Standardised crude probabilities of death to improve understanding of national and international cancer survival comparisons

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LSHTM Cancer Survival Group and Karolinska/Leicester Meeting
London 7-8 October 2019

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- We usually present age-standardized net/relative survival.
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Survival in the **hypothetical** situation where

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2. the age distribution was not as it is observed, but as that in a reference population.

- Many examples of the media, politicians, clinicians, patients and scientists interpreting incorrectly.

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- When comparing population subgroups we are interested in whether there are differences in cancer mortality rates.

For Fair Comparisons differences between population groups should not depend on,

1. differences in the age distribution,
2. differences in other cause mortality rates.

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However, (2) and (3) depend on other cause mortality.

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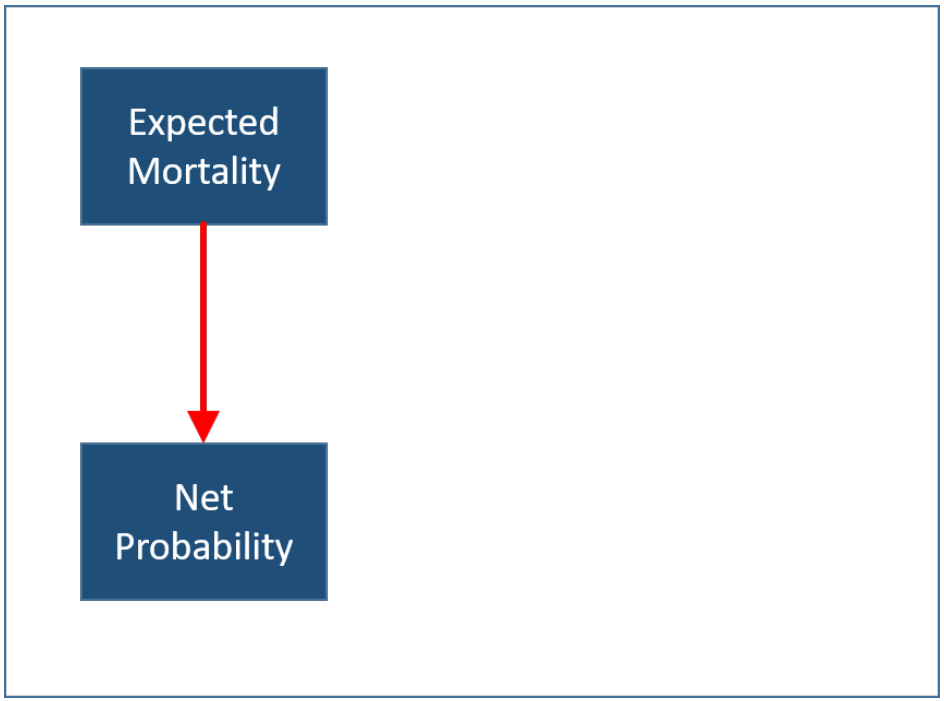

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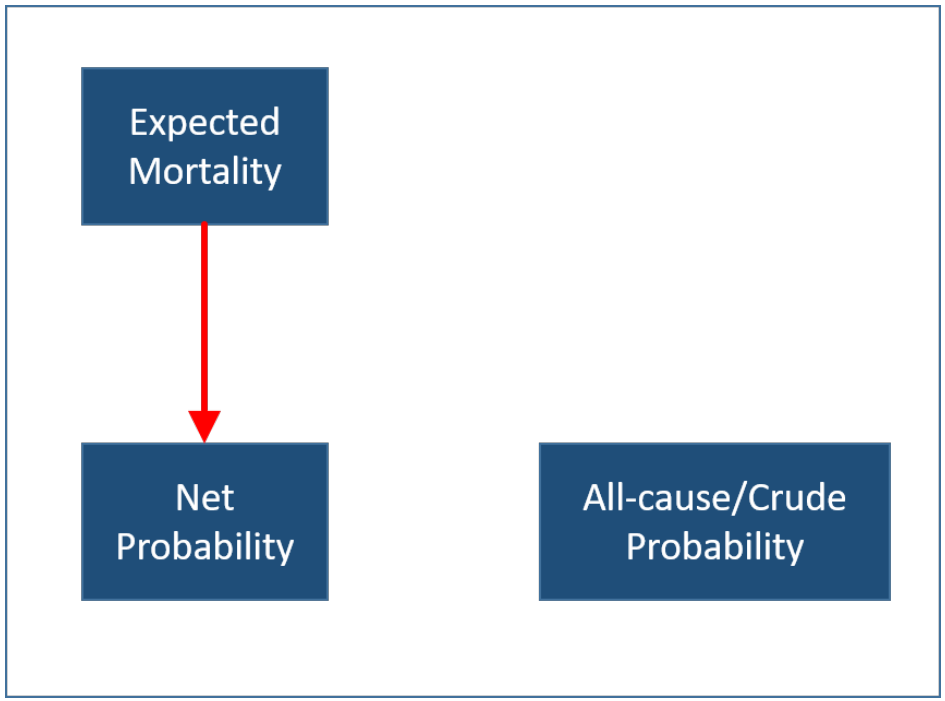

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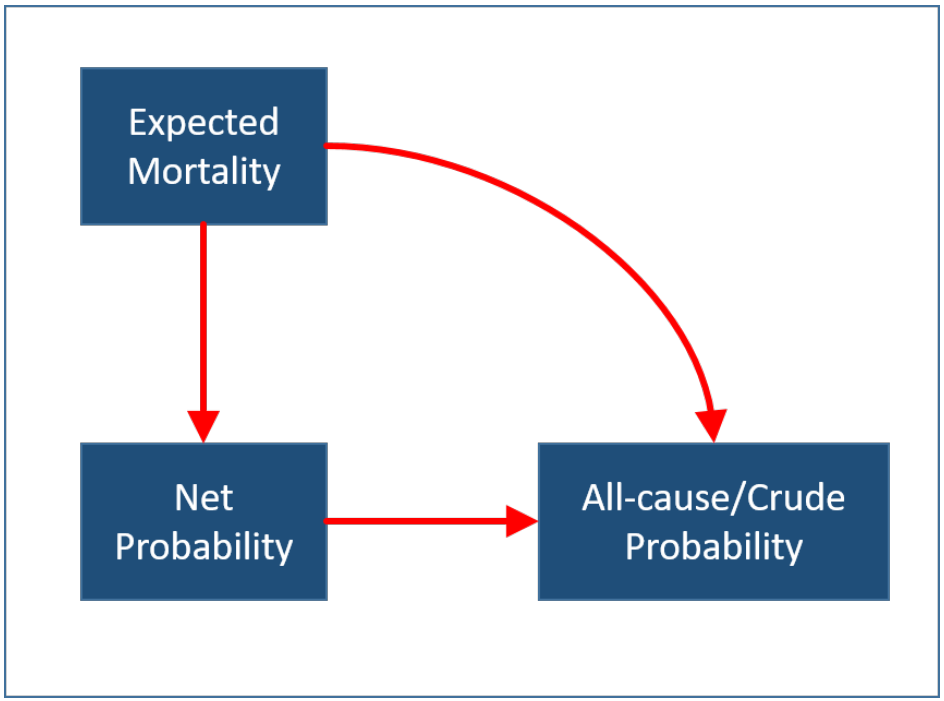

