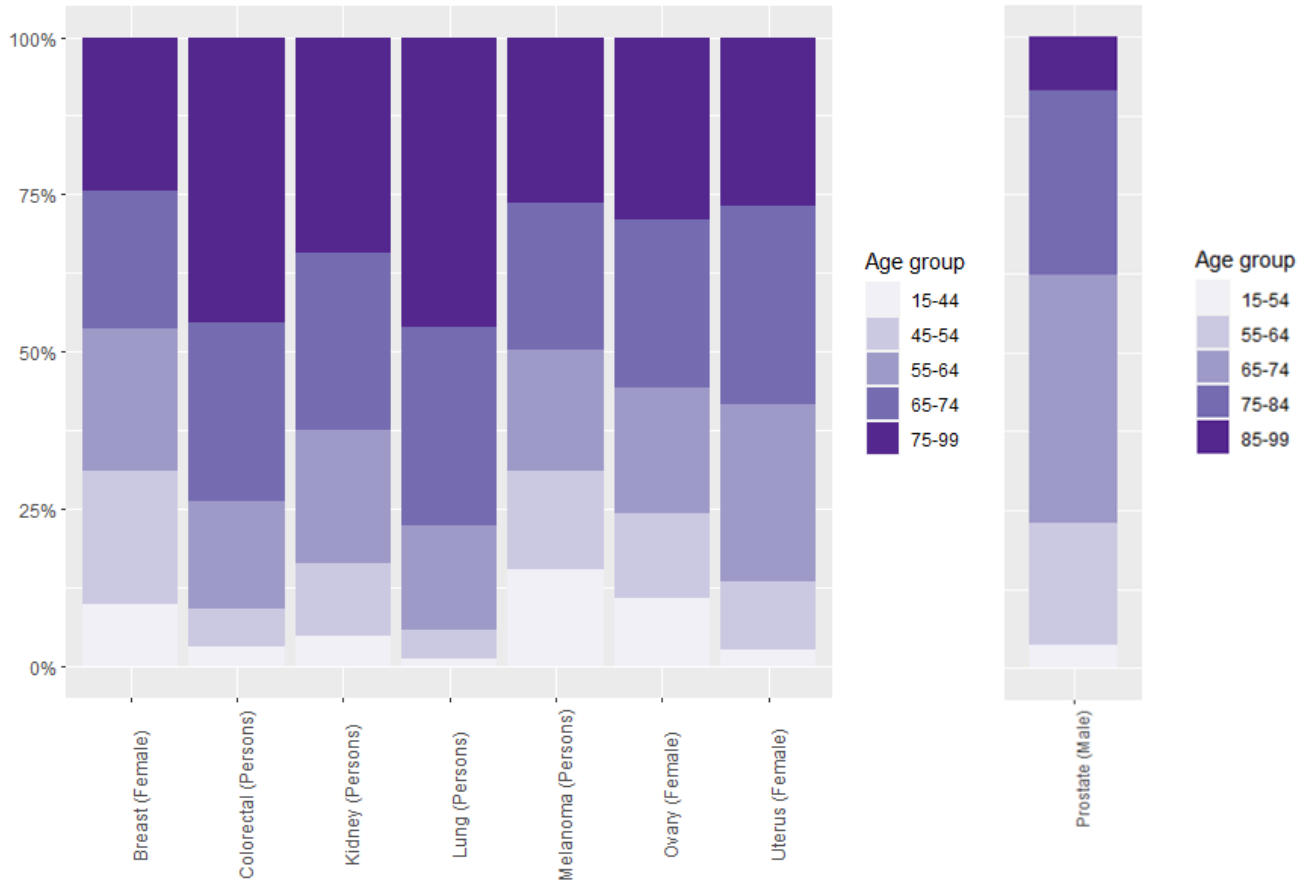


Figure 2 shows the variation by age group distribution in the different cancer sites. Existing survival methodology groups prostate cancer into different age groups (15 to 54, 55 to 64, 65 to 74, 75 to 84, 85 to 99).

Figure 2. Age group proportions in East of England by cancer site included in the production of 10-year net survival estimates (diagnosed in 2007 to 2017)



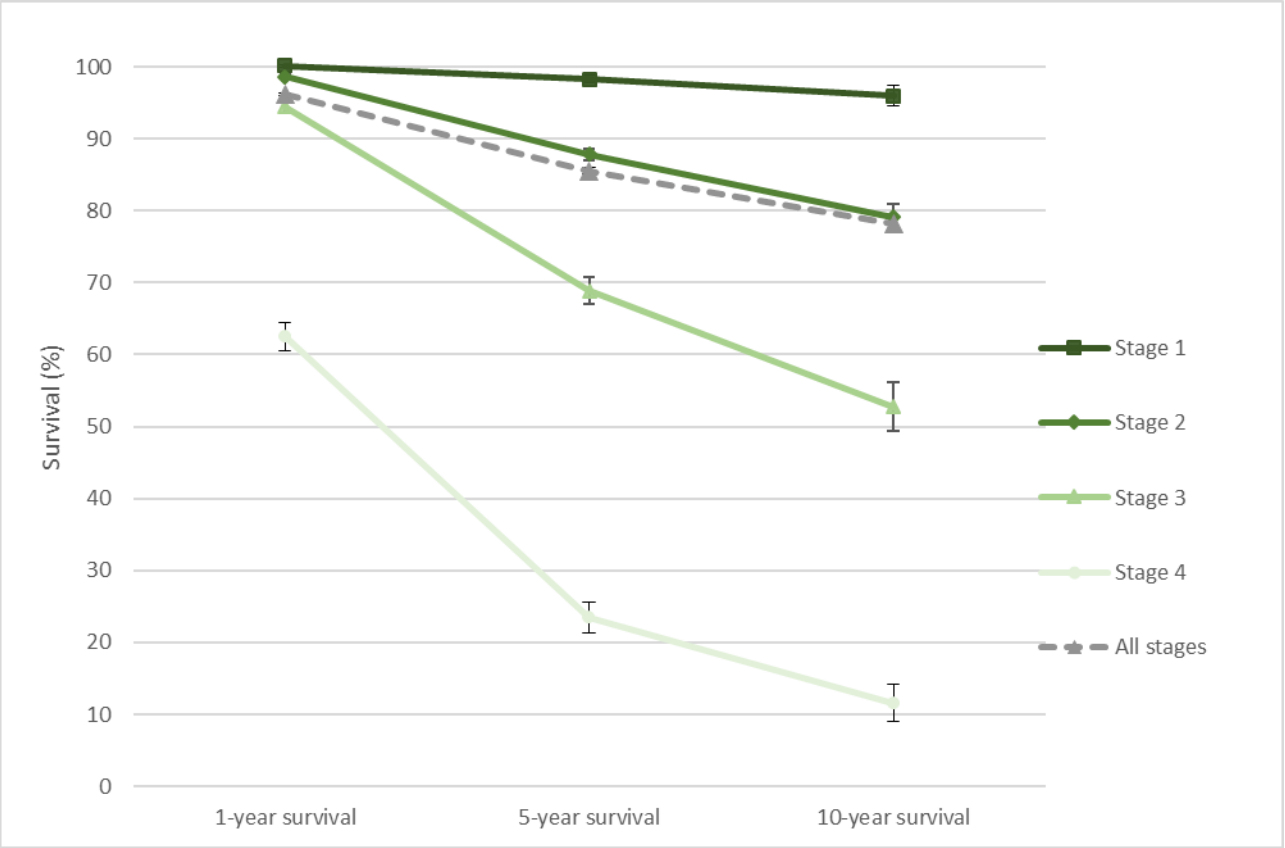
10-year net survival estimates for the East of England

One, 5 and 10-year non-age-standardised survival estimates are presented by site and stage in the figures below for the East of England, showing net survival estimates with confidence intervals for each estimate. Estimates with large confidence intervals should be interpreted with some caution. These are likely the result of small numbers in a particular site or stage combination. In addition, a brief description of additional analysis by sex (where relevant) and age groups is also provided. Full results of these additional analyses are found in Appendix E and Appendix F.

Appendix D, table D1 shows all survival estimates along with absolute and relative differences between 5 and 10-year survival estimates by site and stage and allows all site or stage comparisons.

Female breast cancer

Figure 3. Non-standardised 1, 5 and 10-year net survival for breast cancer (females) in the East of England



There was a decrease in survival with later stage for 1, 5 and 10-year survival with 10-year survival ranging from 96.0% for stage 1 to 11.6% for stage 4 (Figure 3). 10-year survival was lower than 5-year survival for each stage with the relative difference between 5 and 10-year estimates increasing by stage (described in table 2).

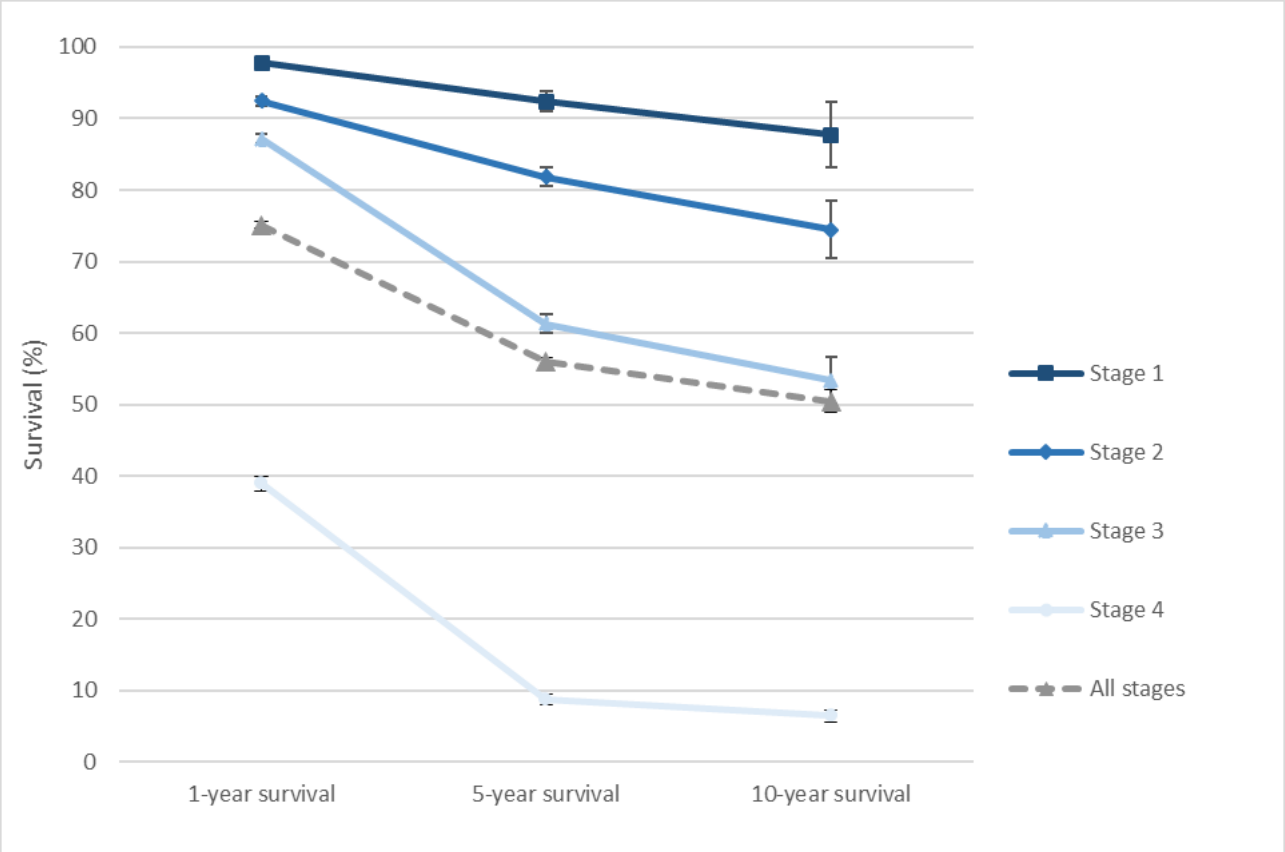
The older age group (65+) experienced poorer survival across each stage but the general trend in survival by stage was the same as that seen for all ages together (Appendix Figure F1). The relative difference between 5 and 10-year survival increased with later stage at diagnosis for both age groups, although this effect was slightly amplified in the older age group.

Table 2. Net survival estimates and absolute and relative differences between 5 and 10-year estimates for East of England by stage for breast cancer

Site	Sex	Stage	Survival estimates			5 vs. 10-year survival	
			1-year survival	5-year survival	10-year survival	Absolute difference	% difference
Breast	Females	1	100.1	98.3	96.0	-2.3	-2.4%
		2	98.7	87.8	79.1	-8.7	-9.9%
		3	94.4	68.8	52.7	-16.1	-23.4%
		4	62.4	23.5	11.6	-11.9	-50.6%
		All stages	96.2	85.6	78.2	-7.4	-8.6%

Colorectal cancer

Figure 4. Non-standardised 1, 5 and 10-year net survival for colorectal cancer (persons) in the East of England



There was a decrease in survival with later stage at diagnosis for 1, 5 and 10-year survival with 10-year survival ranging from 87.7% for stage 1 to 6.5% for stage 4 (Figure 4). 10-year survival was lower than 5-year survival for each stage, but this decrease was smallest in stage 4 producing a flatter line (described in table 3). The relative difference between 5 and 10-year survival increased for later stages, but this difference remained relatively low compared with other cancer sites.

