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INTRODUCTION

- Stage at diagnosis is highly prognostic for life expectancy across cancer types¹. Detection at earlier stages is associated with improved survival outcomes through wider eligibility for curative-intent treatment and lower disease burden.
- Loss of life expectancy (LOLE) is an intuitive metric for comparing the contribution of diseases to mortality while taking into account the duration of the remaining lifetime that is lost².
- In the LOLE calculation, premature mortality is quantified relative to the population life expectancy for a person of the same sex and age.
- The population impact of cancer on premature mortality and the variability across cancer types and stages can then be visualized.
- A recent study by Stannard et al.¹ estimated life expectancy by stage at diagnosis for 10 cancer types in England using a flexible parametric excess hazard model. Our study utilizes similar methods, extending to calculation of LOLE across 21 cancer types, thereby allowing a comprehensive view across routinely staged cancers.

OBJECTIVE

- To estimate the LOLE across cancer types by stage at diagnosis and to aid comparisons of cancer burden across cancer types and stage at diagnosis through visualization.

METHODS

Data

- Summary count data from 3,357,734 patients aged 40 years or more and diagnosed with cancer in England between 2013–2020 were obtained from the National Cancer Registration and Analysis Service (NCRAS).
- Follow-up continued through 2023 and was limited to a maximum of 10 years.
- The data included all primary malignancies. Secondary and subsequent tumours of the same cancer site were excluded. We excluded patients with unknown stage and unstageable cancers.

Statistical Analysis

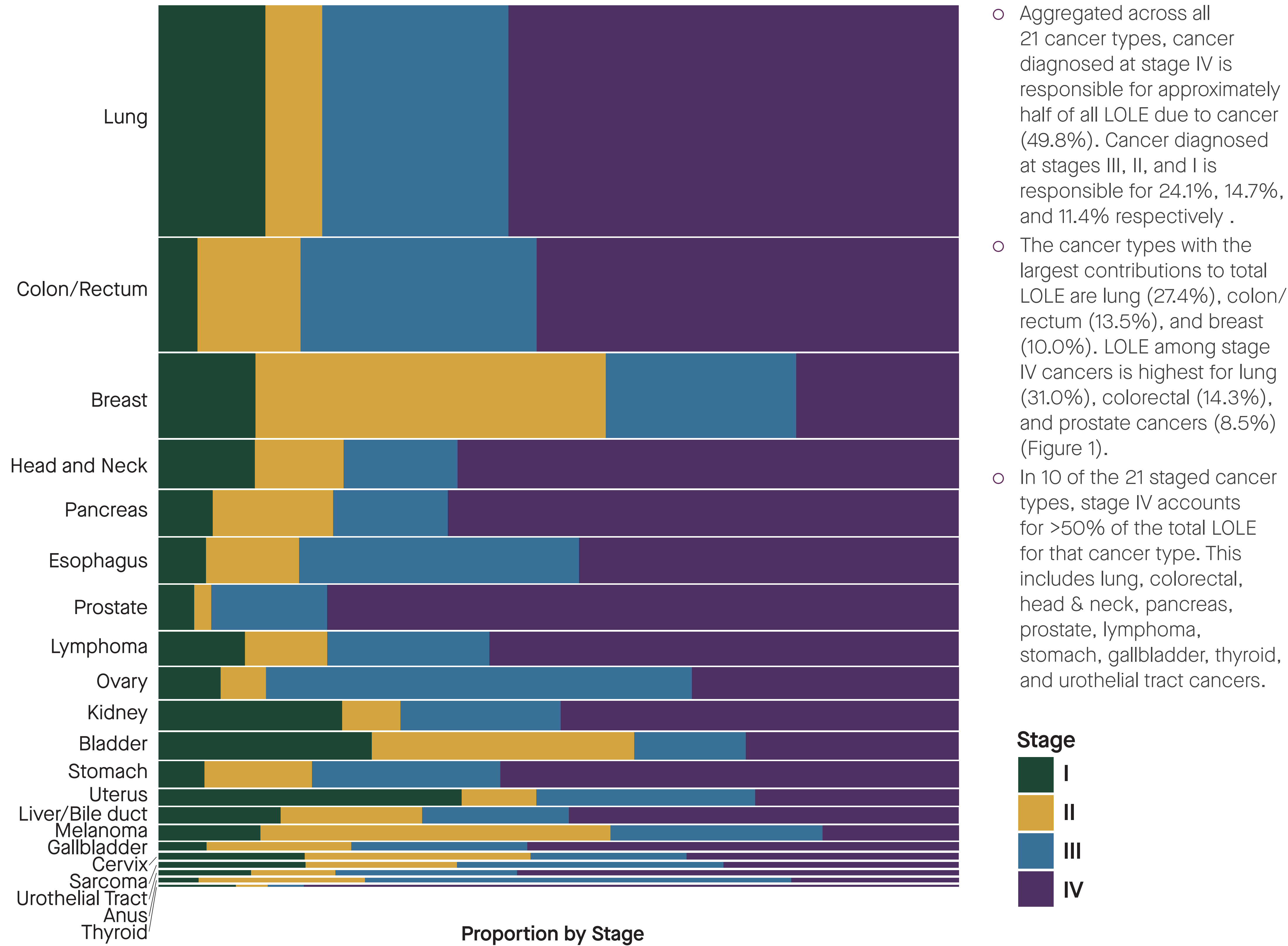
- A Bayesian flexible parametric survival model³ within a relative survival framework was used. Separate models were estimated for each cancer type, stage, sex, and age group.
- The restricted mean survival time at 100 years of attained age was calculated from each model. LOLE was then calculated by comparing these estimates with age- and sex-specific English life tables⁴.
- The total burden of LOLE by cancer type and stage was estimated by summing across age- and sex-specific strata. This produces an incidence-weighted total that accurately represents the population burden for each cancer type and stage.