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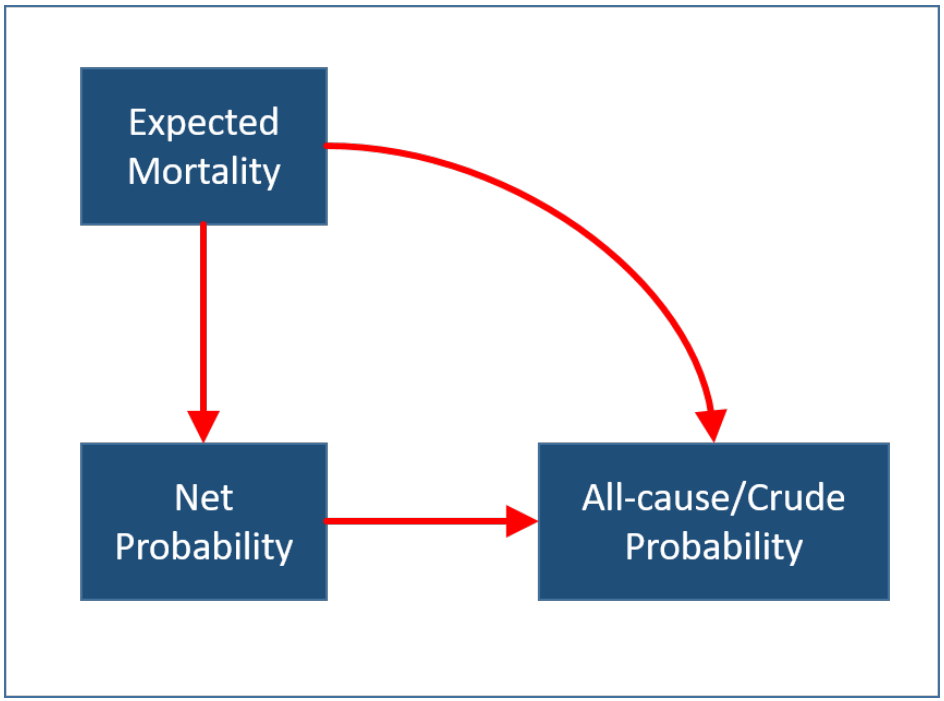

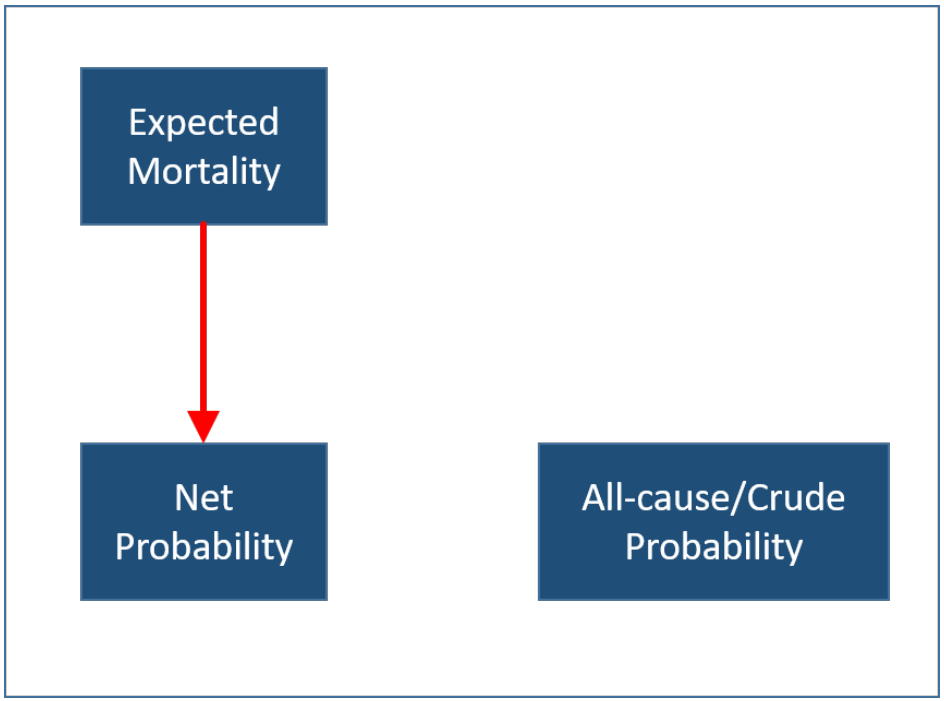

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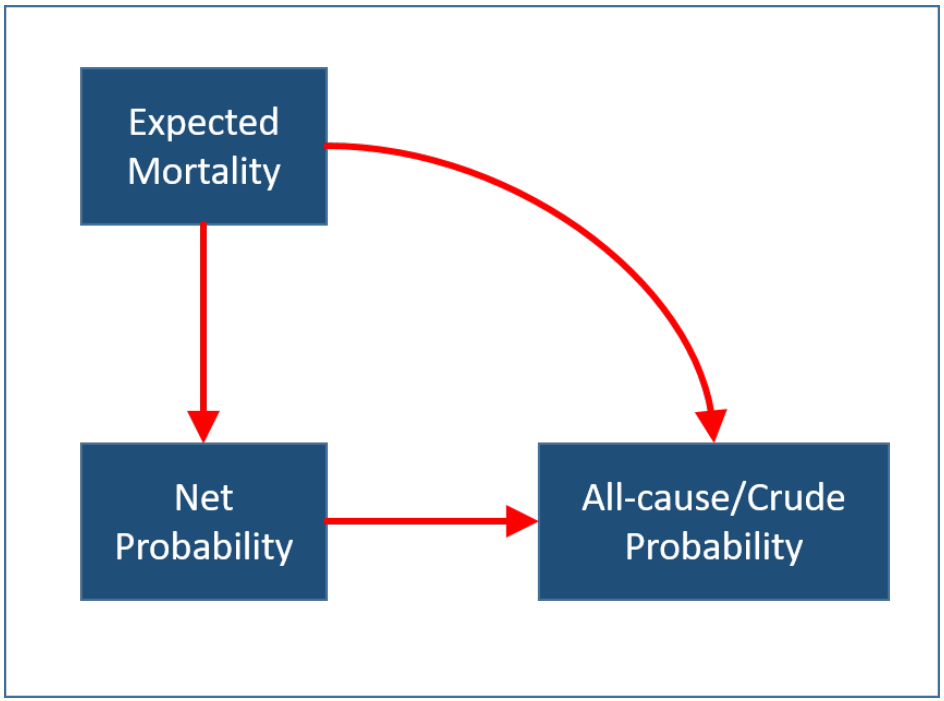