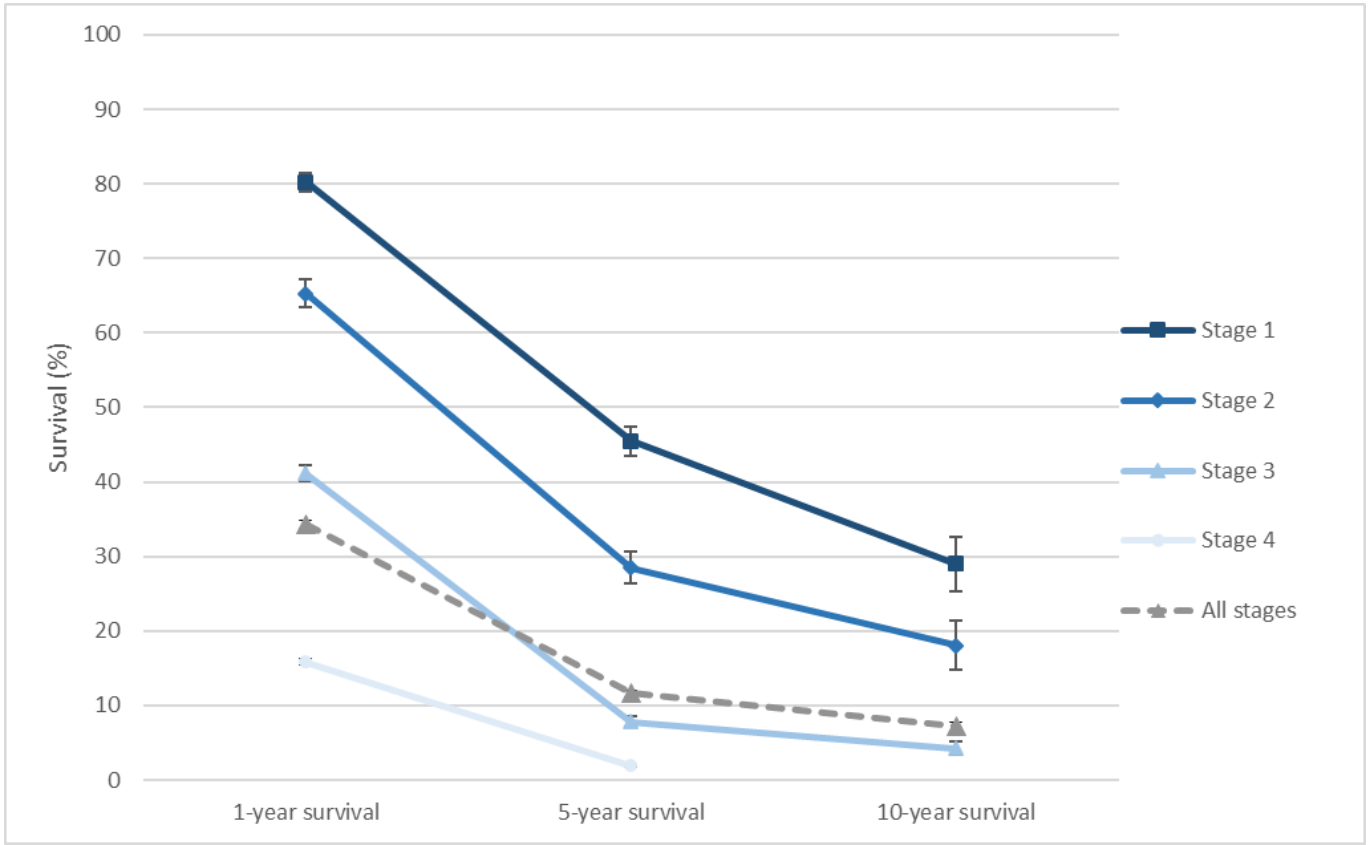
There were some differences in survival estimates by sex (Appendix Figure E1), with males generally having higher 1-year survival but lower 10-year survival than females. Survival was poorer across each stage for the 65+ age group compared with 15 to 64 but the same general trend was seen for both age groups by stage with a large reduction in survival between stages 3 and 4 (Appendix Figure F2).

Table 3. Net survival estimates and absolute and relative differences between 5 and 10-year estimates for East of England by stage for colorectal cancer

Site	Sex	Stage	Survival estimates			5- vs. 10-year survival	
			1-year survival	5-year survival	10-year survival	Absolute difference	% difference
Colorectal	Persons	1	97.8	92.4	87.7	-4.7	-5.1%
		2	92.4	81.8	74.4	-7.4	-9.1%
		3	87.1	61.3	53.3	-7.9	-13.0%
		4	39.0	8.7	6.5	-2.2	-25.6%
		All stages	75.1	56.0	50.5	-5.5	-9.8%

Lung cancer

Figure 5. Non-standardised 1, 5 and 10-year net survival for lung cancer (persons) in the East of England



There was a decrease in survival with later stage at diagnosis for 1, 5 and 10-year survival with 10-year survival ranging from 29.0% for stage 1 to 4.2% for stage 3 (Figure 5: stage 4 estimate suppressed). There was a decrease in survival between 5 and 10 years for all of the stages for which survival estimates were available, described in table 4. Lung cancer patients experienced lower survival across each stage compared with other sites.

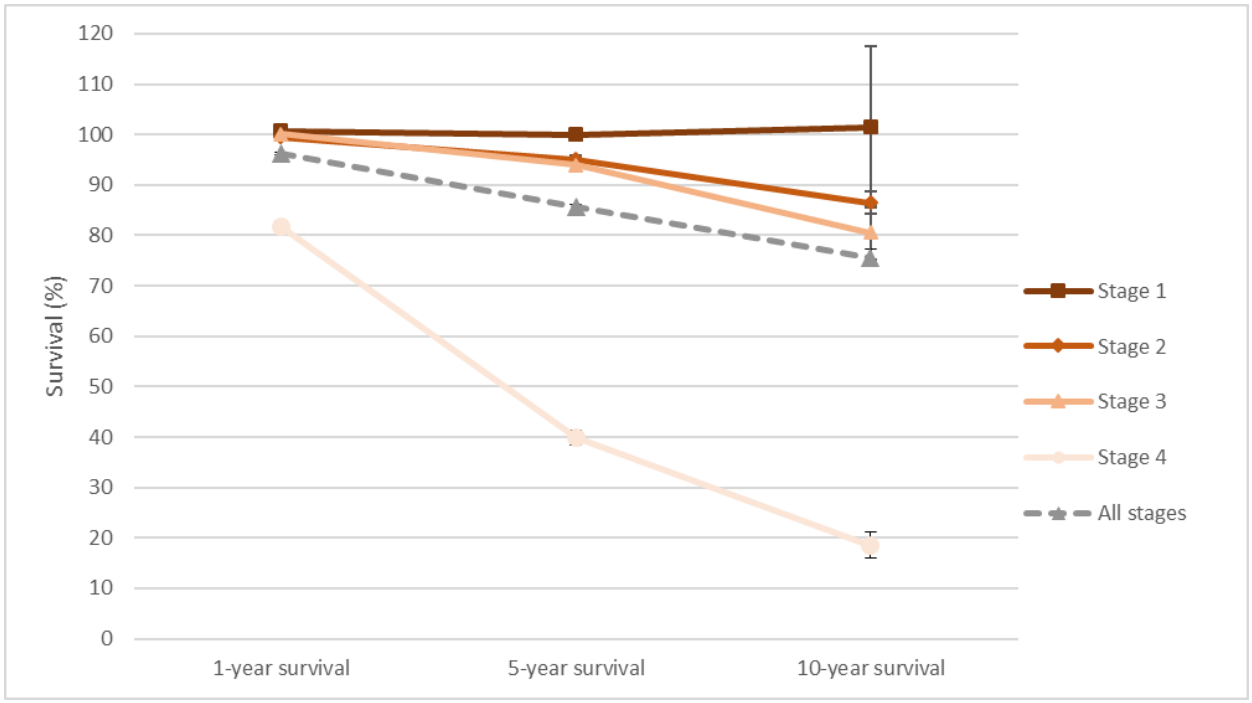
Survival was consistently poorer in males across each stage for 1, 5 and 10-year survival compared with females (Appendix Figure E2). Survival was poorer across each stage for the 65+ age group compared with 15 to 64. The same general trend was seen for both age groups with survival decreasing with later stage at diagnosis. However, this decrease was greater among the younger age group. (Appendix Figure F3).

Table 4. Net survival estimates and absolute and relative differences between 5 and 10-year estimates for East of England by stage for lung cancer

Site	Sex	Stage	Survival estimates			5 vs. 10-year survival	
			1-year survival	5-year survival	10-year survival	Absolute difference	% difference
Lung	Persons	1	80.2	45.5	29.0	-16.5	-36.2%
		2	65.3	28.5	18.0	-10.4	-36.7%
		3	41.1	7.8	4.2	-3.5	-45.6%
		4	15.8	1.9	N/A	N/A	N/A
		All stages	34.3	11.6	7.2	-4.4	-38.2%

Male prostate cancer

Figure 6. Non-standardised 1, 5 and 10-year net survival for prostate cancer (males) in the East of England



1, 5 and 10- year survival by stage for prostate cancer is highest of the 4 most common cancers. Survival remains high for stages 1 to 3 and then decreases substantially for stage 4 for all estimates (Figure 6). There was a general decrease in survival with later stage at diagnosis for 1, 5 and 10-year survival with 10-year survival ranging from no significant additional cancer mortality (101.4%[2]) for stage 1 to 18.6% for stage 4. Stages 2 to 4 had lower 10-year survival compared with 5-year survival with the absolute and relative difference increasing with later stage, described in table 5. Survival was poorer across stages 2 to 4 for the 65+ age group compared with 15 to 64 but the same general trend was seen for both age groups by stage with relatively high survival across stages 1 to 3 and a large reduction in survival between stages 3 and 4. The relative difference between 5- and 10-year survival increased for later stages, but this effect was amplified for the older age group (Appendix Figure F4).

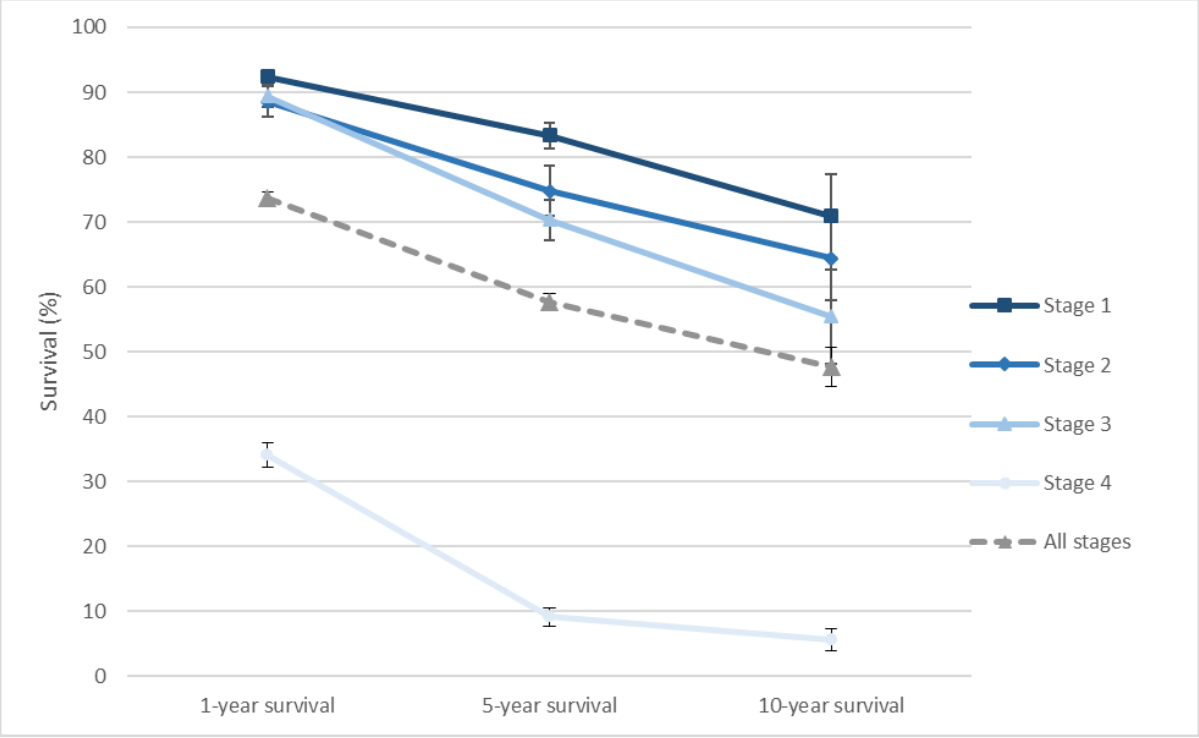
[2] Net survival may be over 100% if the diagnosed population have a better chance of surviving than the general population used to account for background mortality.

Table 5. Net survival estimates and absolute and relative differences between 5 and 10-year estimates for East of England by stage for prostate cancer

Site	Sex	Stage	Survival estimates			5 vs. 10-year survival	
			1-year survival	5-year survival	10-year survival	Absolute difference	% difference
Prostate	Males	1	100.7	99.9	101.4	1.5	1.5%
		2	99.5	95.0	86.5	-8.6	-9.0%
		3	100.1	94.0	80.5	-13.5	-14.3%
		4	81.8	39.9	18.6	-21.3	-53.5%
		All stages	96.2	85.6	75.7	-9.9	-11.6%

Kidney cancer

Figure 7. Non-standardised 1, 5 and 10-year net survival for kidney cancer (persons) in the East of England



Kidney cancer 1, 5 and 10-year survival for persons decreased relatively little between stages 1 and 3 when compared with other sites and then dropped substantially for stage 4 (Figure 7). 10-year survival ranged from 70.9% for stage 1 to 5.6% for stage 4. 10-year survival was lower than 5-year survival for each stage, but this absolute decrease was smallest in stage 4 producing a flatter line (described in table 6). However, the relative difference between 5 and 10-year survival increased with later stage.

Five and 10-year survival estimates were higher for females than males diagnosed at stages 1 and 2, but lower for females than males for stage 3. All stage survival estimates were similar for both sexes (Appendix Figure E3).

