Stage at Diagnosis and Years of Life Lost Across 21 Cancer Types in the United States

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INTRODUCTION

- The primary goal of cancer prevention and early detection is to reduce premature deaths, but this outcome is not captured directly by cancer-specific mortality
- Earlier stage at diagnosis is a key determinant of higher probability of cure and long-term survival across the spectrum of cancer types
- Years of life lost (YLL) is an intuitive measure of premature death derived by extrapolating observed long-term cancer outcomes to the full patient lifespan
- YLL thus minimizes the influence of lead-time bias and facilitates evaluation of the potential benefits of cancer prevention and screening
- Most prior studies of YLL due to cancer were focused on specific cancer types and/or did not differentiate by stage at diagnosis, other than a study in the Netherlands[1]

OBJECTIVE

- To quantify the potential reduction of premature deaths due to early detection, we estimated YLL associated with stage and age at diagnosis across 21 stageable cancer types among persons aged 50 to 79 years in the United States (US)

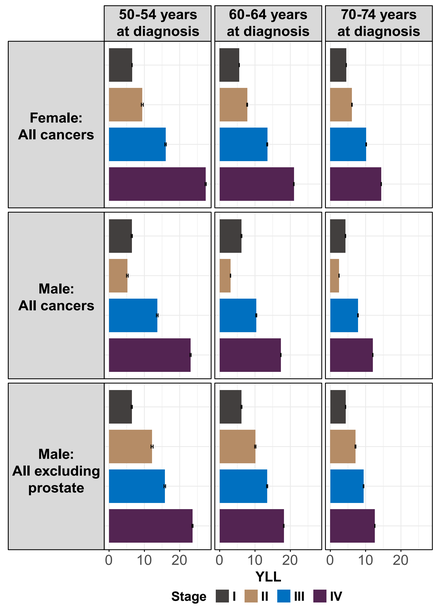
METHODS

- We used data from 1,776,541 patients diagnosed with any of 21 cancer types in the US Surveillance, Epidemiology, and End Results (SEER) population-based cancer registries for 17 geographic regions[2]
- Included patients were those with a first primary malignancy diagnosed at 50 to 79 years of age (with age given in 5-year groups) from the beginning of 2006 to the end of 2015, followed for survival through the end of 2021
- We used a Bayesian flexible parametric survival model framework[3,4] to extrapolate patient survival past the last point of observation, incorporating population-based life tables and cure fraction estimates for specific cancer types[5,6]
- To estimate patient life expectancy, we calculated the restricted mean survival time at 100 years of attained age from each estimated model. YLL, with associated 95% credible interval, was calculated by comparing estimated patient life expectancy with age- and sex-specific US life tables[5]
- We merged per-patient YLL estimates by cancer type, stage, age, and sex back to the SEER individual patient-level data to produce tabulations of the total burden of YLL. As such, this total burden is the result of both cancer incidence and the magnitude of YLL
- We additionally considered the impact on total YLL under three hypothetical scenarios involving reduction of late-stage cancer incidence i) all stage IV cancers shifted equally (33.3%) to stages III, II, and I; ii) all stage IV cancers shifted to stage III; and iii) all stages IV and III cancers shifted to stage II

KEY RESULTS: LATER STAGE AT DIAGNOSIS IS ASSOCIATED WITH MORE YEARS OF LIFE LOST ACROSS CANCER TYPES, WITH THE LARGEST GAP BETWEEN STAGES IV AND III FOR NEARLY HALF OF CANCER TYPES