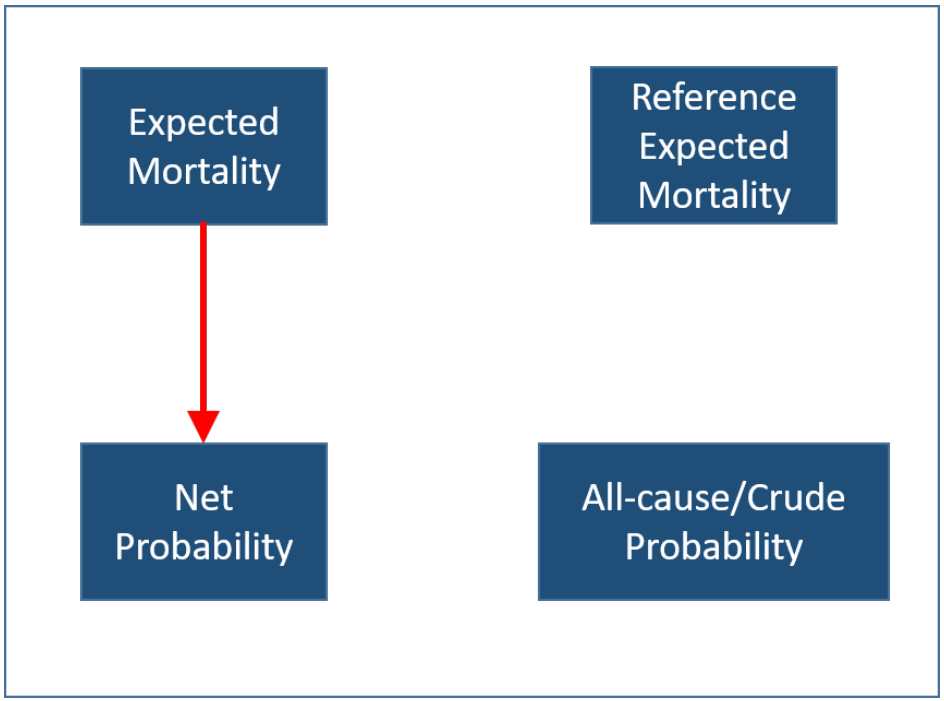

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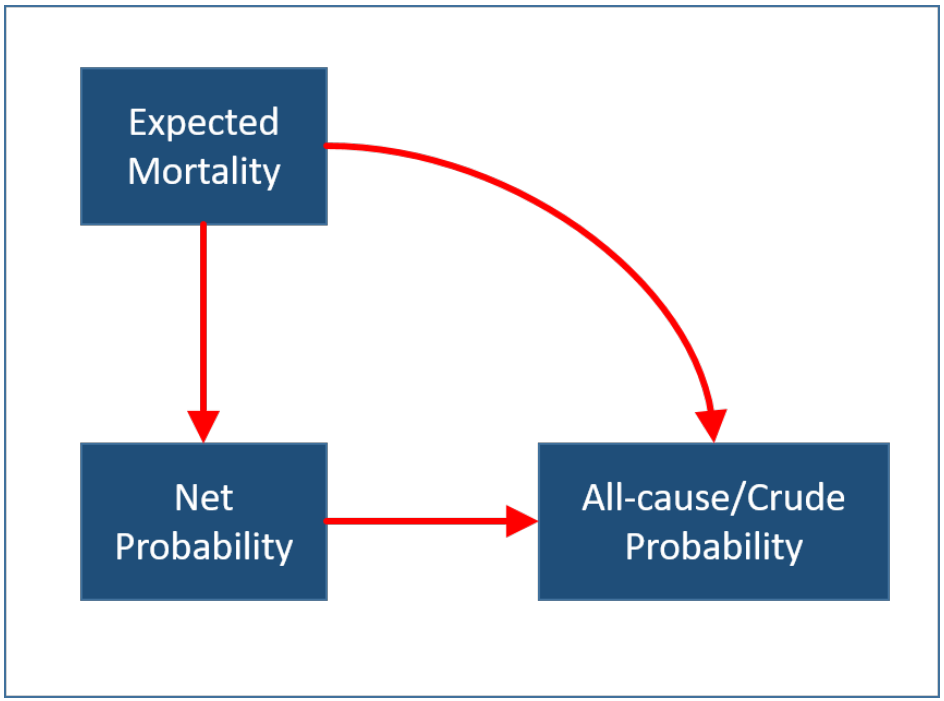
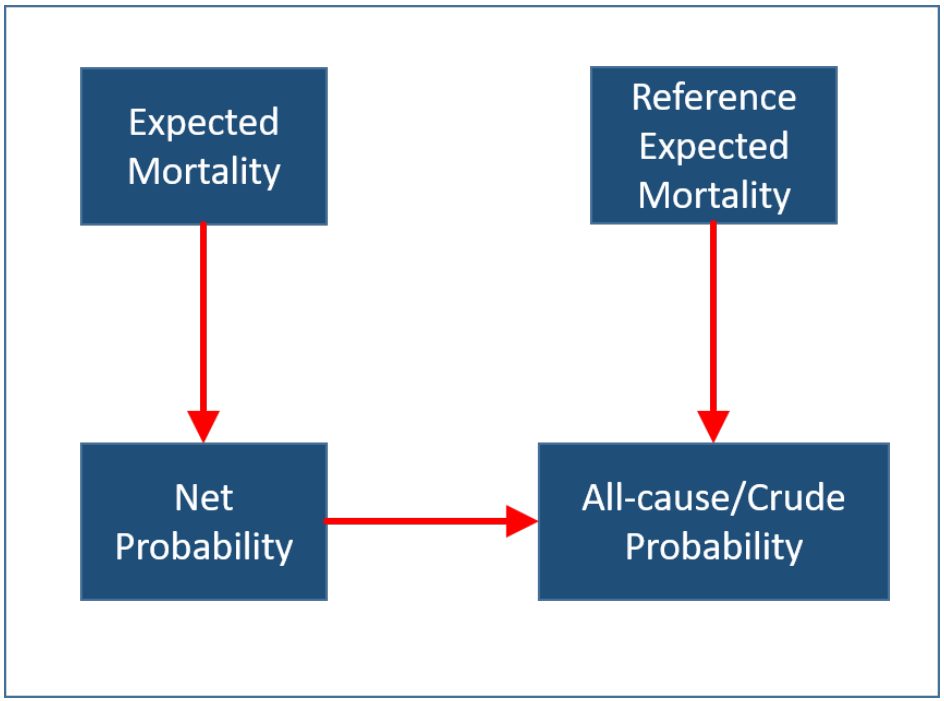
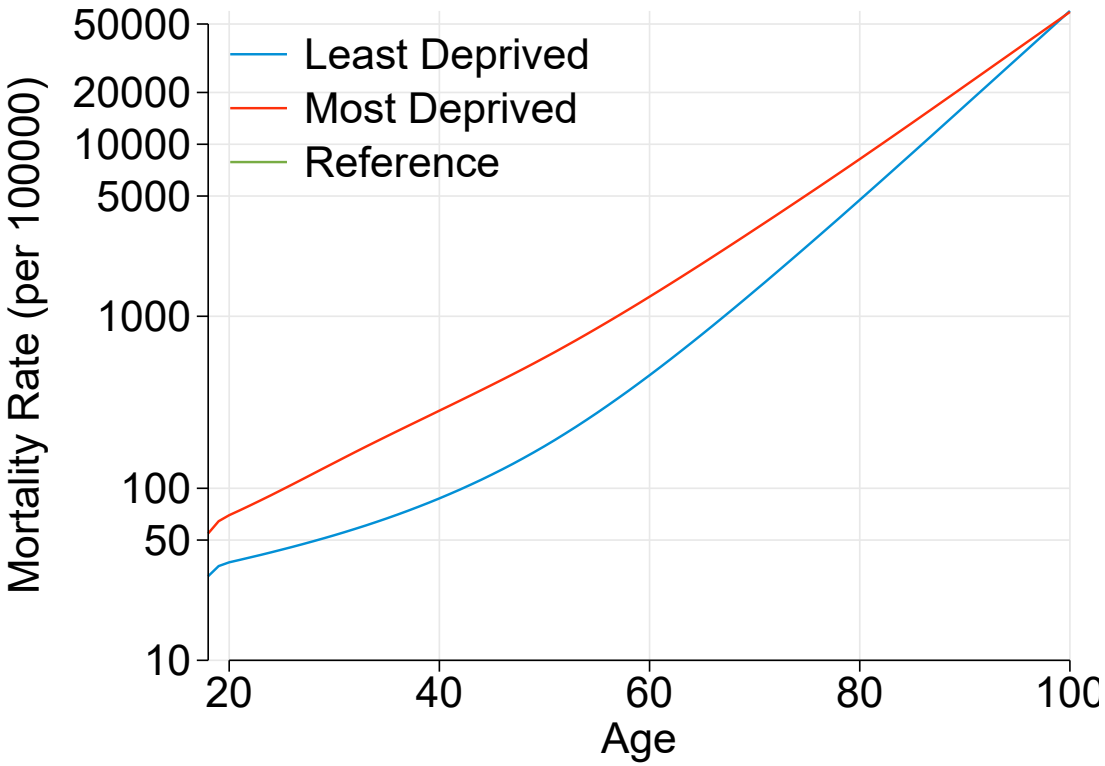




Example

- Men diagnosed in England with Melanoma.
- Compare those who live in most deprived areas with least deprived areas.



