Estimation of age-standardized survival, even when age-specific data are sparse

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Motivation

- Relative (net) survival approaches are typically used for population-based cancer data to ensure fair comparison.
- Common practice to age-standardise survival estimates in order to allow direct comparability across regions, countries, time-periods or other population groups.
- Sparsity creates difficulties for the standard approaches of age-standardisation.
- Trying to estimate net measures from real-world data - depletion due to other causes.

Traditional age-standardization approaches

- Weighted average of separate survival estimates for each age-group.
- Requires net survival estimates for all time-points for all age-groups.
- Estimating excess mortality can be hampered by high competing mortality, or low numbers initially.
- Typically now done using a Pohar Perme estimate in each age-group and taking a weighted sum.
- Could also be done using weighted regression standardization.

Age-group-specific Pohar Perme estimates

For each individual i and time-interval j:

d_{ij}: all-cause death indicator,

d^*_{ij}: expected deaths based on population lifetable estimates.

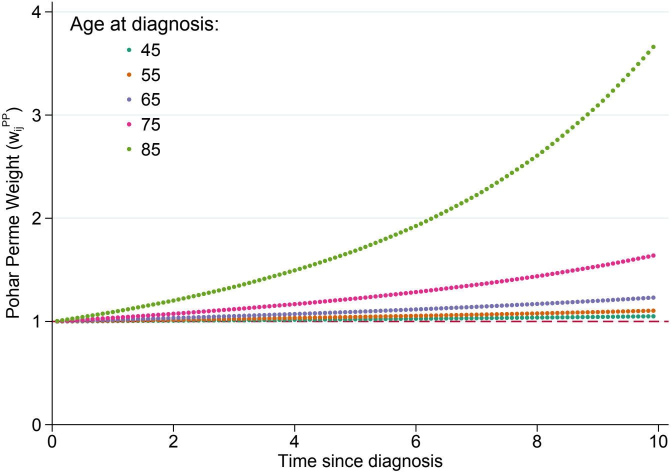
y_{ij}: individuals time at risk in each interval, j.

$w^{PP}_{ij} = \frac{1}{S^*_{ij}}$: a weight to account for differential loss due to other causes based again on population life-tables.

Then, for each age-group, k, we can calculate the excess mortality rate in each interval j:

$$\lambda_{jk} = \frac{\sum_{i \in k} w^{PP}_{ij} d_{ij} - \sum_{i \in k} w^{PP}_{ij} d^*_{ij}}{\sum_{i \in k} w^{PP}_{ij} y_{ij}},$$

Pohar Perme weights (w_{ij}^{PP})



Age-group-specific Pohar Perme estimates

We can convert the excess mortality estimates to the survial scale using the following relationship:

$$R_{jk} = \exp(-\Lambda_{jk}),$$

where the cumulative excess hazard, Λ_{jk} is calculated as $\Lambda_{jk} = \sum_j l_j \lambda_{jk}$

Externally age-standardised survival

To convert the age-group specific estimates into an externally standardised estimate using the International Cancer Survival Standard weights:

$$\overline{R}^{ICSS}(t) = \sum_{k=1}^{5} w_k^{ICSS} R_k(t),$$

Age-group	$\mathbf{w_k^{ICSS}}$
15-44	0.07
45-54	0.19
55-64	0.23
65-74	0.29
75+	0.29

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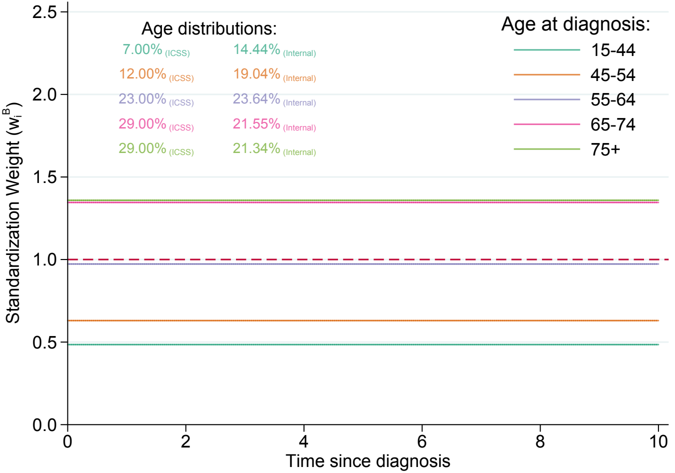
An alternative: the pre-weighting approach