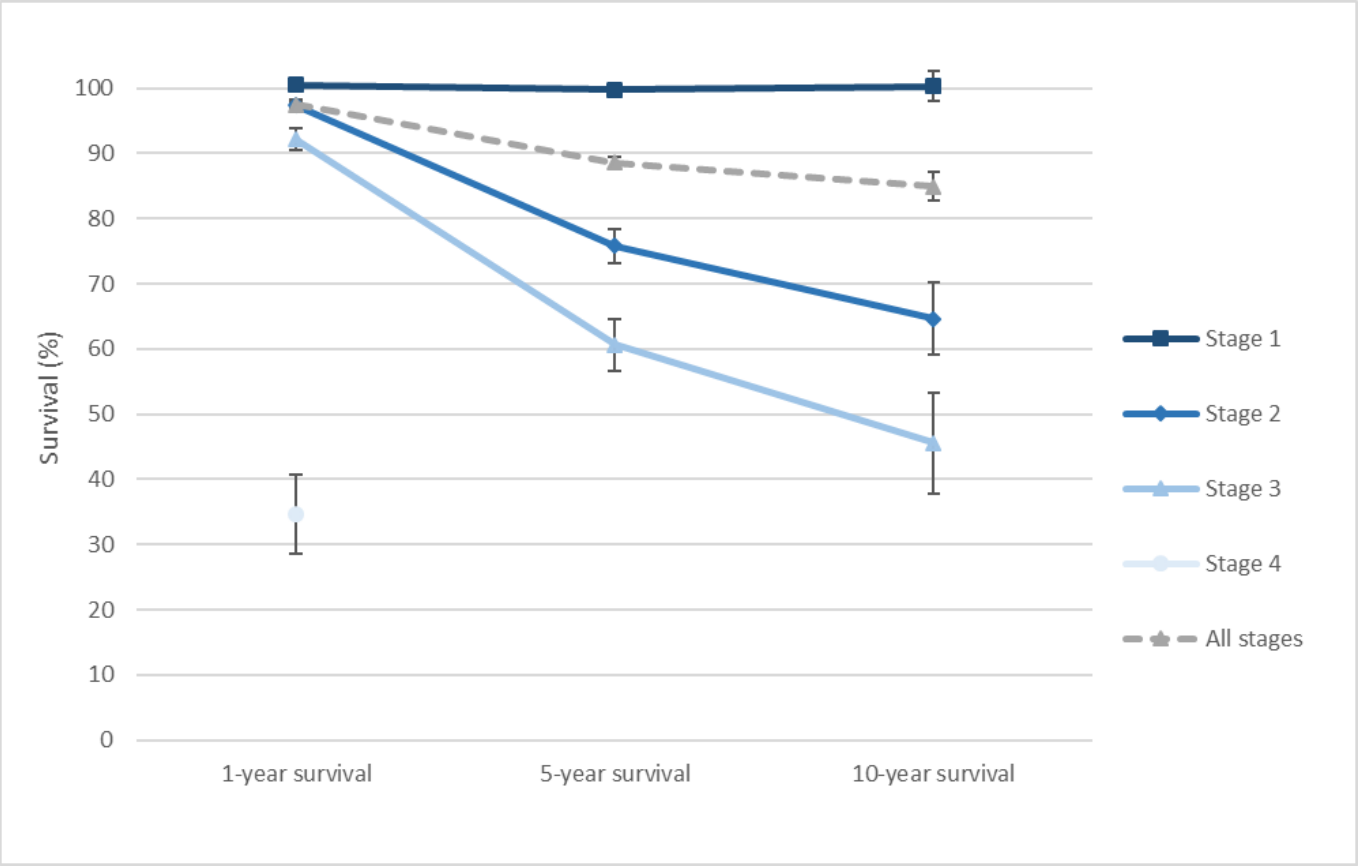
10-year survival for stage 1 and stage 2 kidney cancer was far lower for those aged 65+ compared with 15 to 64 (89.7% vs. 58.7% and 81.0% vs. 49.0% respectively) and the relative difference between 5 and 10-year survival for stages 1 and 2 kidney cancer is larger in the older age group (Appendix Figure F5).

Table 6: Net survival estimates and absolute and relative differences between 5 and 10-year estimates for East of England by stage for kidney cancer

Site	Sex	Stage	Survival estimates			5 vs. 10-year survival	
			1-year survival	5-year survival	10-year survival	Absolute difference	% difference
Kidney	Persons	1	92.4	83.3	70.9	-12.4	-14.8%
		2	88.6	74.8	64.4	-10.4	-13.9%
		3	89.4	70.3	55.4	-14.9	-21.2%
		4	34.1	9.2	5.6	-3.6	-38.7%
		All stages	73.8	57.7	47.6	-10.1	-17.5%

Melanoma

Figure 8. Non-standardised 1, 5 and 10-year net survival for melanoma (persons) in the East of England



There was a relatively linear decrease in survival with later stage at diagnosis for 1, 5 and 10-year survival (Figure 8) with 10-year survival for persons ranging from 100.3% for stage 1 to 45.6% for stage 3 (both 5 and 10-year survival estimates were suppressed for stage 4; very few melanoma patients are diagnosed at stage 4). 10-year survival was lower than 5-year for stages 2 and 3 and the relative difference between 5 and 10-year survival increased with later stage.

Survival for males with melanoma was generally lower across each stage than survival for females (Appendix Figure E4).

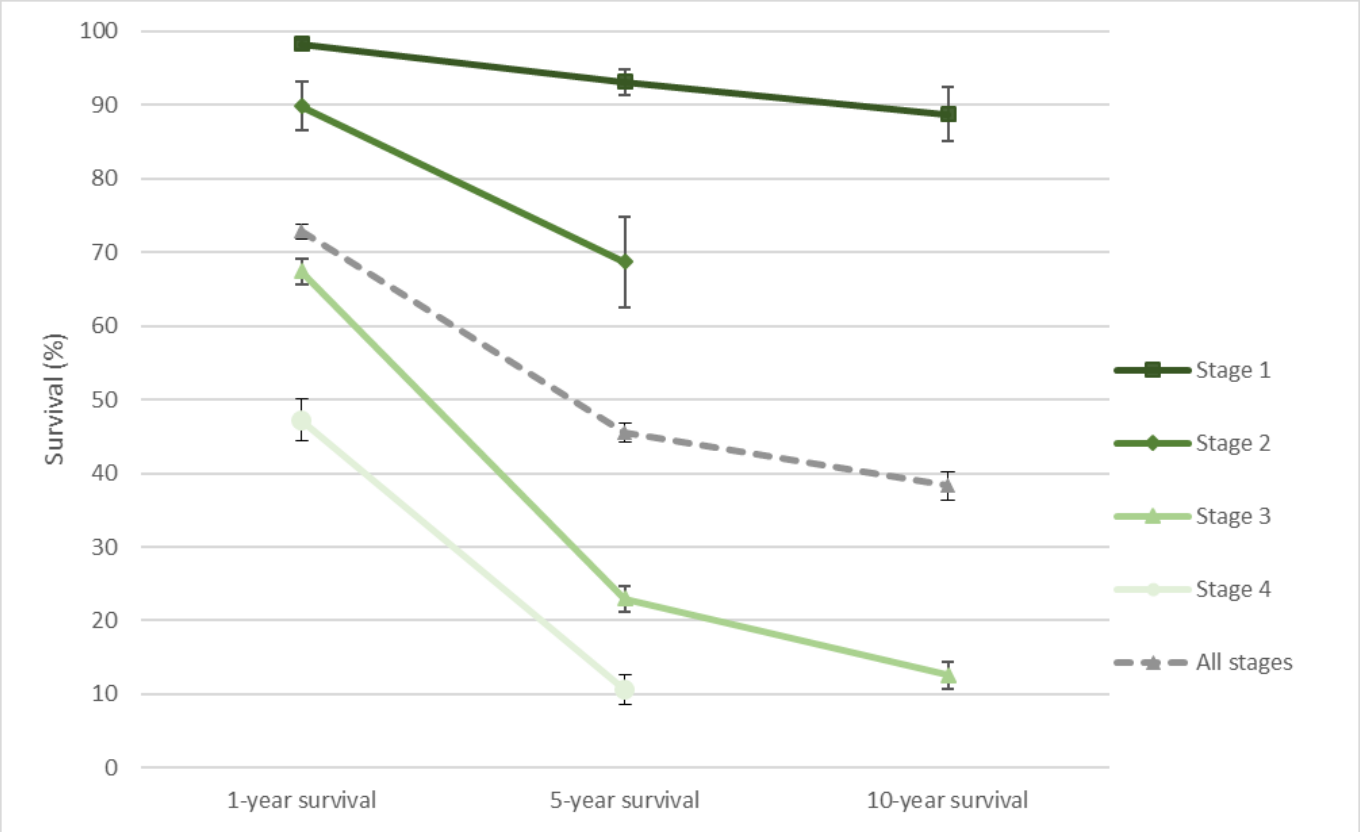
The older age group (65+) generally had lower survival estimates across stages and timeframes compared with the younger age group (Appendix Figure F6).

Table 7. Net survival estimates and absolute and relative differences between 5 and 10-year estimates for East of England by stage for melanoma

Site	Sex	Stage	Survival estimates			5 vs. 10-year survival	
			1-year survival	5-year survival	10-year survival	Absolute difference	% difference
Melanoma	Persons	1	100.5	99.8	100.3	0.6	0.6%
		2	97.3	75.7	64.7	-11.1	-14.7%
		3	92.2	60.6	45.6	-15.0	-24.8%
		4	34.6	N/A	N/A	N/A	N/A
		All stages	97.4	88.5	84.9	-3.6	-4.0%

Female ovarian cancer

Figure 9. Non-standardised 1, 5 and 10-year net survival for ovarian cancer (females) in the East of England



10-year survival estimates were suppressed for stages 2 and 4 which limits the interpretation (Figure 9). 10-year survival for ovarian cancer in stages 1 and 3 was lower than 5-year estimates, with a larger absolute and relative difference between these estimates at stage 3 (Table 8). The overall trend for 5-year survival indicated that survival was relatively high for stages 1 and 2 and dropped for stages 3 and 4.

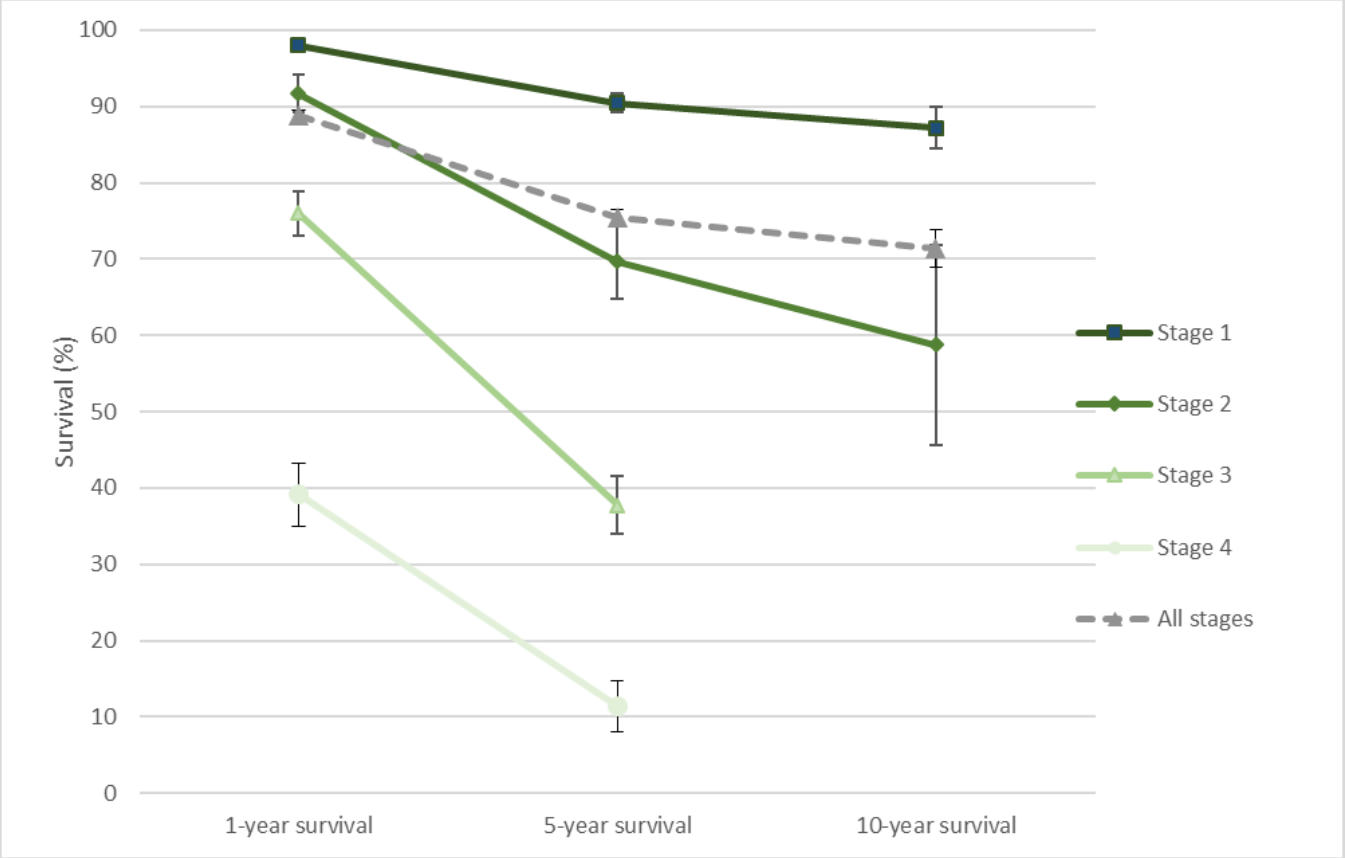
Survival estimates by age group showed significantly lower survival for the 65+ age group compared with the younger group for each stage and timeframes (where available) (Appendix Figure F7).

Table 8. Net survival estimates and absolute and relative differences between 5 and 10-year estimates for East of England by stage for ovarian cancer

Site	Sex	Stage	Survival estimates			5 vs. 10-year survival	
			1-year survival	5-year survival	10-year survival	Absolute difference	% difference
Ovarian	Females	1	98.3	93.1	88.7	-4.4	-4.7%
		2	89.9	68.7	N/A	N/A	N/A
		3	67.4	23.0	12.6	-10.4	-45.4%
		4	47.2	10.7	N/A	N/A	N/A
		All stages	72.8	45.4	38.3	-7.1	-15.7%

Female uterine cancer

Figure 10. Non-standardised 1, 5 and 10-year net survival for uterine cancer (females) in the East of England



10-year survival estimates were suppressed for stages 3 and 4 which limits the interpretation (Figure 10). 10-year survival for stages 1 and 2 was lower than 5-year estimates (Table 9), with relatively large confidence intervals. The overall trend for 5-year survival indicated a relatively linear decrease in survival with later stage at diagnosis.