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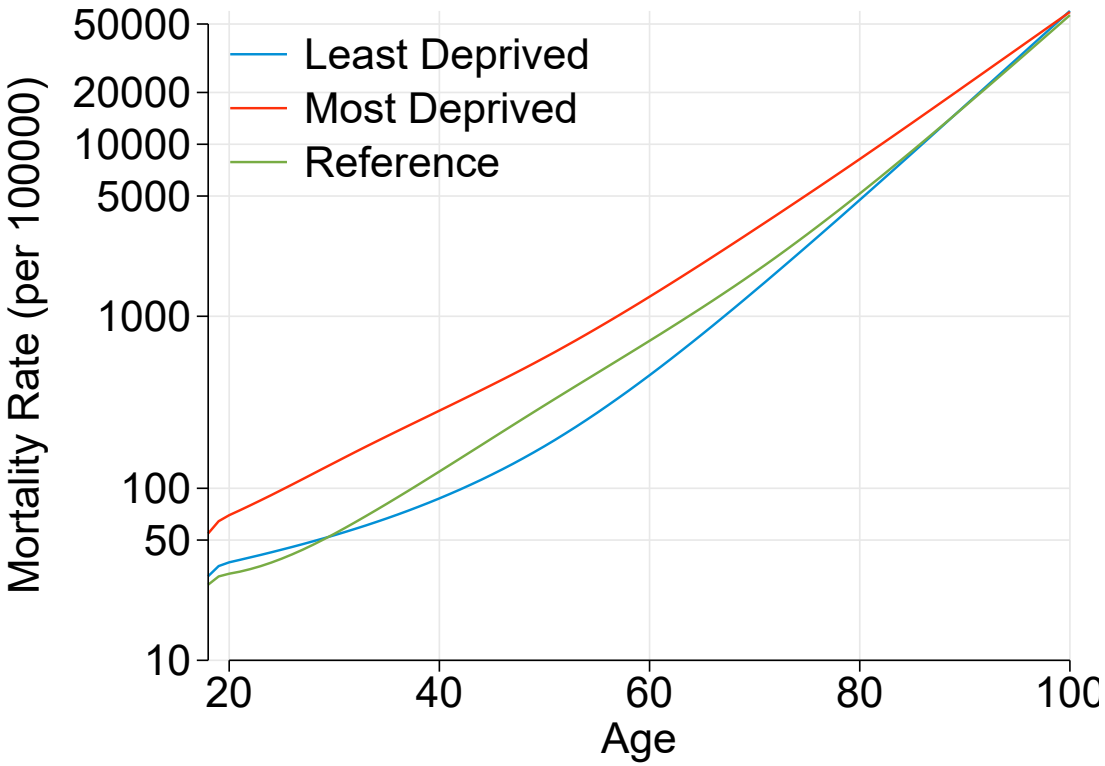


All-cause survival

Reference Population

$S^{**}(t|Z_i)$ - expected survival in the reference population.
$h^{**}(t|Z_i)$ - expected mortality rate in the reference population.

- Marginal all-cause survival (study population)

$$\bar{S}(t|Z) = \frac{1}{N}\sum_{i=1}^{N} w_i S^{*}(t|Z_i)\widehat{R}(t|Z_i)$$

- Marginal all-cause survival using reference expected survival.

$$\bar{S^R}(t|Z) = \frac{1}{N}\sum_{i=1}^{N} w_i S^{**}(t|Z_i)\widehat{R}(t|Z_i)$$

Crude Probabilities of death due to cancer

- Crude probability of death due to cancer (study population).

$$\bar{F}_c(t|Z) = \frac{1}{N}\sum_{i=1}^{N} w_i \int_0^t S^*(u|Z_i)\widehat{R}(u|Z_i)\widehat{\lambda}(u|Z_i)du$$

- Crude probability of death due to cancer (using reference population).

$$\bar{F}_c^R(t|Z) = \frac{1}{N}\sum_{i=1}^{N} w_i \int_0^t S^{**}(u|Z_i)\widehat{R}(u|Z_i)\widehat{\lambda}(u|Z_i)du$$

- Note if $S^*(u|Z_i) = 1$ or $S^{**}(u|Z_i) = 1$ for all Z_i, this reduces to $1 - \bar{R}(t|Z)$.

Crude Probabilities of death due to other causes

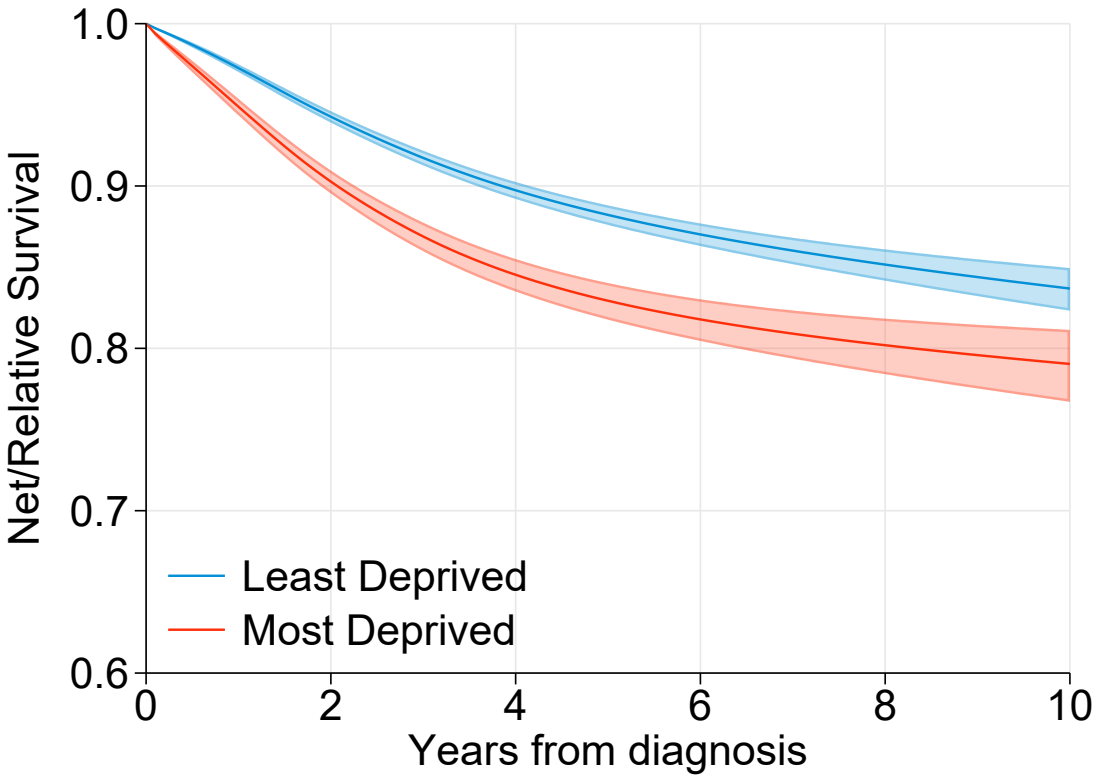
- Crude probability of death due to other causes (study population).

$$\bar{F}_o(t|\boldsymbol{Z}) = \frac{1}{N}\sum_{i=1}^{N} w_i \int_0^t S^*(u|\boldsymbol{Z}_i)\widehat{R}(u|\boldsymbol{Z}_i)h^*(u|\boldsymbol{Z}_i)du$$