Could add a further weight, w_i^B, to re-weight to the external standard and not stratify by age-group:

$$\lambda_j = \frac{\sum_i w_i^B w_{ij}^{PP} d_{ij} - \sum_i w_i^B w_{ij}^{PP} d_{ij}^*}{\sum_i w_i^B w_{ij}^{PP} y_{ij}},$$

where $w_i^B = \frac{w_i^{ICSS}}{a_i}$, with w_i^{ICSS} the value of the external standard weight depending on the age-group of individual, i, and a_i is the proportion of people in the age-group to which the individual belongs in the sample.

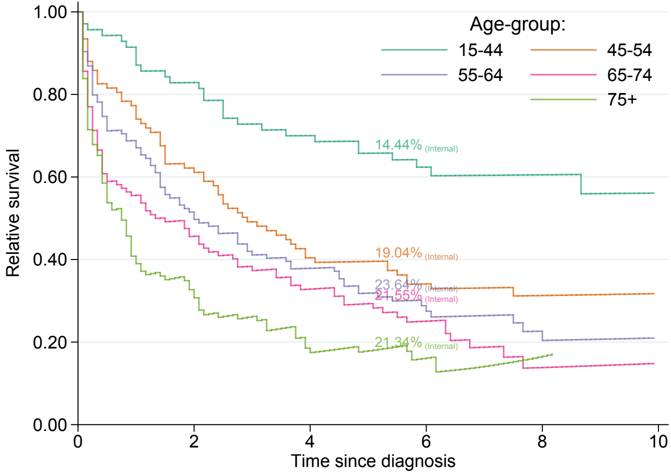
Standardization Weights (w_i^B)



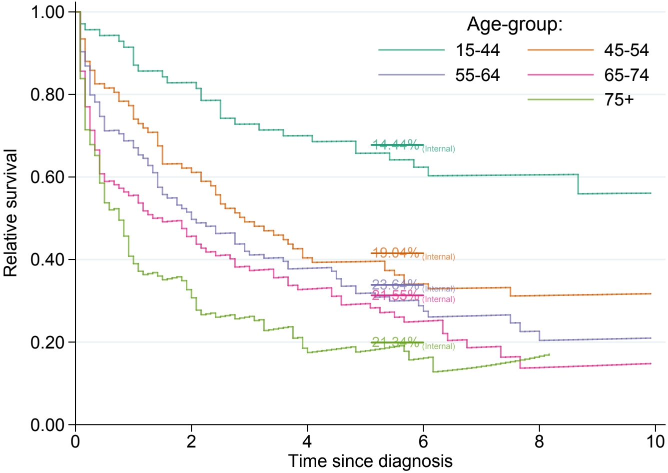
Motivating example

- SEER public-use data for ovarian cancer for 8 US states.
- Restricted calendar years of diagnosis (2005-2009) and the black race group to create sparsity setting.
- Use a state, race, calendar year, age and sex specific lifetable.
- Use the external age ICSS weights for age-standardisation.
- Illustrate the approach with a Pohar Perme approach and a model-based approach (flexible parametric model).

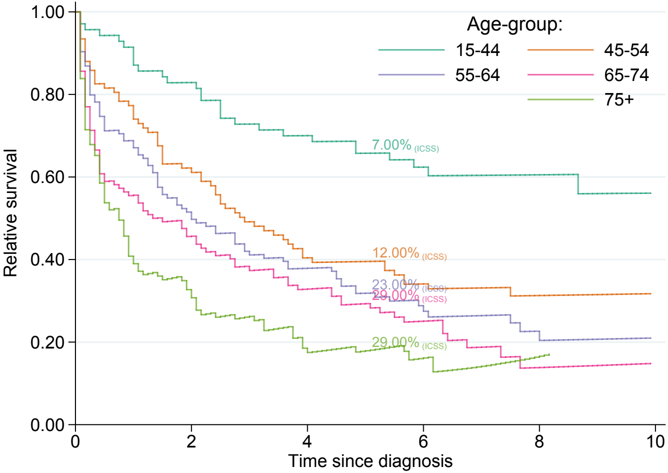
Ovarian cancer survival: age-group-specific