Analysis by age group resulted in suppression of 5 and 10-year estimates for stage 4. In general, the older age group (65+) had lower survival estimates than the younger group (Appendix Figure F8).

Table 9. Net survival estimates and absolute and relative differences between 5 and 10-year estimates for East of England by stage for uterine cancer

Site	Sex	Stage	Survival estimates			5 vs. 10-year survival	
			1-year survival	5-year survival	10-year survival	Absolute difference	% difference
Uterus	Females	1	98.0	90.4	87.2	-3.3	-3.6%
		2	91.7	69.7	58.7	-10.9	-15.7%
		3	76.0	37.8	N/A	N/A	N/A
		4	39.1	11.3	N/A	N/A	N/A
		All stages	88.9	75.4	71.4	-3.9	-5.2%

Discussion

Key findings

Net survival estimates at 10 years were generally lower for all sites than 5-year estimates. For stage 1 this decrease was small or non-existent except for lung and kidney cancer which had large reductions in stage 1 net survival between 5 and 10 years. The relative difference between 5 and 10-year net survival generally increased with later stage at diagnosis. Of the sites that had 10-year net survival estimates for stage 4 (breast, colorectal, kidney and prostate), colorectal cancer had the lowest relative difference between 5 and 10-year survival for stage 4 (25.6%) while prostate cancer had the highest (53.5%). Further investigation into longer-term survival for prostate cancer may provide reasons for this difference.

Of the 4 most common cancers, prostate cancer had the highest 10-year net survival across each of the 4 stages and lung cancer the lowest. The pattern of net survival by stage differed by site with prostate cancer 10-year net survival remaining high for stages 1 to 3 but low for stage 4, breast and colorectal cancer also show a large drop in net survival between stage 3 and 4 but net survival also decreases substantially between stages 1 to 3. For lung cancer, net survival is low at each stage and decreases relatively linearly between stages 1 to 3.

Prostate cancer and melanoma had 10-year survival estimates for stage 1 of over 100%. This means that there is no significant additional cancer mortality for these patients above that of the general population of the same age/deprivation. Many earlier stage prostate cancers in this period could have been diagnosed via a PSA test for prostate cancer, where males are likely to live with, rather than die from, prostate cancer if diagnosed at early stages. There is also very good prognosis for early stage melanoma.

Strengths and limitations of this work

Using the East of England's well completed historical stage data, we have been able to produce 10-year net survival by stage estimates for many cancer sites. The comparison of East of England with England for 5-year net survival and age distribution suggests that the East of England 10-year net survival results are a reasonable proxy for England.

Using the period approach is different from officially produced National Statistics (1), however since the period approach uses the most recent cohort of patients, the estimates reflect the most recent observed survival experience. While the use of the period approach allows the production of more up to date estimates it still involves the survival of patients diagnosed up to 10 years ago and hence these estimates will not fully reflect the survival experience of patients diagnosed in the present, especially for site and stage combinations where there has been substantial treatment progress during the period used for the survival analysis.

The results of this analysis are not age-standardised so some caution is needed in interpretation, as there are different age distributions by stage which may impact on results and create or amplify some of the trends seen. The median age increased with later stage for breast, melanoma, ovary, prostate and uterus cancer; however, when analysing the data by age groups (Appendix F), the trends over time and by stage are very similar, so the non-standardised estimates seem likely to be a reasonable reflection/estimate of the trends in survival. Additionally, the trends identified, both for 5 and 10-years, are similar to those for published 5-year age-standardised estimates by stage (1).

This analysis demonstrates the survival benefits of an earlier diagnosis but cannot take quality of life into account, whereby someone may live longer if diagnosed at stage 3 rather than stage 4, but further research would be needed to examine quality of life differences by stage.

Implications for policy, practice and patients

Production of these estimates for 10-year survival by stage highlights the benefit of achieving the ambitions of the NHS Long Term Plan, where more patients should be diagnosed at stages 1 and 2 (5), in addition to showing the benefits to long term survival between diagnosis at stage 3 compared with stage 4. There is the potential to have a large effect on survival if a significant number of most cancers in this analysis currently diagnosed at stage 4 can instead be diagnosed at stage 3. This would be particularly relevant for prostate cancer, where survival estimates remain relatively high for stage 3.

This work also shows the ongoing need to continue research efforts into improving treatment across each stage of disease (but particularly for some stages or sites) and reducing any variation in access to treatment to optimise survival across the stages.

10-year survival estimates for those diagnosed at stage 1 were poorer for older age groups for most sites (notable exceptions being prostate, melanoma and breast, which for breast may be at least partly due to more aggressive cancer in younger patients) (10,11). Further studies could investigate whether older patients are receiving recommended treatments, whether due to comorbidities or patient choice. In addition, there are strong links between smoking and particular cancers (lung and kidney cancer) and this, along with comorbidities, will also affect treatment options and therefore survival. Nonetheless, diagnosis at earlier stage for both age groups in all sites would result in higher survival estimates.

There were interesting and large differences by age group for kidney cancer, whereby older age groups have much lower survival estimates for stages 1 and 2 than those under 65. Further investigation into this could be particularly insightful. Possible reasons for this difference could include older patients having more aggressive forms of kidney cancer, having worse survival for particular types of kidney cancer (12) or having different treatments and/or more comorbidities.

This work provides a baseline for future analysis once there is more complete historic stage completeness data for England, the size of the population included in this future analysis will also enable the production of age-standardised net survival estimates.

Conclusions

Ten-year survival estimates have been successfully produced for the East of England and are likely to reflect 10-year survival in England. They provide useful site-specific information for policy makers and early diagnosis initiatives.

These results add further evidence to how early diagnosis benefits longer-term cancer survival. Additionally, efforts to reduce the number of patients diagnosed at a late stage is key to improving longer-term cancer outcomes. Even for lung cancer where early stage 10-year survival is poor, there remains a huge patient benefit in earlier stage diagnosis as stage 3 estimates are significantly worse than those diagnosed at stages 1 or 2.

This work could be used as a basis for future nationwide age-standardised 10-year survival by stage estimates and will be valuable to have at a national level when there is enough historical data with good completeness. In particular, the national level will allow for estimates to cover a wider range of sites.

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Appendix A: Description of complete and period approach

The 10-year estimates were produced using both the complete and period approach. The complete approach is used for the official adult cancer survival by stage at diagnosis for England statistics (1) and uses all potential years of follow up for patients diagnosed during a specified period (patients diagnosed from 2008 to 2017 and followed up to 05/01/2019). For the period approach, survival is estimated in a specific calendar period (2017) but using data for patients diagnosed in 2007 to 2017 with the most recently available cohort of patients contributing their survival to the estimate at each time point, for example for 2017 estimates 0 to 1 year of follow up is used from those diagnosed in 2017, 1 to 2 years of follow up for those diagnosed in 2016 and so on, until the 10 years of follow up required is produced. The complete and period approaches generated similar estimates across all site and stage combinations and the period approach estimates were focused on as they use more up to date data to provide a prediction of the survival that will be experienced by patients diagnosed in 2017.

Table A1. The years of diagnosis and follow up included for the complete approach and period approach 10-year survival analysis

	Year of follow up											
Diagnosis year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2007	0	1	2	3	4	5	6	7	8	9	10	11
2008		0	1	2	3	4	5	6	7	8	9	10
2009			0	1	2	3	4	5	6	7	8	9
2010				0	1	2	3	4	5	6	7	8
2011					0	1	2	3	4	5	6	7
2012						0	1	2	3	4	5	6
2013		Survival data used in complete analysis					0	1	2	3	4	5
2014								0	1	2	3	4
2015				Survival data used in period analysis					0	1	2	3
2016										0	1	2
2017											0	1

Appendix B: Comparison of England and East of England survival estimates

5-year net survival estimates were produced using the complete approach for patients diagnosed from 2013 to 2017, for either the whole of England or the former Eastern Cancer Registration and Information Centre (ECRIC) (covering the East of England region). The age-standardised estimates for England and East of England were largely comparable (Table B1), although the kidney cancer net survival estimate for females diagnosed at stage 4 was significantly lower for the East of England compared with England as a whole, as was the uterine cancer net survival estimate for females diagnosed at stage 3.

Similarly, the non-standardised estimates were largely comparable for England and East of England (Table B2), although there were significant differences for certain site, sex and stage combinations including colorectal cancer for females and persons diagnosed at stage 4, stage 3 ovarian cancer and stage 3 uterine cancer. Median age by site and stage for patients contributing to the 5-year net survival estimates are very similar for England and East of England (Table B3).

While there were a small number of differences it was decided that the England and East of England estimates were similar enough to provide justification for generating East of England 10-year net survival by stage estimates as a proxy for England 10-year net survival by stage. These estimates were used for comparative purposes but most of them do not pass small number checks surrounding reliability and so should be viewed with caution.

Table B1. Five-year age-standardised net survival estimates calculated using the complete approach for England and East of England (patients diagnosed 2013-2017 and followed up to 05/01/2019)

Cancer site	Sex	5-year age-standardised net survival for England					5-year age-standardised net survival for East of England				
		All stages	Stage 1	Stage 2	Stage 3	Stage 4	All stages	Stage 1	Stage 2	Stage 3	Stage 4
Breast	Females	85.0	97.9	89.6	72.0	26.2	85.8	97.8*	88.5	70.1*	28.5*
Colorectal	Males	58.2	90.7*	83.5	64.2	10.3	57.9	89.4*	83.3*	64.6*	8.5*
Colorectal	Females	58.6	93.1*	84.9*	65.9*	10.3	58.6*	93.5*	85.3*	63.4*	8.1*
Colorectal	Persons	58.4	91.7*	84.1	64.9	10.3	58.2	91.3*	84.2*	64.2*	8.4*
Kidney	Males	62.9	85.8*	76.2*	75.3*	11.9*	59.4*	82.7*	71.7*	76.1*	9.1*
Kidney	Females	65.4	88.3*	77.0*	72.3*	13.2*	64.9*	87.3*	82.8*	73.2*	7.3*
Kidney	Persons	63.8	86.8*	76.6*	74.3*	12.4	61.4*	84.7*	76.3*	75.3*	10.4*
Lung	Males	13.8	51.4*	32.8*	11.6*	2.3*	13.2*	53.6*	33.1*	10.3*	1.8*
Lung	Females	19.0*	61.7*	36.8*	13.7*	3.5*	18.9*	63.4*	38.3*	11.6*	3.2*
Lung	Persons	16.2	56.9*	34.6*	12.6*	2.9*	15.8*	58.7*	34.9*	11.0*	2.6*
Melanoma	Males	89.0	99.0*	77.8*	67.5*	28.7*	89.2*	98.3*	80.8*	69.7*	24.9*
Melanoma	Females	93.4	100.3	83.0*	74.0*	29.4*	93.3*	99.6*	84.7*	80.0*	21.4*
Melanoma	Persons	91.3	99.6	80.4	70.6	29.4*	91.3*	98.9*	82.9*	74.3*	24.6*
Ovary	Females	42.1	93.3*	67.7*	26.9	13.4	42.5*	96.8*	75.8*	23.2*	13.8*
Prostate	Males	86.6	100.1	100.2	95.6	49.0	88.3*	99.8*	98.1*	94.9*	48.6*
Uterus	Females	75.6*	92.1*	74.2*	47.6*	15.3*	74.5*	90.2*	71.1*	24.2*	16.3*

* indicates estimates that do not pass small number checks surrounding reliability and so should be viewed with caution

Table B2. Five-year non-age-standardised survival estimates calculated using the complete approach for England and East of England (patients diagnosed 2013-2017 and followed up to 05/01/2019)

Cancer site	Sex	5-year non-standardised survival for England						5-year non-standardised survival for East of England				
		All stages	Stage 1	Stage 2	Stage 3	Stage 4		All stages	Stage 1	Stage 2	Stage 3	Stage 4
Breast	Females	86.6	98.5	90.2	74.2	27.5		87.3	98.3	89.3	72.1	29.4
Colorectal	Males	56.7	90.0	81.9	63.6	10.2		56.0	89.2	81.8	63.1	8.9
Colorectal	Females	55.4	92.2	82.5	63.5	9.8		54.7	92.3	82.6	60.8	7.4
Colorectal	Persons	56.1	90.9	82.2	63.5	10.0		55.4	90.6	82.2	62.1	8.2
Kidney	Males	63.4	86.7	79.1	75.9	12.3		60.4	84.1	75.1*	76.4	10.8
Kidney	Females	64.2	88.2	78.2	72.3	12.2		63.7	86.4	80.4*	74.4	10.1*
Kidney	Persons	63.7	87.3	78.8	74.7	12.3		61.5	84.9	77.1	75.7	10.4
Lung	Males	12.3	45.9	28.6	10.4	2.1		11.8	47.0	27.5	9.0	1.6
Lung	Females	17.3	56.8	33.2	12.8	3.1		17.1	57.4	34.5	10.8	3.2
Lung	Persons	14.6	51.6	30.6	11.5	2.6		14.1	52.2	30.1	9.8	2.3
Melanoma	Males	86.2	98.8	73.1	65.1	24.8		85.7	97.8	74.5	64.0	25.9*
Melanoma	Females	92.2	100.4	77.6	71.1	26.6		91.9	99.7	79.8	77.6*	19.9*
Melanoma	Persons	89.2	99.6	75.0	67.6	25.3		88.8	98.8	76.8	69.5	23.3*
Ovary	Females	48.8	94.1	70.9	29.6	14.5		47.5	96.4	76.4*	24.4	14.6
Prostate	Males	85.9	100.7	100.8	96.5	45.7		87.2	100.4	98.5	96.3	44.3
Uterus	Females	76.6	92.5	74.3	47.1	14.9		75.4	90.8	70.4	36.9	16.0*

* indicates estimates that do not pass small number checks surrounding reliability and so should be viewed with caution

Table B3: Median age (IQR) by site and stage of patients contributing to the 5-year net survival estimates for England and East of England