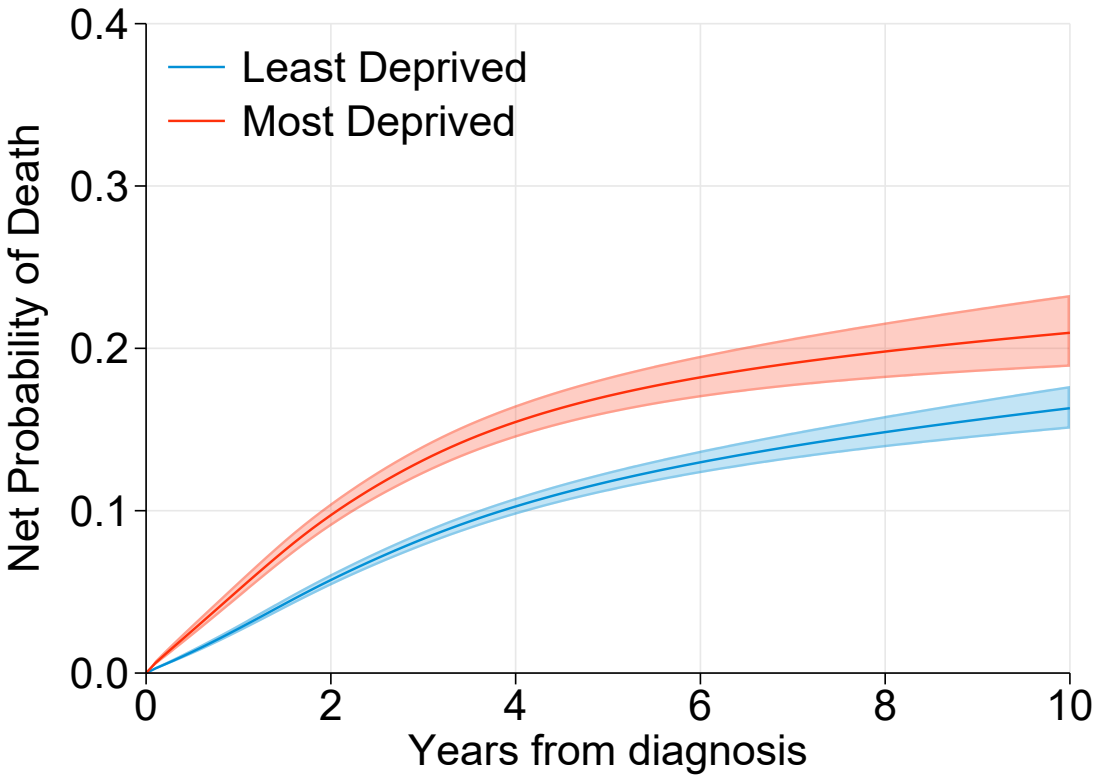
- Crude probability of death due to other causes (using reference population).

$$\bar{F}_o^R(t|\boldsymbol{Z}) = \frac{1}{N}\sum_{i=1}^{N} w_i \int_0^t S^{**}(u|\boldsymbol{Z}_i)\widehat{R}(u|\boldsymbol{Z}_i)h^{**}(u|\boldsymbol{Z}_i)du$$

Net Probability of Survival



Net Probability of Death



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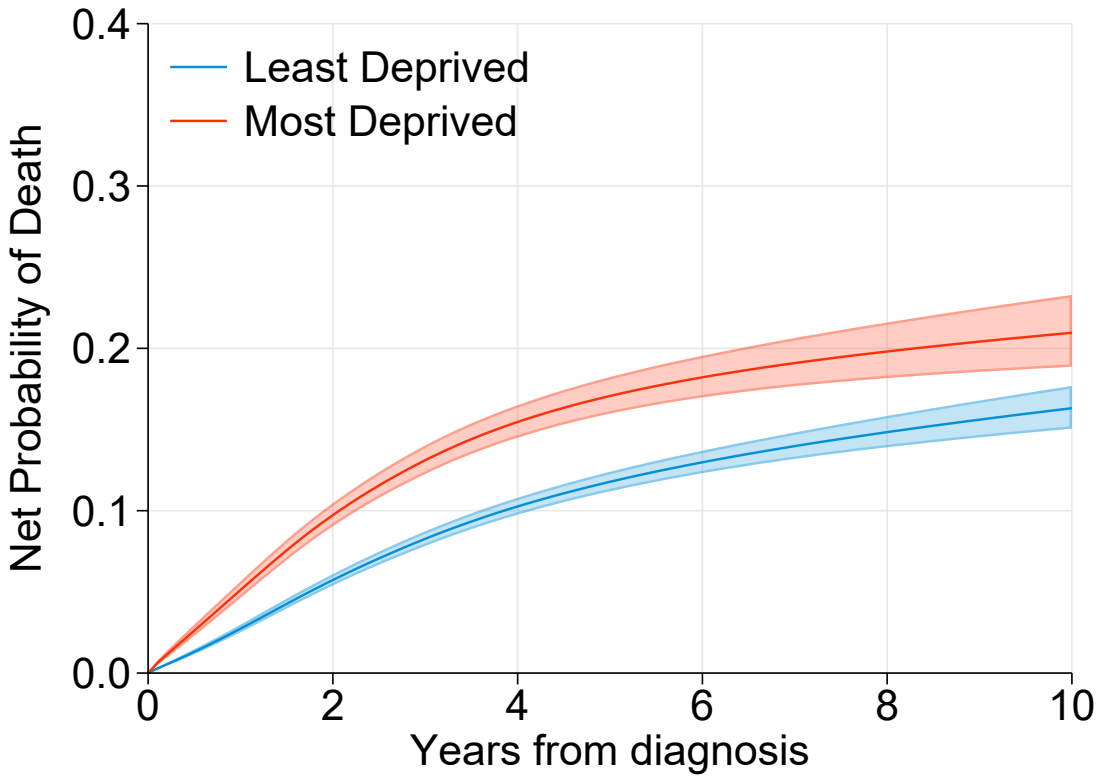
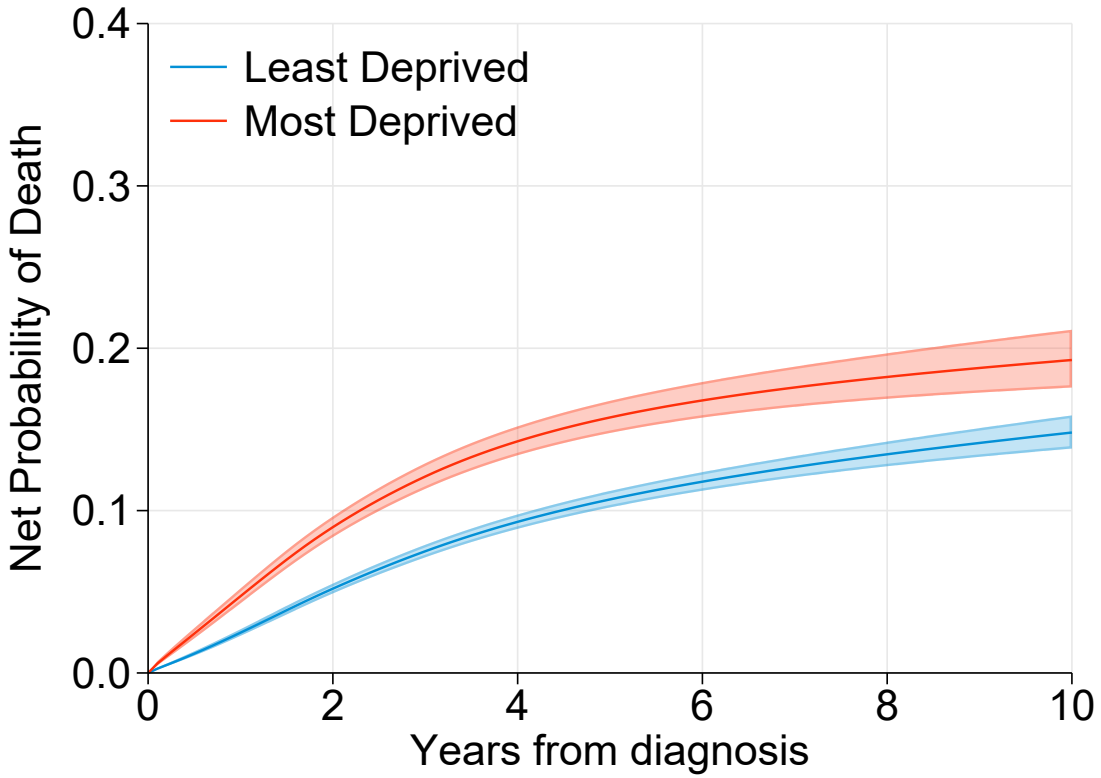