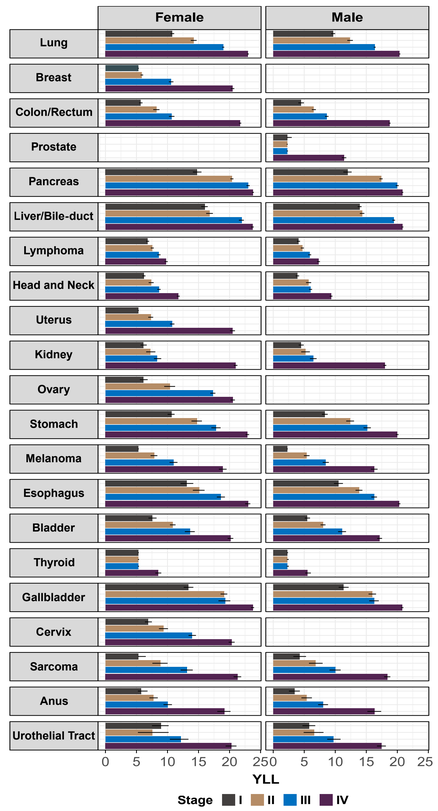
- YLL increased with later stage at diagnosis and decreased with older age at diagnosis (**Figure 1**)
  - For women aged 60-64 years at diagnosis, estimated YLL increased four-fold from 5.54 years at stage I to 20.98 years at stage IV
  - For men, the increasing trend in YLL by later stage at diagnosis was non-monotonic due to the preponderance of stage II prostate cancer potentially relating overdiagnosis, but it was monotonic after excluding prostate cancer
- For nearly half of cancer types, the difference in stage-specific YLL was greatest between stages III and IV (**Figure 2**)
- Aggregated across all SEER patients, stage IV cancer was responsible for nearly half of total YLL (42%). Stages III, II, and I cancer contributed 20%, 18%, and 20% of total YLL, respectively (**Figure 3**)
- Hypothetically, shifting all stage IV diagnoses equally to stages III, II, and I would reduce total YLL by 18%, amounting to a gain of 8.1 life-years per stage IV cancer patient
- Hypothetically, shifting all stage IV diagnoses to stage III would reduce total YLL by 11% (a gain of 5.1 life-years per stage IV cancer patient); and shifting all stages IV and III cancer diagnoses to stage II would reduce total YLL by 24% (a gain of 5.3 life-years per stages III/IV cancer patient)

Figure 1. Median YLL and 95% Credible Interval Across All Cancers Combined by Stage and Age Group at Diagnosis, Patients Diagnosed 2006-2015, Followed Through 2021



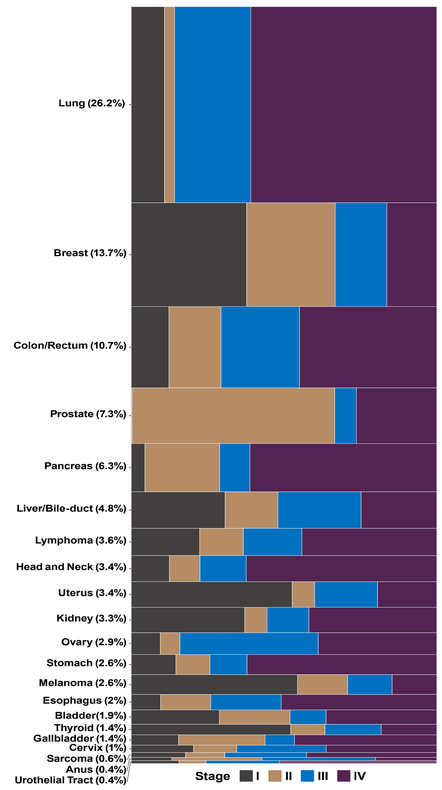
YLL, years of life lost.

Figure 2. Median YLL and 95% Credible Interval by Cancer Type, Stage at Diagnosis, and Sex for an Individual Aged 60-64 Years at Diagnosis



YLL, years of life lost.

Figure 3. Proportions of Total YLL by Stage at Diagnosis and Cancer Type, Patients Diagnosed 2006-2015, Followed Through 2021



Percentage of total YLL attributable to each cancer (all stages) is depicted on the y-axis. Percentage of YLL attributable to each stage for each cancer type is depicted on the x-axis.
YLL, years of life lost.

CONCLUSIONS

- YLL by cancer stage at diagnosis illustrates the immense burden of life lost prematurely to stage IV cancer and the untapped public health potential for gain in life-years through earlier detection across all cancer types
- Stage at diagnosis is one of the strongest influences on YLL and is amenable to change through interventions that detect cancer earlier
- A limitation of this analysis is that YLL does not account for non-mortality impacts of cancer, such as morbidity, quality of life, and patient-reported outcomes
- Given that nearly half of total YLL is attributed to stage IV cancer diagnoses, technologies that can detect a broad range of cancer types before stage IV (i.e., multi-cancer early detection tests) can potentially yield a substantial reduction in the burden of YLL due to cancer

References

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Disclosures

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