Cancer site	Sex	Median age (IQR) for England						Median age (IQR) for East of England				
		All stages	Stage 1	Stage 2	Stage 3	Stage 4		All stages	Stage 1	Stage 2	Stage 3	Stage 4
Breast	Females	63 (52-73)	63 (53-70)	62 (50-74)	61 (49-74)	69 (55-80)		64 (52-74)	63 (53-70)	63 (50-75)	64 (50-76)	72 (57-81)
Colorectal	Males	72 (63-79)	70 (63-78)	73 (64-80)	70 (61-78)	71 (62-79)		72 (63-80)	70 (63-78)	73 (64-80)	71 (62-79)	72 (63-80)
Colorectal	Females	74 (64-82)	71 (62-79)	74 (65-82)	72 (62-80)	73 (62-82)		74 (64-83)	71 (63-79)	75 (66-82)	72 (63-81)	74 (64-83)
Colorectal	Persons	72 (63-81)	71 (63-78)	73 (65-81)	71 (61-79)	72 (62-81)		73 (64-81)	71 (63-78)	74 (65-81)	72 (62-80)	73 (63-81)
Kidney	Males	68 (58-76)	67 (57-75)	65 (55-74)	67 (58-75)	69 (60-77)		68 (58-77)	68 (57-76)	65 (56-76)	67 (58-74)	69 (60-78)
Kidney	Females	70 (60-79)	68 (57-77)	67 (57-76)	69 (60-77)	73 (64-81)		70 (60-79)	68 (58-78)	70 (56-79)	67 (59-76)	74 (64.25-82)
Kidney	Persons	68 (59-78)	67 (57-76)	66 (56-75)	68 (59-75)	70 (61-79)		69 (59-78)	68 (57-77)	66 (56-78)	67 (58-75)	70 (61-80)
Lung	Males	73 (66-80)	74 (67-80)	74 (67-80)	72 (65-79)	72 (65-80)		74 (66-81)	75 (68-81)	75 (67.5-81)	74 (66-80)	73 (66-80)
Lung	Females	73 (65-80)	73 (66-80)	73 (66-80)	72 (65-79)	72 (65-80)		73 (66-81)	74 (67-81)	74 (66-81)	72 (65-80)	72 (65-80)
Lung	Persons	73 (66-80)	74 (67-80)	73 (66-80)	72 (65-79)	72 (65-80)		73 (66-81)	74 (67-81)	74 (67-81)	73 (66-80)	73 (65-80)
Melanoma	Males	67 (55-77)	65 (52-74)	72 (62-81)	66 (54-76)	70 (59-79)		68 (55-77)	65 (52-73)	72 (63-81)	67 (54-76)	72 (63-81)
Melanoma	Females	62 (48-74)	58 (45-70)	71 (58-81)	64 (50-76)	70 (58-80)		64 (50-75)	60 (48-71)	71 (59-81)	63.5 (52-75)	69 (57.5-83.5)
Melanoma	Persons	65 (51-75)	61 (48-72)	72 (61-81)	65 (52-76)	70 (59-79.5)		66 (52-76)	62 (49-72)	71 (62-81)	65 (53-76)	71 (60-82.25)
Ovary	Females	66 (54-76)	56 (45-68)	64 (53-73)	68 (59-76)	70 (61-78)		67 (55-77)	58 (45-68)	65 (52.25-75.75)	69 (61-77)	72 (62-79)
Prostate	Males	71 (65-77)	69 (63-75)	69 (63-74)	70 (65-76)	74 (67-81)		71 (65-78)	70 (64-76)	69 (64-75)	70 (65-76)	75 (68-82)
Uterus	Females	67 (59-75)	66 (58-73)	68 (59-77)	69 (61-77)	70 (62-78)		68 (59-76)	66 (58-74)	68 (60-77)	70 (62-78)	70.5 (64-79.25)

Appendix C: Survival estimates using complete and period approach

Figure C1. Comparison of non-standardised 1, 5 and 10-year net survival estimates using complete and period approaches for colorectal cancer (persons) in the East of England

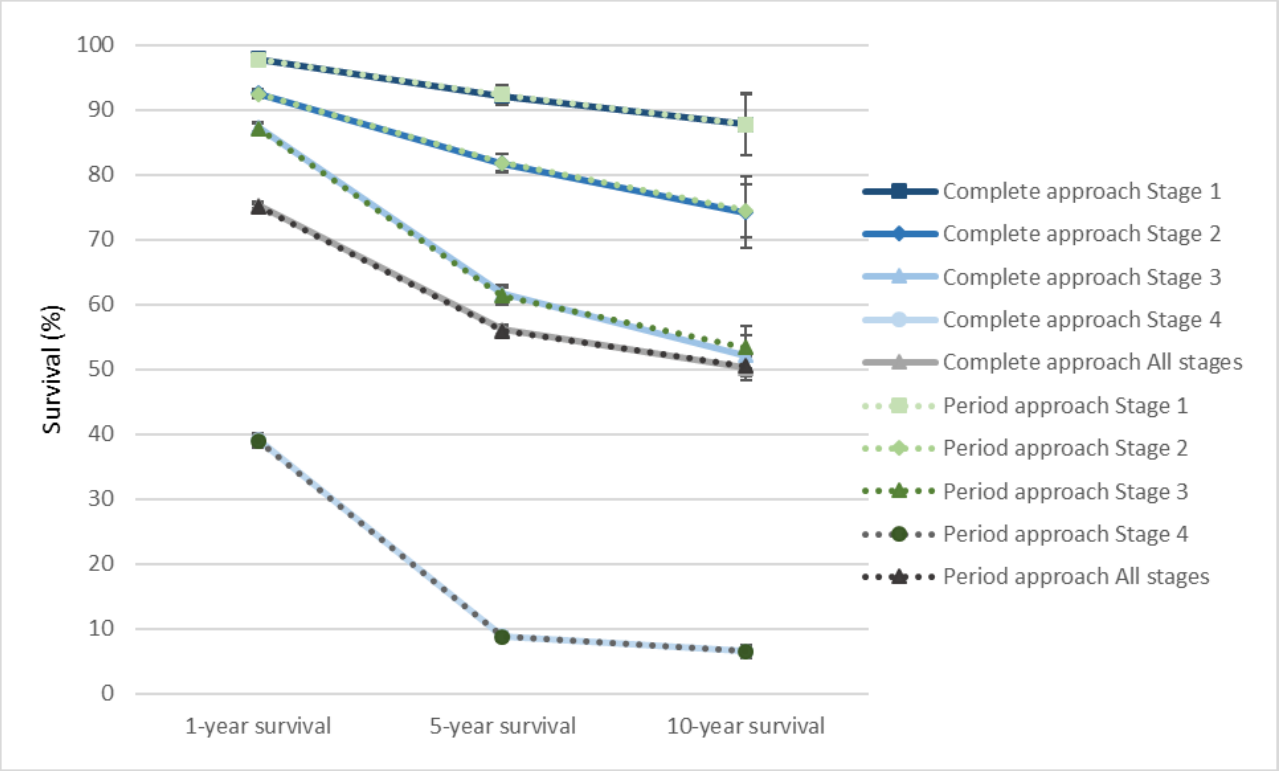
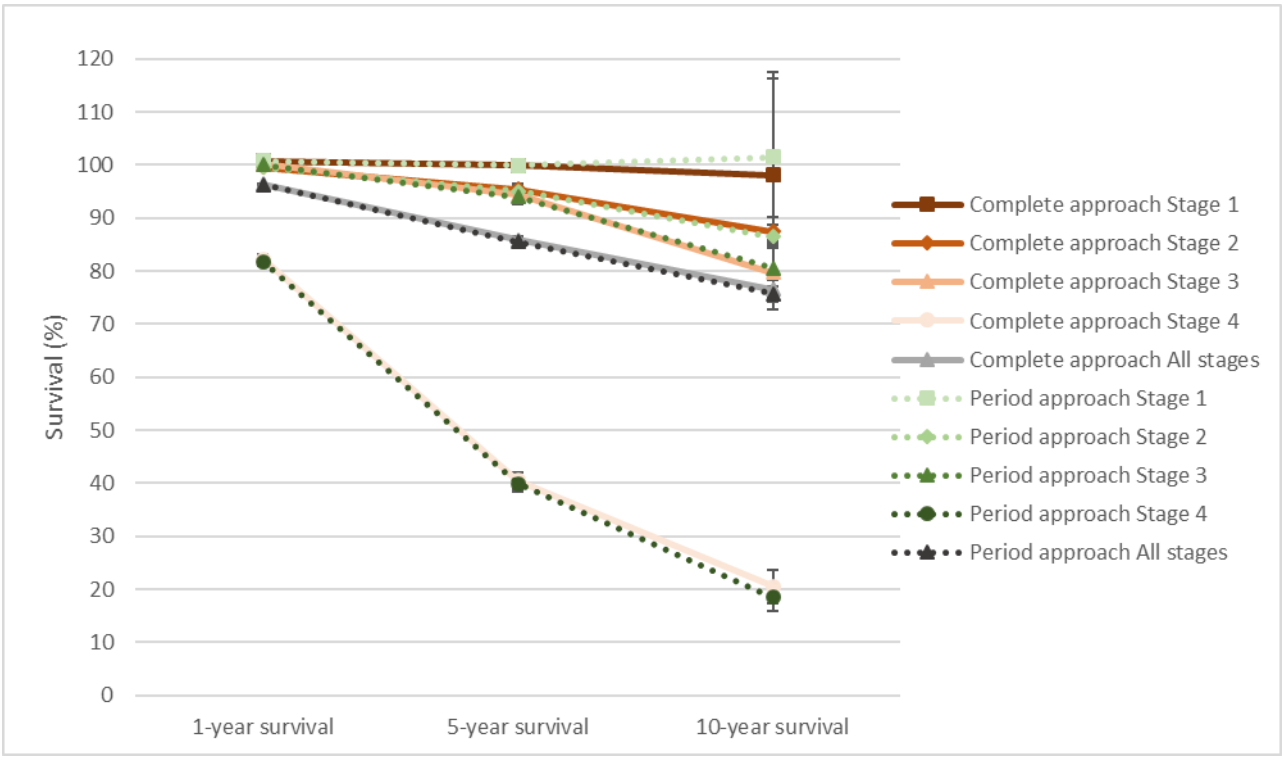


Figure C2. Comparison of non-standardised 1 ,5 and 10-year net survival estimates using complete and period approaches for prostate cancer (males) in the East of England



Appendix D: 5 and 10-year estimates: absolute and relative differences

Table D1. Non-age standardised net survival estimates and absolute and relative differences between 5 and 10-year estimates for East of England by site and stage

Cancer site	Sex	Stage	Patients contributing to estimates (n)	Survival estimates			5- vs. 10-year survival	
				1-year survival	5-year survival	10-year survival	Absolute difference	% difference
Breast	Females	1	20,209	100.1	98.3	96.0	-2.3	-2.4%
		2	20,648	98.7	87.8	79.1	-8.7	-9.9%
		3	4,545	94.4	68.8	52.7	-16.1	-23.4%
		4	2,593	62.4	23.5	11.6	-11.9	-50.6%
		All stages	51,106	96.2	85.6	78.2	-7.4	-8.6%
Colorectal	Persons	1	6,976	97.8	92.4	87.7	-4.7	-5.1%
		2	10,606	92.4	81.8	74.4	-7.4	-9.1%
		3	10,783	87.1	61.3	53.3	-7.9	-13.0%
		4	9,374	39.0	8.7	6.5	-2.2	-25.6%
		All stages	42,297	75.1	56.0	50.5	-5.5	-9.8%
Kidney	Persons	1	3,825	92.4	83.3	70.9	-12.4	-14.8%
		2	878	88.6	74.8	64.4	-10.4	-13.9%
		3	1,586	89.4	70.3	55.4	-14.9	-21.2%
		4	2,359	34.1	9.2	5.6	-3.6	-38.7%
		All stages	9,499	73.8	57.7	47.6	-10.1	-17.5%
Lung	Persons	1	5,341	80.2	45.5	29.0	-16.5	-36.2%
		2	2,761	65.3	28.5	18.0	-10.4	-36.7%
		3	8,951	41.1	7.8	4.2	-3.5	-45.6%
		4	19,089	15.8	1.9	-	-	-
		All stages	39,859	34.3	11.6	7.2	-4.4	-38.2%
Melanoma	Persons	1	9,196	100.5	99.8	100.3	0.6	0.6%
		2	2,752	97.3	75.7	64.7	-11.1	-14.7%
		3	1,299	92.2	60.6	45.6	-15.0	-24.8%
		4	250	34.6	-	-	-	-
		All stages	14,547	97.4	88.5	84.9	-3.6	-4.0%
Ovary	Females	1	2,337	98.3	93.1	88.7	-4.4	-4.7%
		2	363	89.9	68.7	-	-	-
		3	3,109	67.4	23.0	12.6	-10.4	-45.4%
		4	1,260	47.2	10.7	-	-	-
		All stages	8,007	72.8	45.4	38.3	-7.1	-15.7%
Prostate	Males	1	14,927	100.7	99.9	101.4	1.5	1.5%
		2	17,269	99.5	95.0	86.5	-8.6	-9.0%
		3	7,856	100.1	94.0	80.5	-13.5	-14.3%
		4	8,760	81.8	39.9	18.6	-21.3	-53.5%
		All stages	52,500	96.2	85.6	75.7	-9.9	-11.6%
Uterus	Females	1	6,494	98.0	90.4	87.2	-3.3	-3.6%
		2	611	91.7	69.7	58.7	-10.9	-15.7%
		3	894	76.0	37.8	-	-	-
		4	550	39.1	11.3	-	-	-
		All stages	9,192	88.9	75.4	71.4	-3.9	-5.2%

Appendix E: Survival estimates by sex

Figure E1. Non-standardised 1, 5 and 10-year net survival for colorectal cancer by sex in the East of England