Age Standardization: Internal

Fair Comparison: ✗

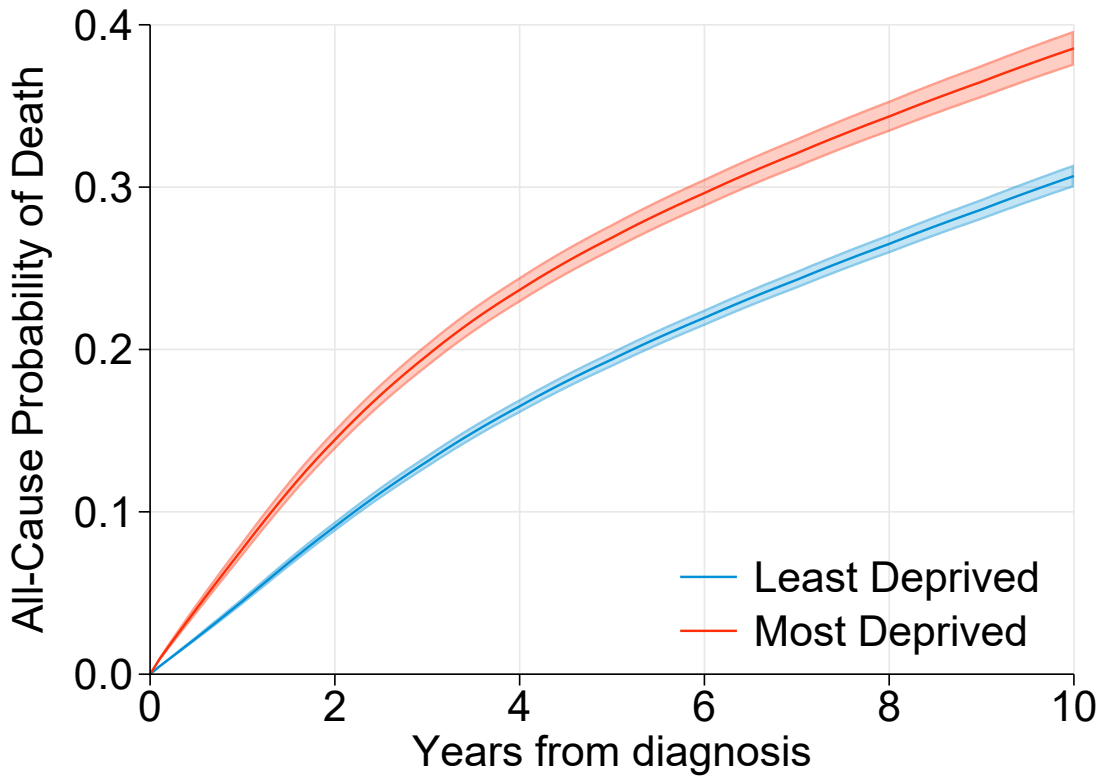
Net Probability of Death



Age Standardization: ICSS

Fair Comparison: ✓

All-cause Probability of Death



Age Standardization: Internal

Expected Rates: Separate

Fair Comparison: ✗

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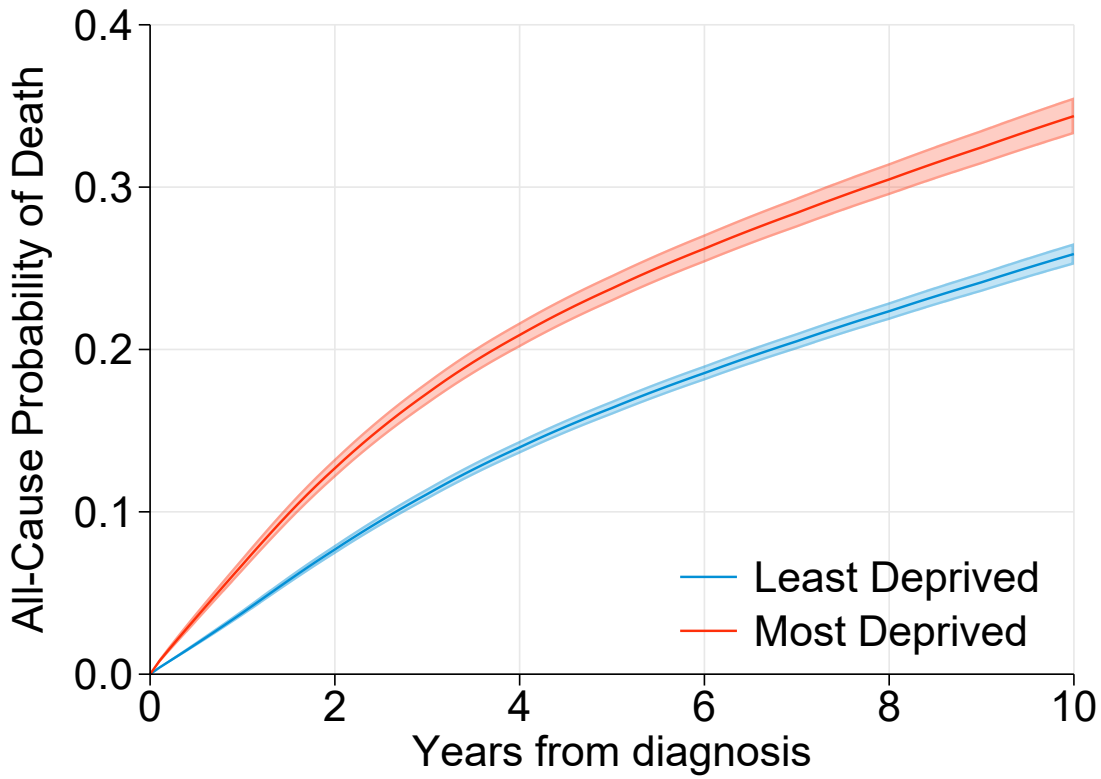