- To understand the impact at an individual level the average proportion of remaining life expectancy lost at each stage at diagnosis was calculated.
- Limitations and Future Analysis**
- Further development of these methods could investigate temporal trends in survival by stage, both within the period in which cohorts were diagnosed and in making predictions for patients diagnosed at the present time.
- Our relative survival framework may be sensitive to misalignment of background mortality rates from population life tables. Future analysis should give this aspect of the analysis further consideration to enhance robustness of the results.

STAGE IV CANCER ACCOUNTS FOR HALF OF ALL LOST LIFE EXPECTANCY

LOST LIFE EXPECTANCY BY STAGE OF DIAGNOSIS AND CANCER TYPE

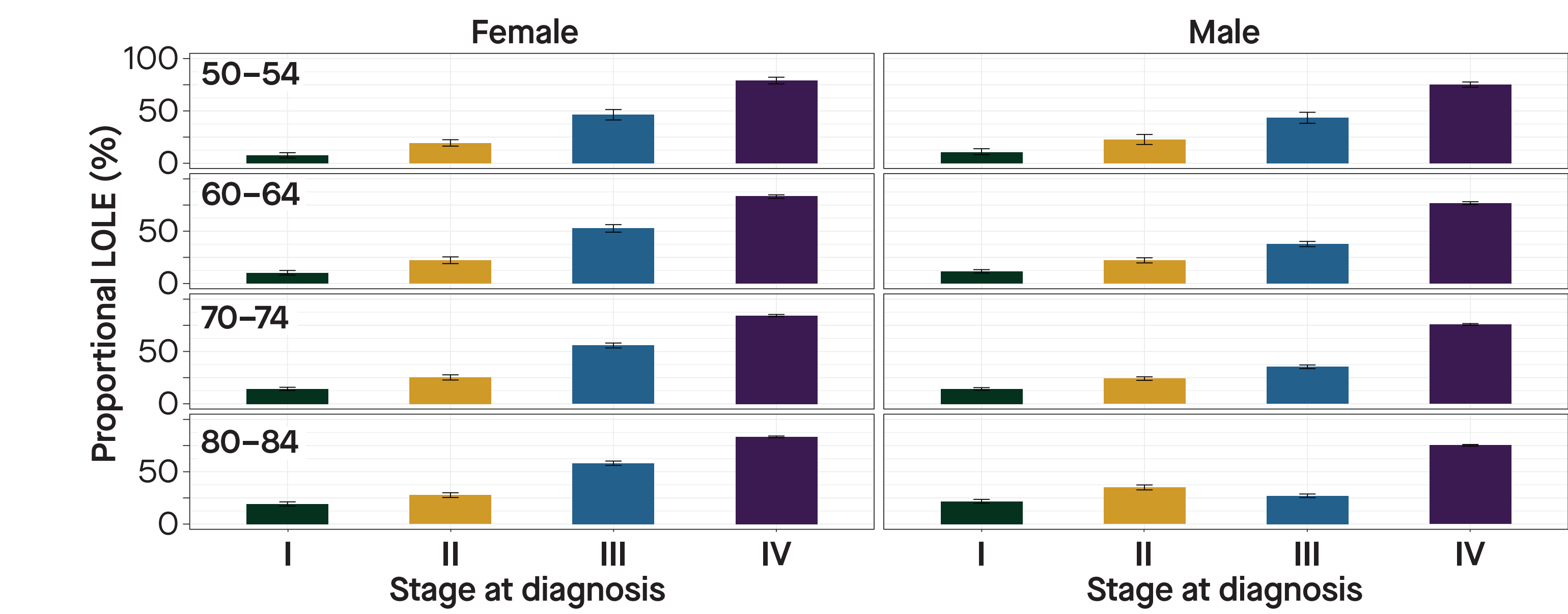
Figure 1. Total Loss of Life Expectancy by Cancer Type and Stage at Diagnosis