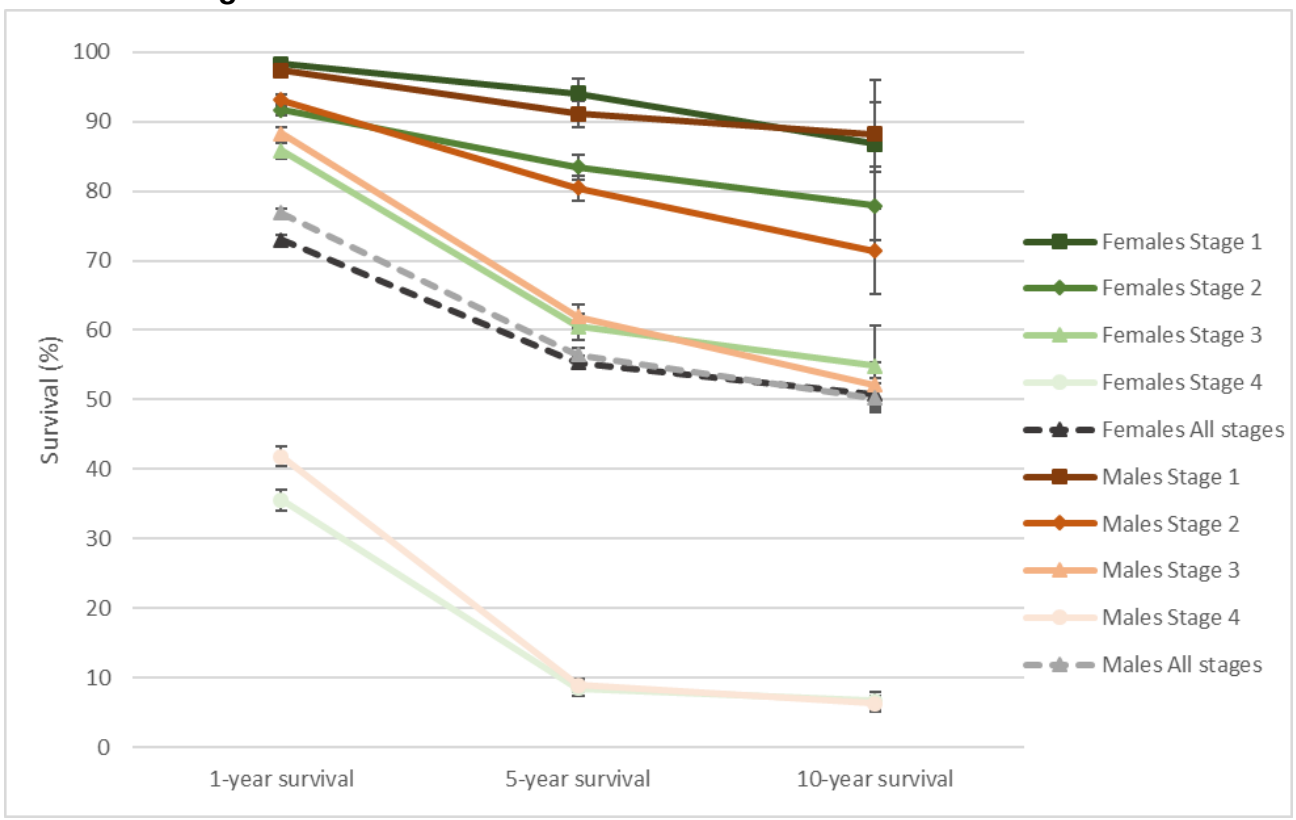


Figure E2. Non-standardised 1, 5 and 10-year net survival for lung cancer by sex in the East of England

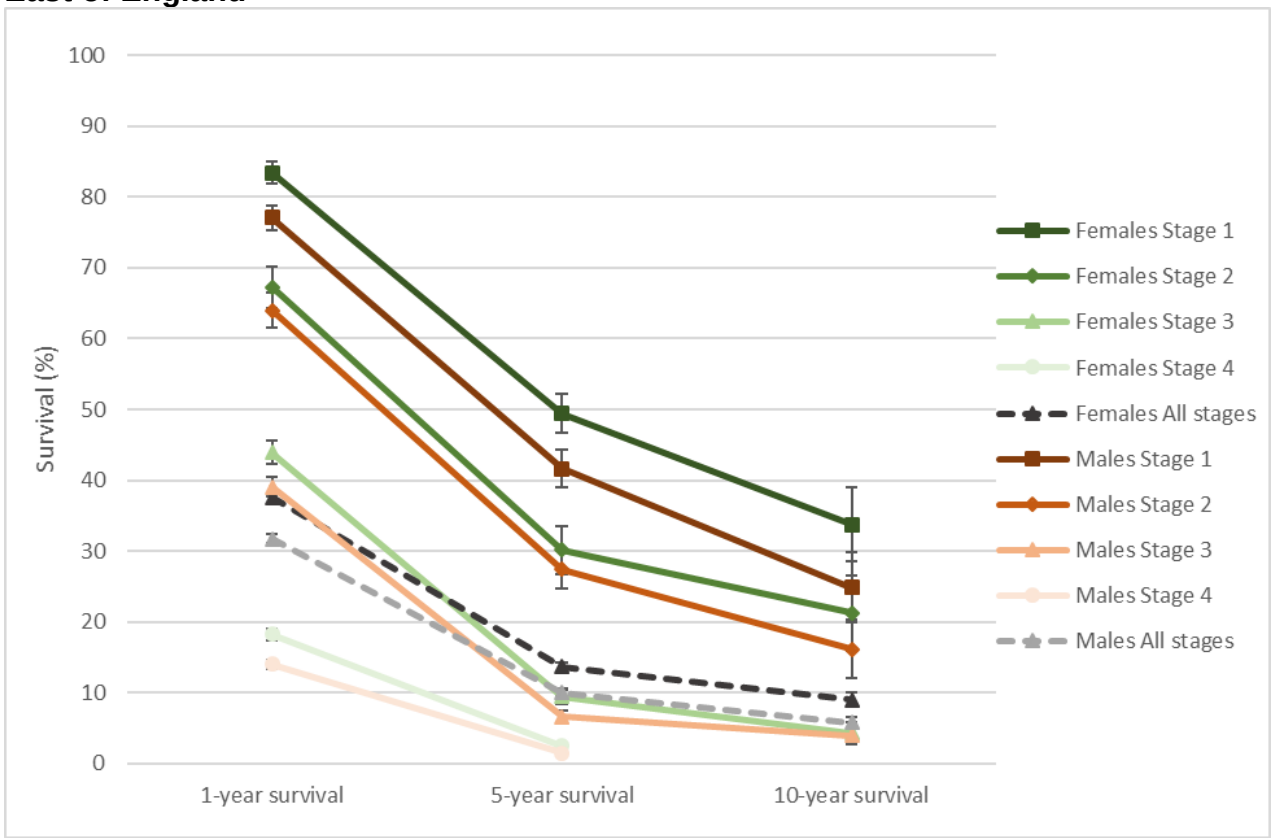


Figure E3. Non-standardised 1, 5 and 10-year net survival for kidney cancer by sex in the East of England

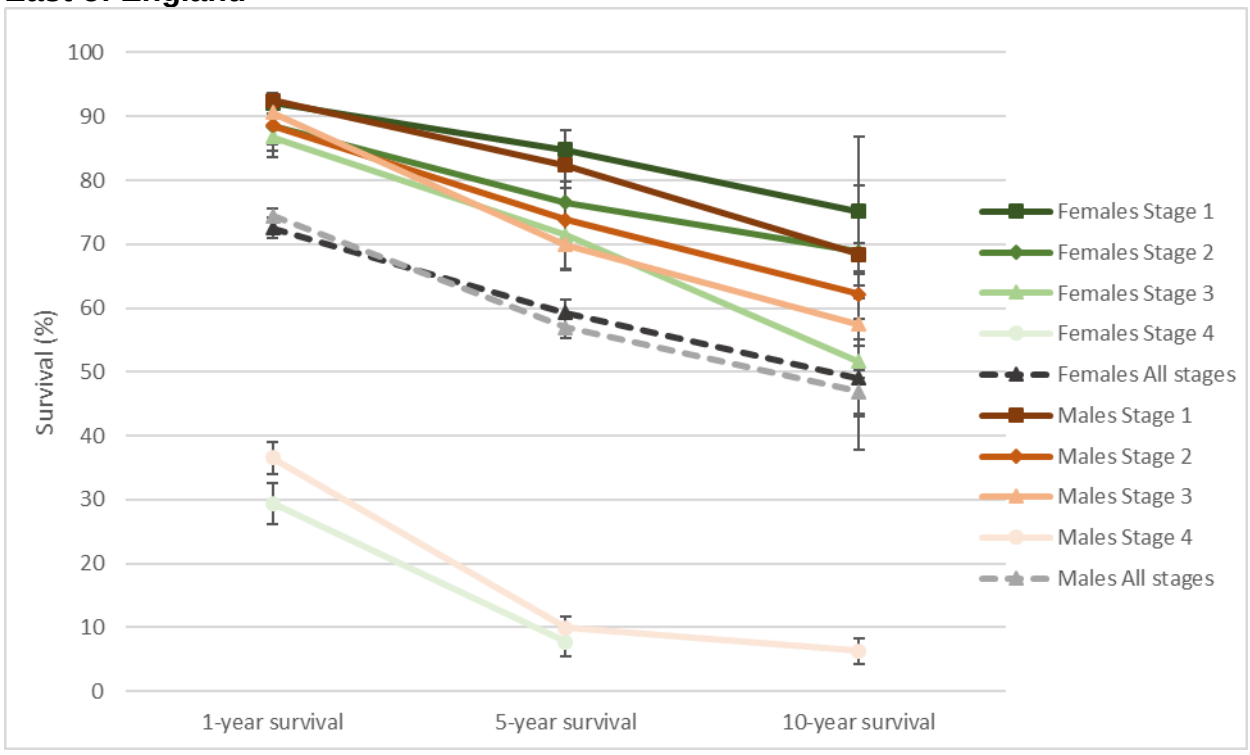
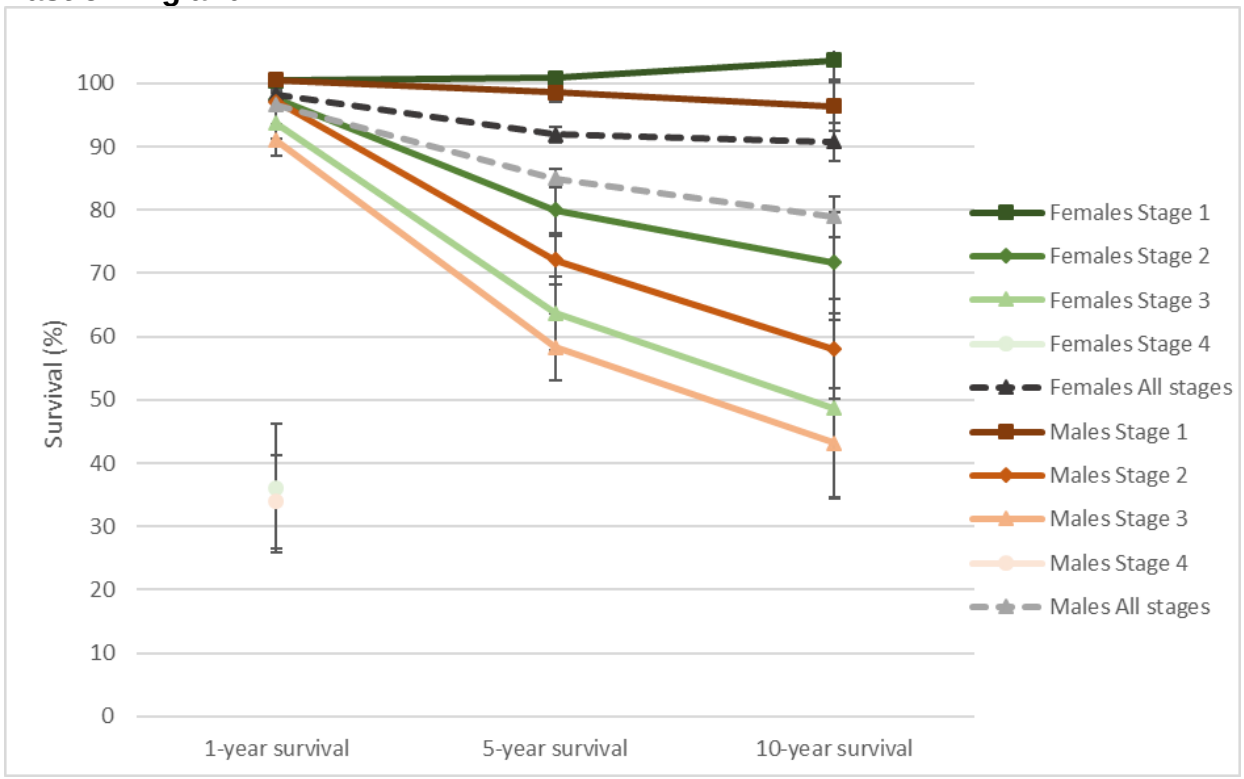


Figure E4. Non-standardised 1, 5 and 10-year net survival for melanoma by sex in the East of England



Appendix F: Survival estimates by age group

Figure F1. Survival by stage estimates by age group for breast cancer (females) in the East of England