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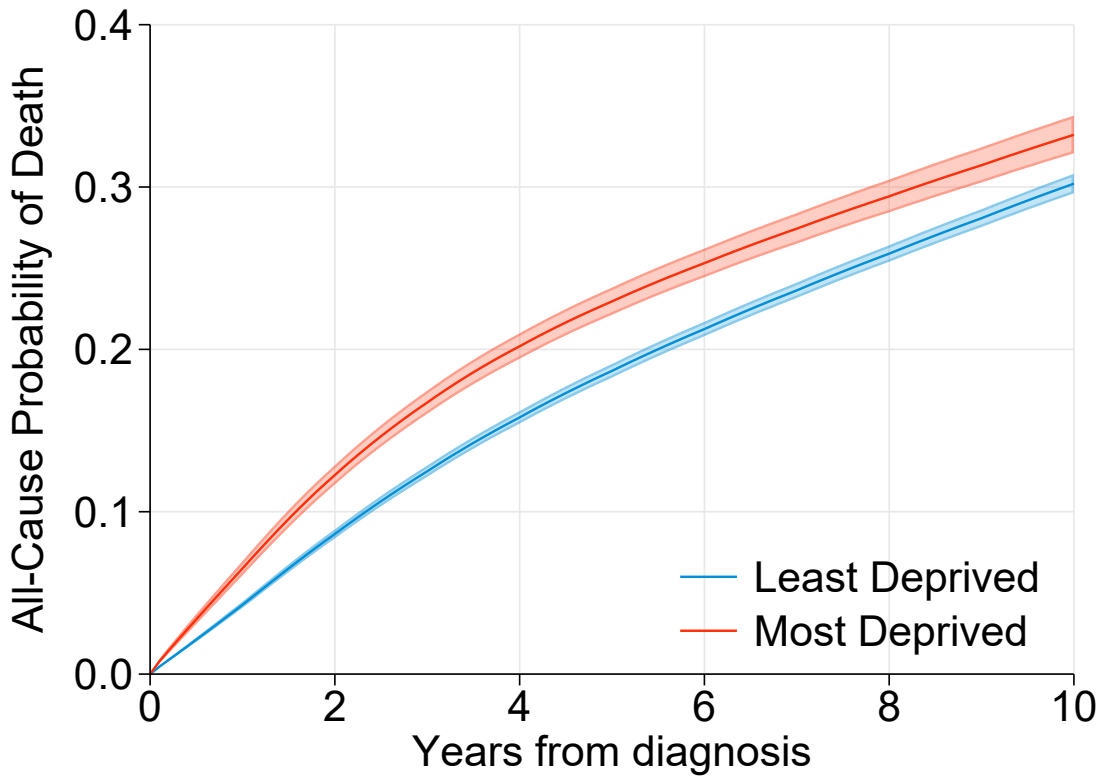
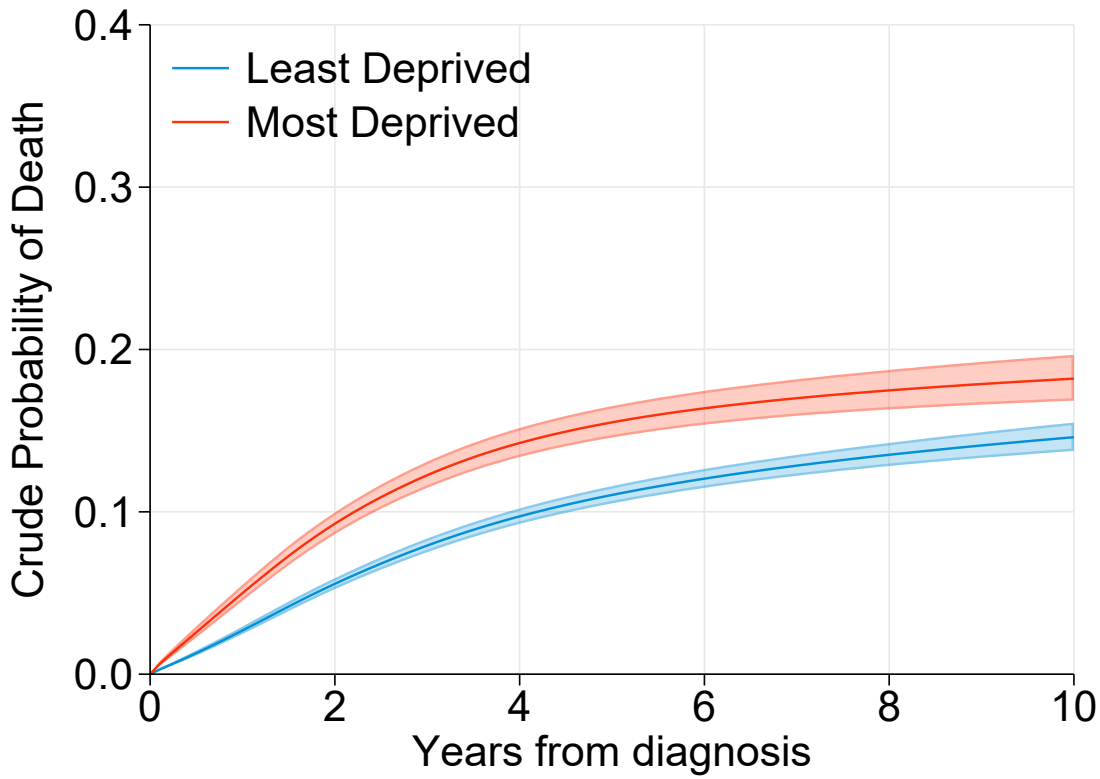


Age Standardization: ICSS

Expected Rates: Reference

Fair Comparison: ✓

Crude Probability of Death



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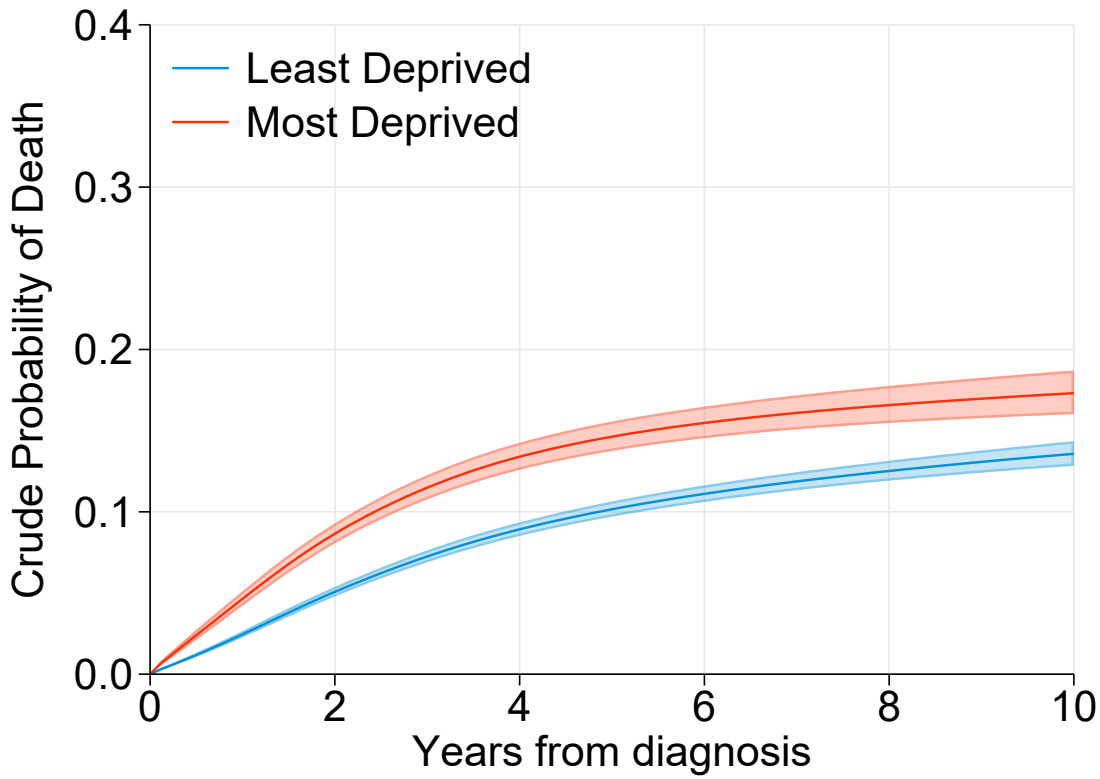