The area of each box in the chart is proportional to the percentages of total LOLE attributable to the cancer type and stage at diagnosis. Bar width indicates the proportion of LOLE within that cancer type. Bar height indicates the proportion among cancer types.

LOST LIFE EXPECTANCY BY SUBGROUPS

Figure 2. Proportional Loss of Life Expectancy Due to Cancer by Stage at Diagnosis for Age Groups



- Aggregated across all 21 cancer types, cancer diagnosed at stage IV is responsible for approximately half of all LOLE due to cancer (49.8%). Cancer diagnosed at stages III, II, and I is responsible for 24.1%, 14.7%, and 11.4% respectively.
- The cancer types with the largest contributions to total LOLE are lung (27.4%), colon/rectum (13.5%), and breast (10.0%). LOLE among stage IV cancers is highest for lung (31.0%), colorectal (14.3%), and prostate cancers (8.5%) (Figure 1).
- In 10 of the 21 staged cancer types, stage IV accounts for >50% of the total LOLE for that cancer type. This includes lung, colorectal, head & neck, pancreas, prostate, lymphoma, stomach, gallbladder, thyroid, and urothelial tract cancers.

- Proportional LOLE due to cancer diagnosed at a given stage is similar across age groups (Figure 2). Results show the least variation at stage IV across sex and age groups. Averaged across all age groups, the proportion of remaining life expectancy that is lost due to cancer is highest at stage IV: 82.1% in females and 75.5% in males.

CONCLUSIONS

- Across all cancer types, stage IV disease predominates contributions to the burden of premature mortality.
- For nearly half of stageable cancer types, stage IV diagnosis accounts for the majority of LOLE.
- Reducing stage IV disease, potentially through evidence-based interventions enabling early detection, could substantially lessen the overall burden of lost life expectancy due to cancer.

Acknowledgements

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Disclosures

Study funded by GRAIL, Inc. LE and EC are current employees of GRAIL, Inc., with equity in the company. EG and DJ are former employees of GRAIL, Inc. EG is a paid consultant for GRAIL, Inc.

References

1. NHS Digital. 2022; Cancer Survival in England, Cancer Survival by Stage. URL: <https://digital.nhs.uk/data-and-information/publications/statistical/cancer-survival-in-england/cancers-diagnosed-2015-to-2019-followed-up-to-2020/cancer-survival-by-stage>. 2. Rutherford, Mark J., et al. "Loss in life expectancy and gain in life years as measures of cancer impact." *Cancer epidemiology* 60 (2019): 168-173. 3. Stannard R, et al. *BMJ oncology*. 2026;5(1):e000999. 4. Jackson CH. *BMC Med Res Methodol*. 2023;23(1):282. 5. Office for National Statistics (ONS). 2020; National life tables: UK: 2017 to 2019. <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/datasets/nationallifetablesunitedkingdomreference> ables&sa=D&source=docs&ust=1788882250924475usg=AOvVaw3-0lgyeALHuD2htJkKaAb