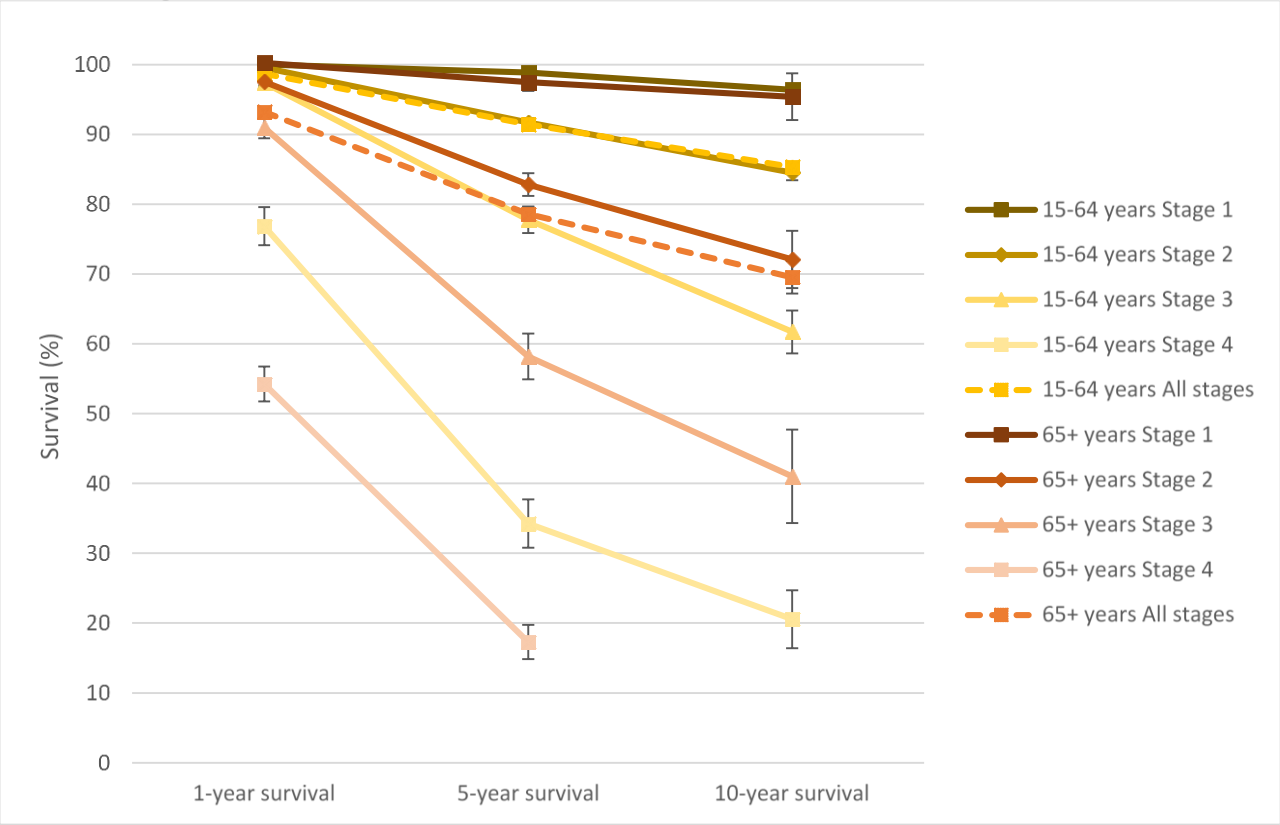


Figure F2. Survival by stage estimates by age group for colorectal cancer (persons) in the East of England

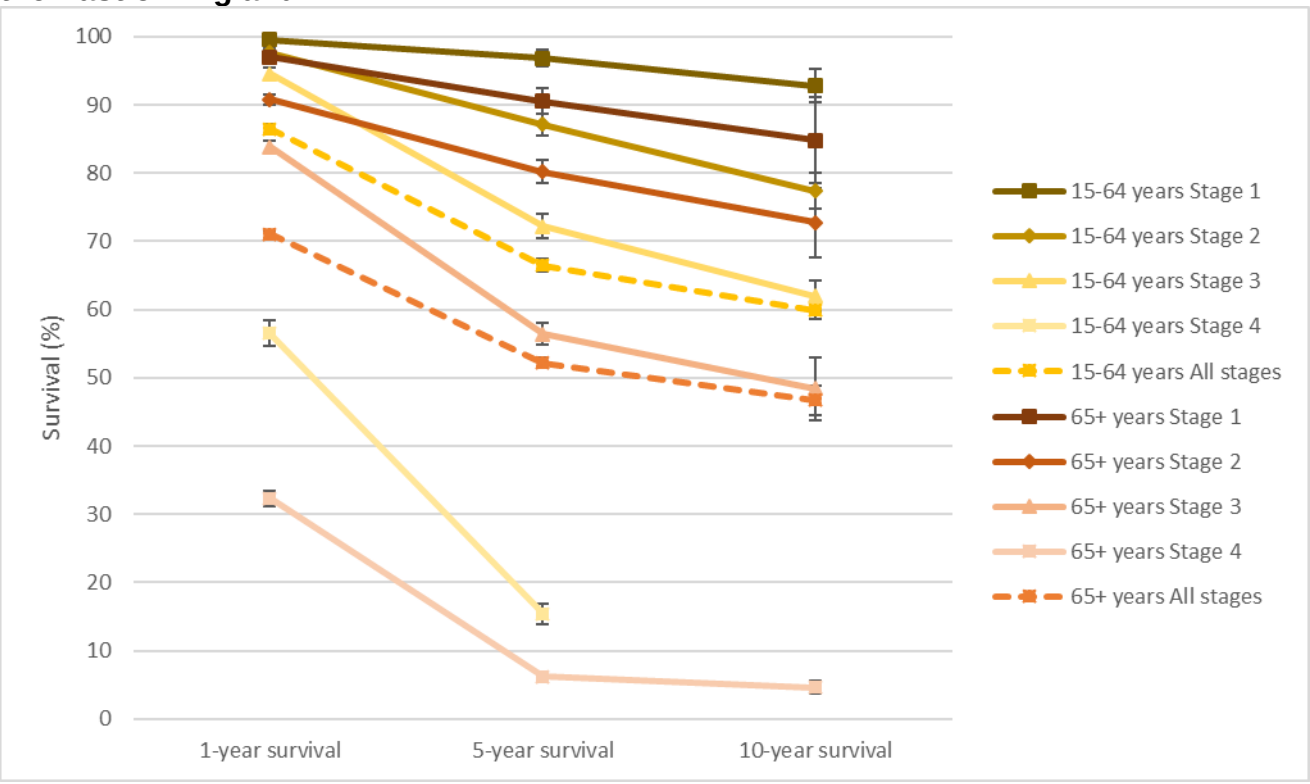


Figure F3. Survival by stage estimates by age group for lung cancer (persons) in the East of England

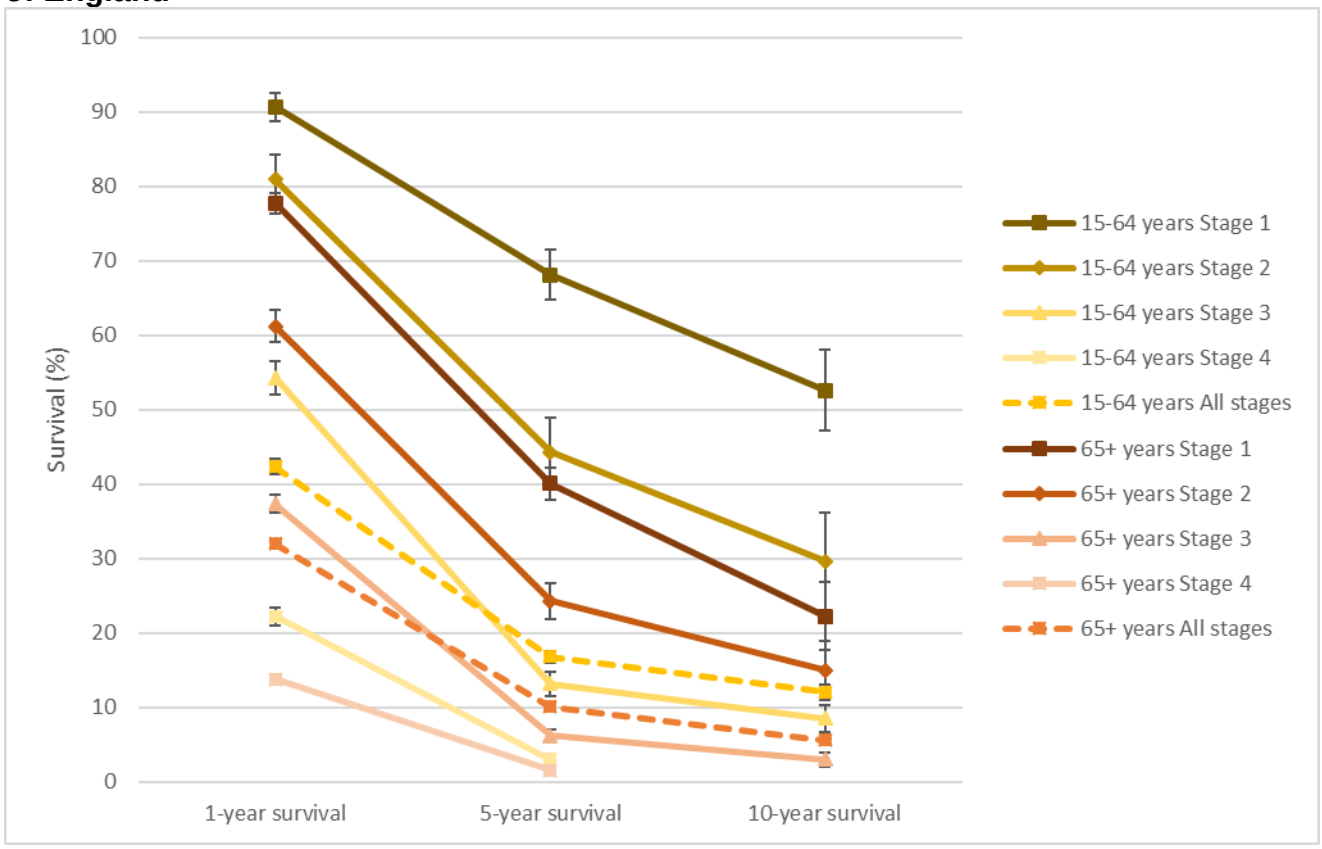


Figure F4. Survival by stage estimates by age group for prostate cancer (males) in the East of England

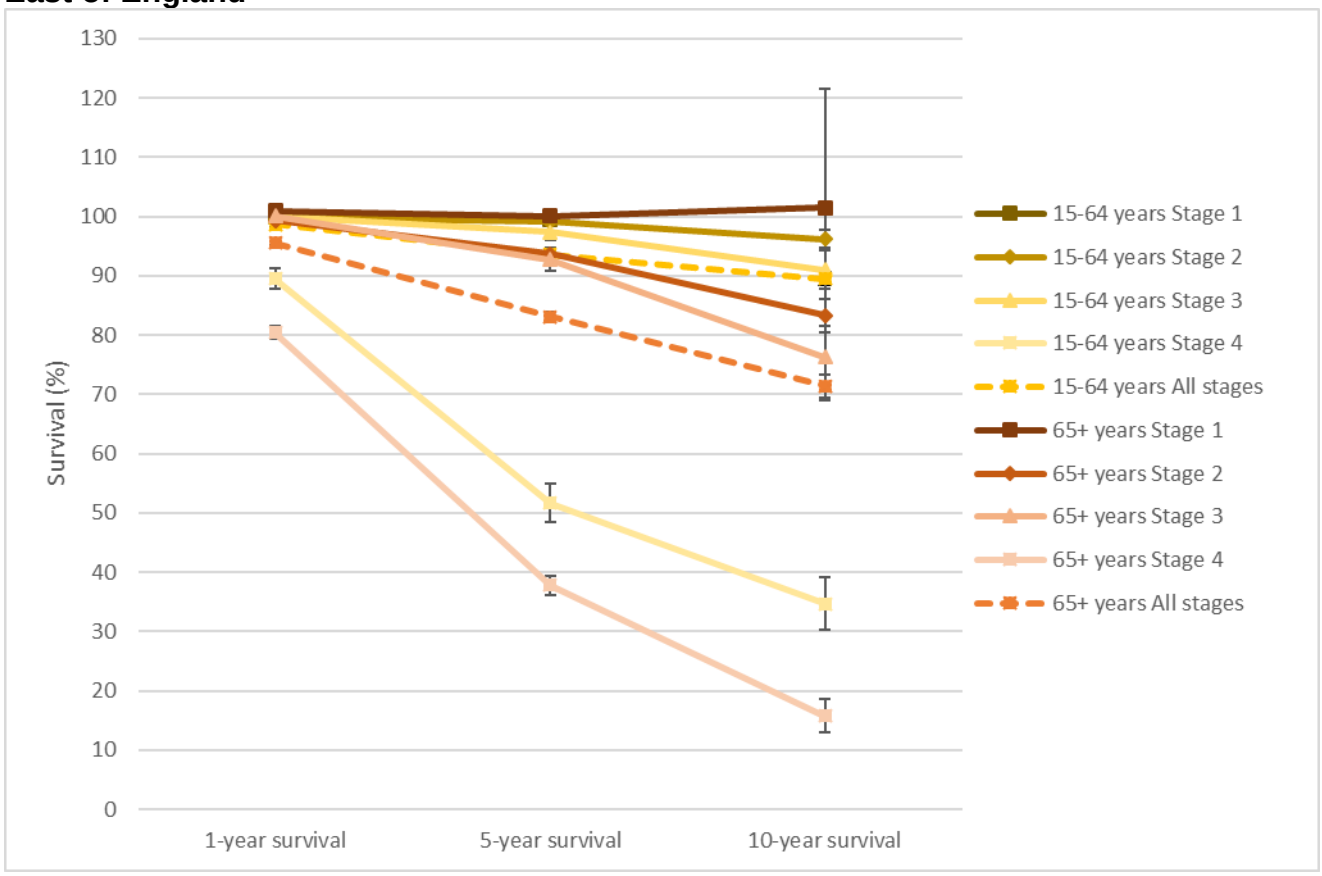


Figure F5. Survival by stage estimates by age group for kidney cancer (persons) in the East of England