Ovarian cancer survival: Internal weights



Ovarian cancer survival: External weights



Ovarian cancer survival: Traditionally standardised

Age-standardized survival

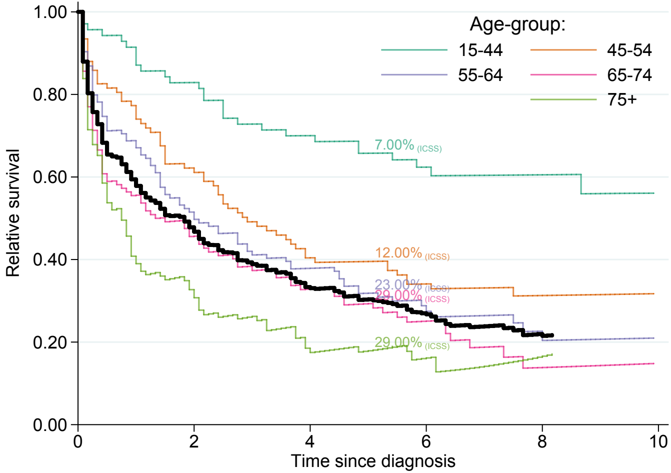
Background

Methods

Application

Conclusion

References



Ovarian cancer survival: Pre-weight (all-age)

Age-standardized survival

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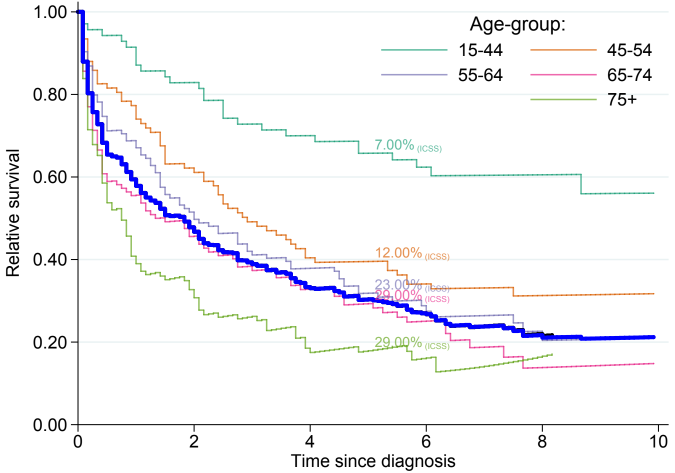
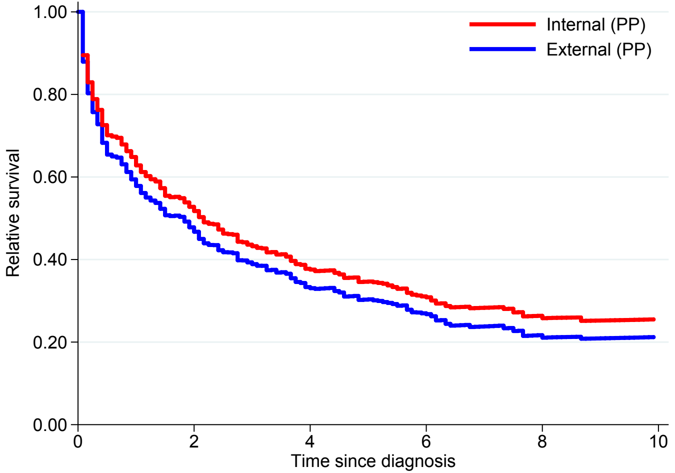


Ovarian cancer survival: Internal vs External



Conclusion

- A Pohar Perme estimate with pre-specified weighting should be used as the non-parametric estimator.
- Parametric models offer an alternative that require careful modelling of covariate and time-dependent covariate effects.
- Care should be taken to correctly specify the internal age distribution in the presence of delayed entry (period analysis estimates).

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