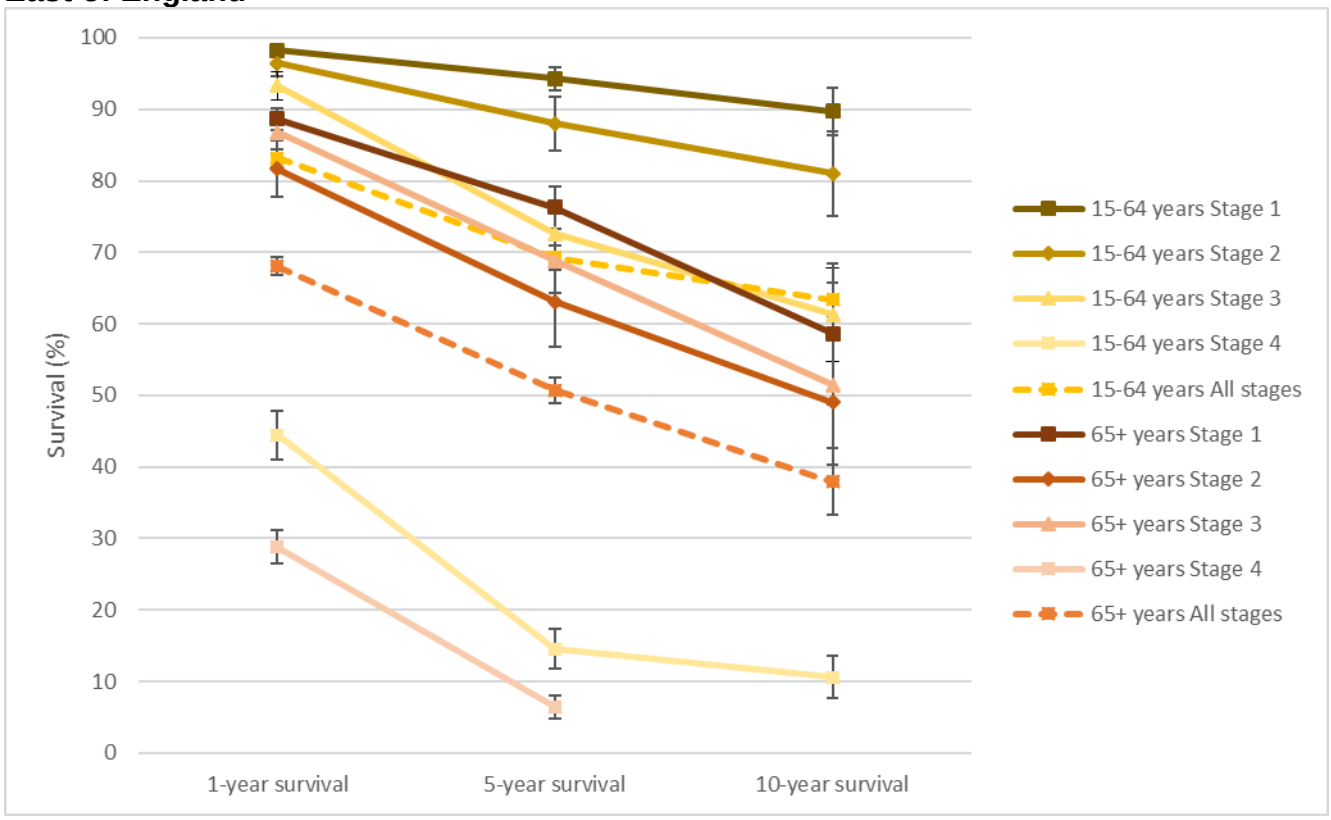


Figure F6. Survival by stage estimates by age group for melanoma (persons) in the East of England

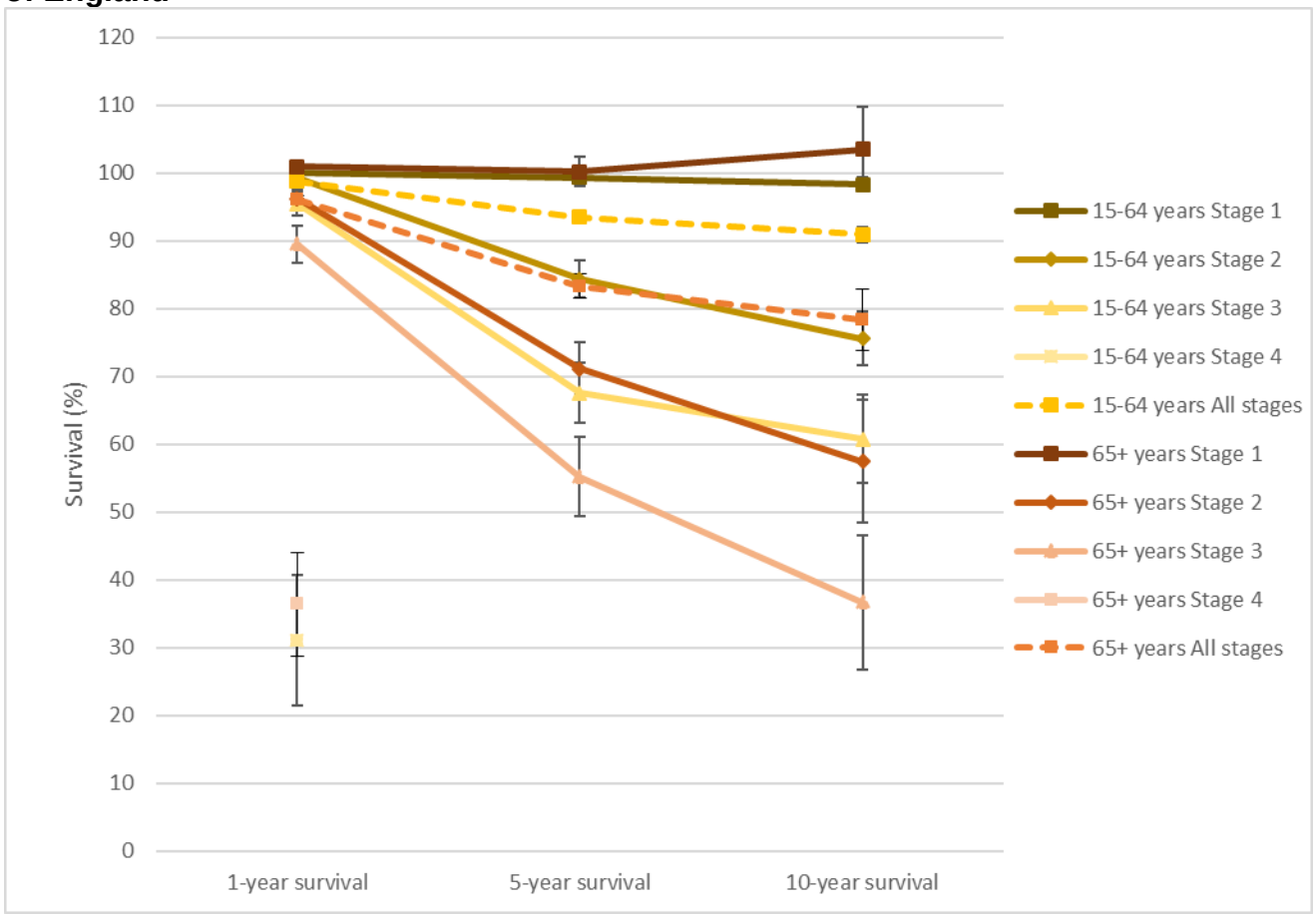


Figure F7. Survival by stage estimates by age group for ovarian cancer (females) in the East of England

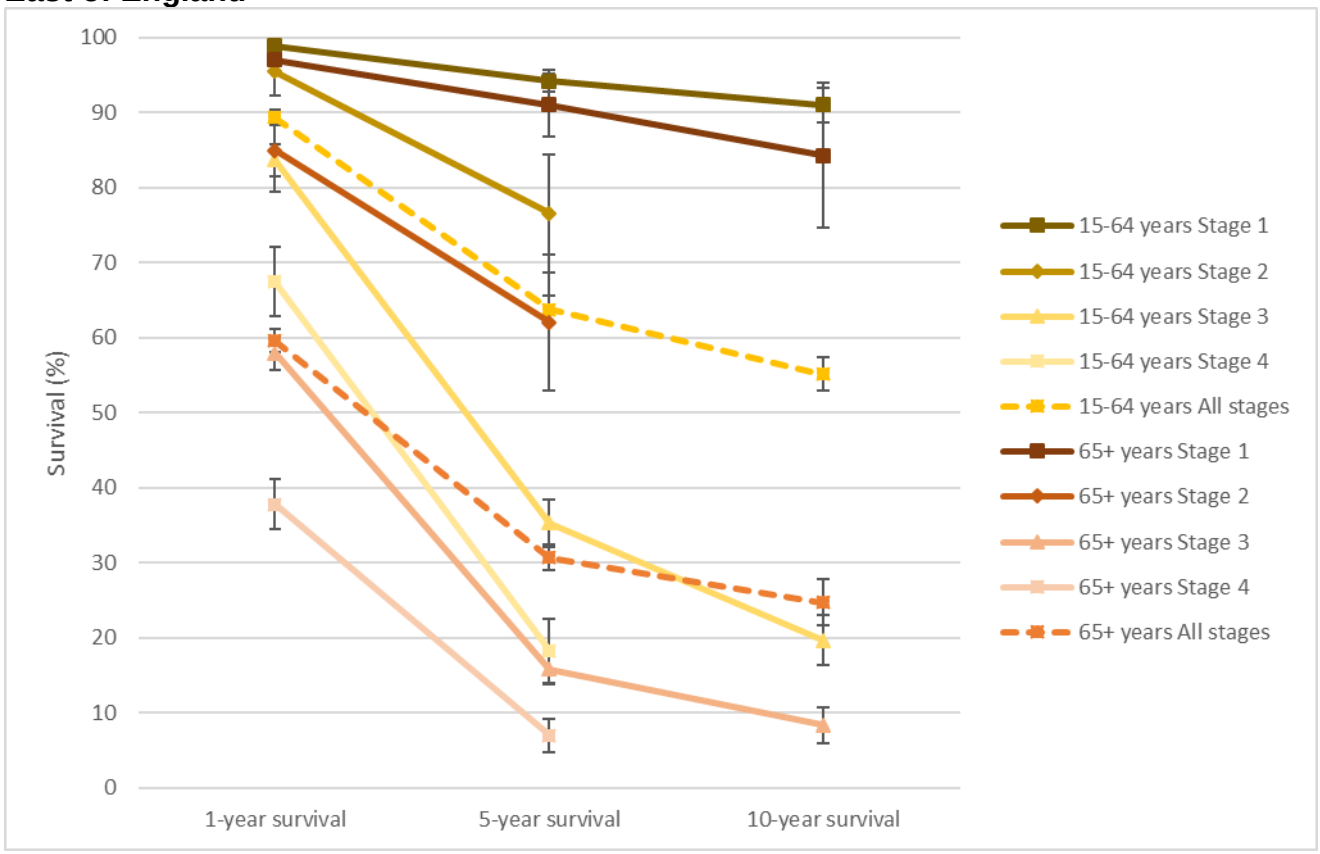
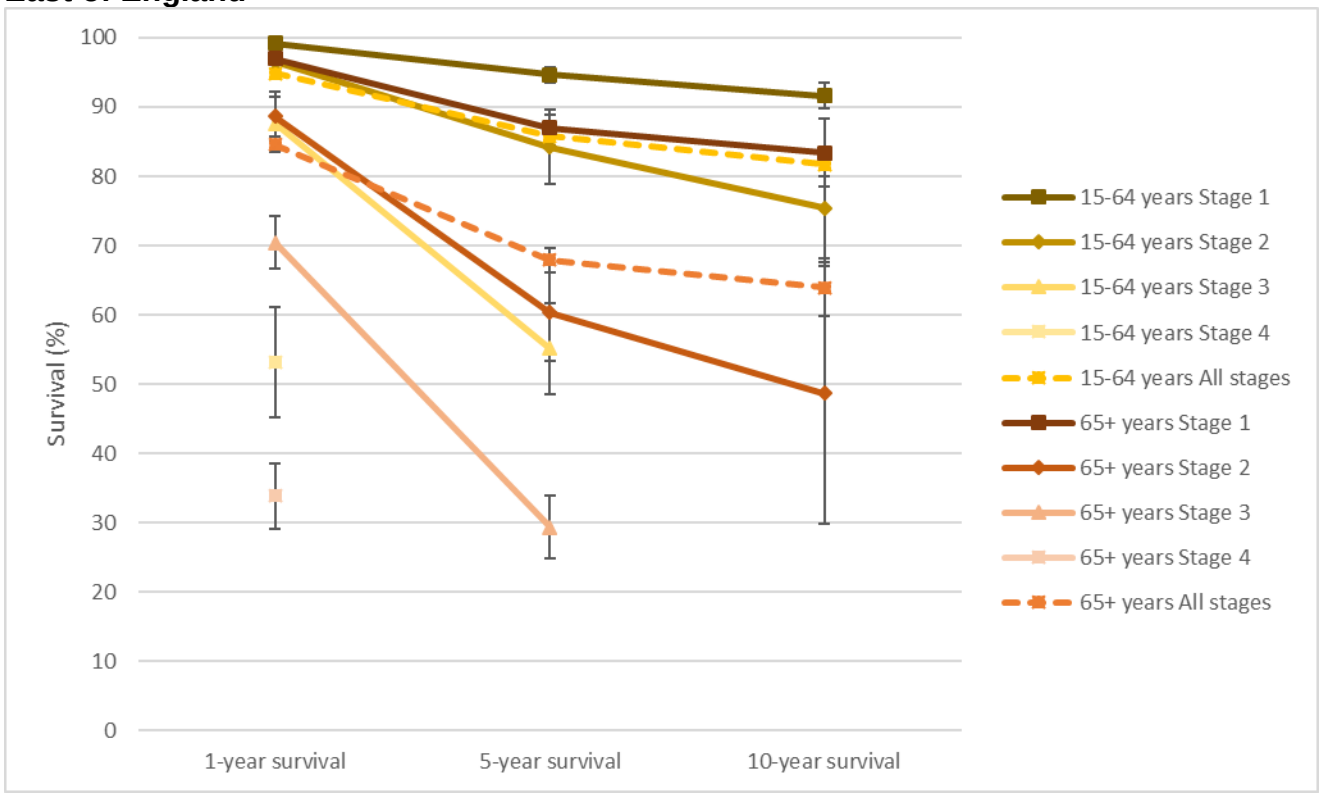


Figure F8. Survival by stage estimates by age group for uterine cancer (females) in the East of England



About Public Health England

Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. We do this through world-leading science, research, knowledge and intelligence, advocacy, partnerships and the delivery of specialist public health services. We are an executive agency of the Department of Health and Social Care, and a distinct delivery organisation with operational autonomy. We provide government, local government, the NHS, Parliament, industry and the public with evidence-based professional, scientific and delivery expertise and support.

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Version 1. February 2021

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Published: February 2021
PHE gateway number: GW-1963

PHE supports the UN Sustainable Development Goals