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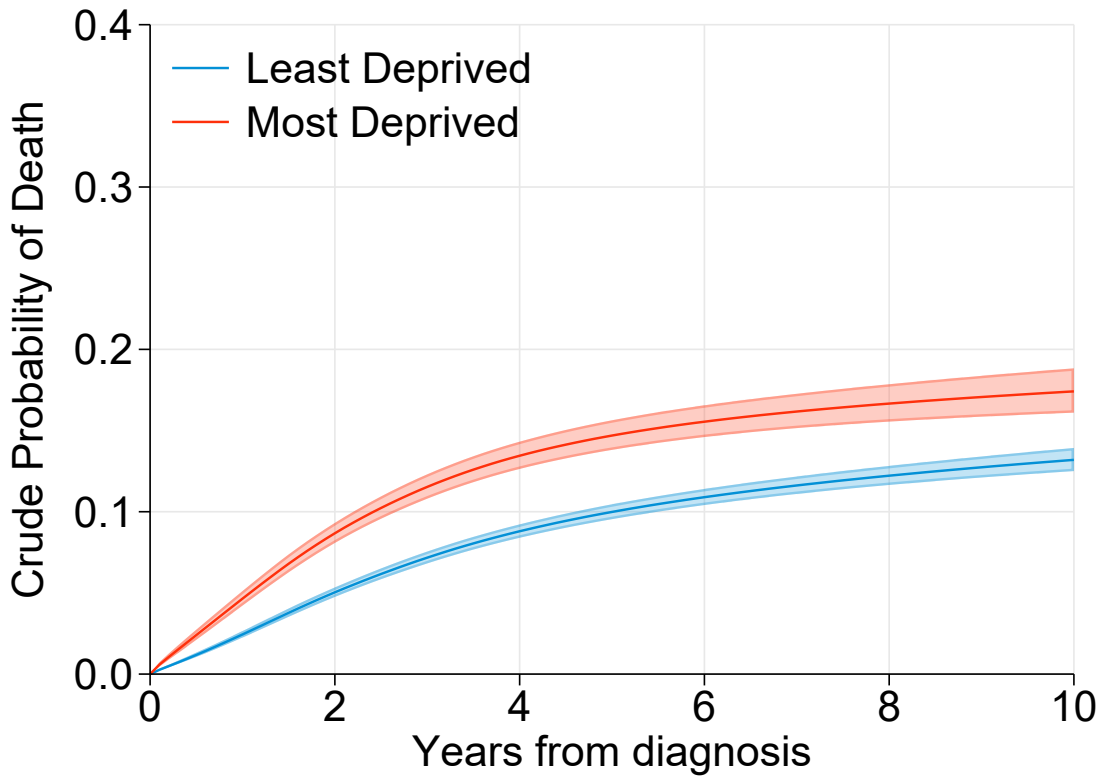


Age Standardization: ICSS

Expected Rates: Reference

Fair Comparison: ✓

Choice of Hypotheticals

Net Probability of Death

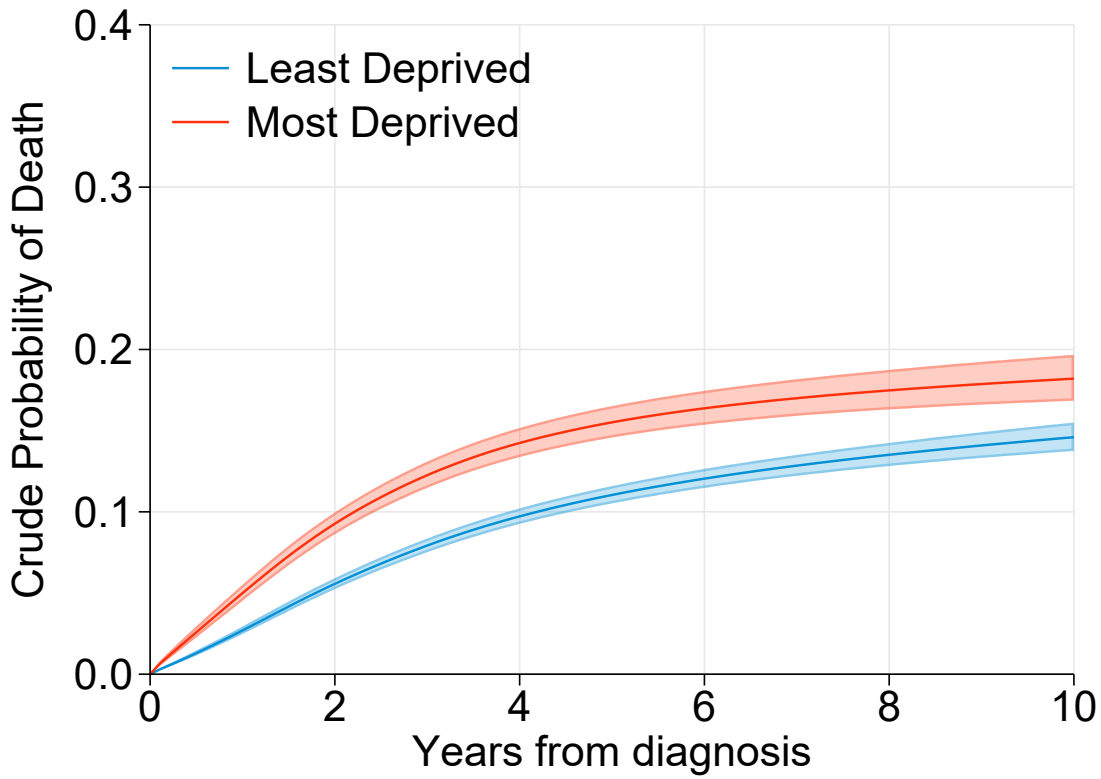
1. Age distribution is that of reference.
2. Mortality rate due to other causes is zero

All-cause/Crude Probability of Death

1. Age distribution is that of reference.
2. Mortality rate due to other causes is that of reference.

- In some situations it is useful to make one group non-hypothetical.
  - Standardize to age distribution of particular group.
  - Use expected mortality rates of particular group.

Crude Probability of Death



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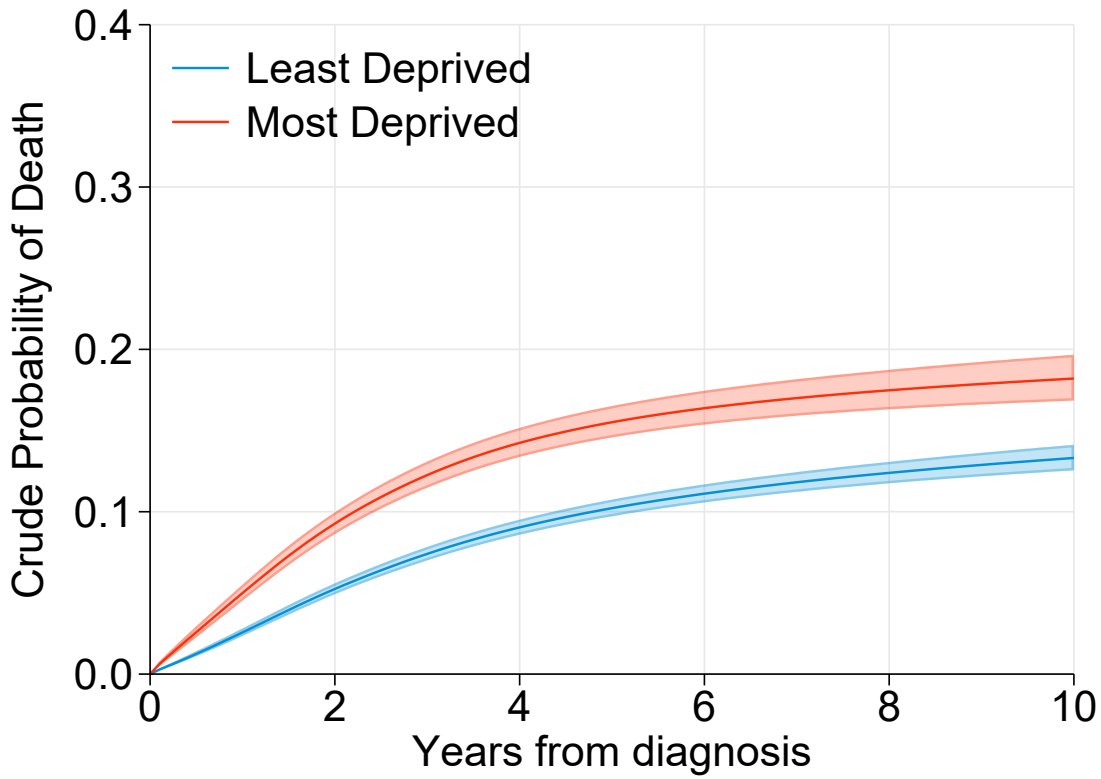
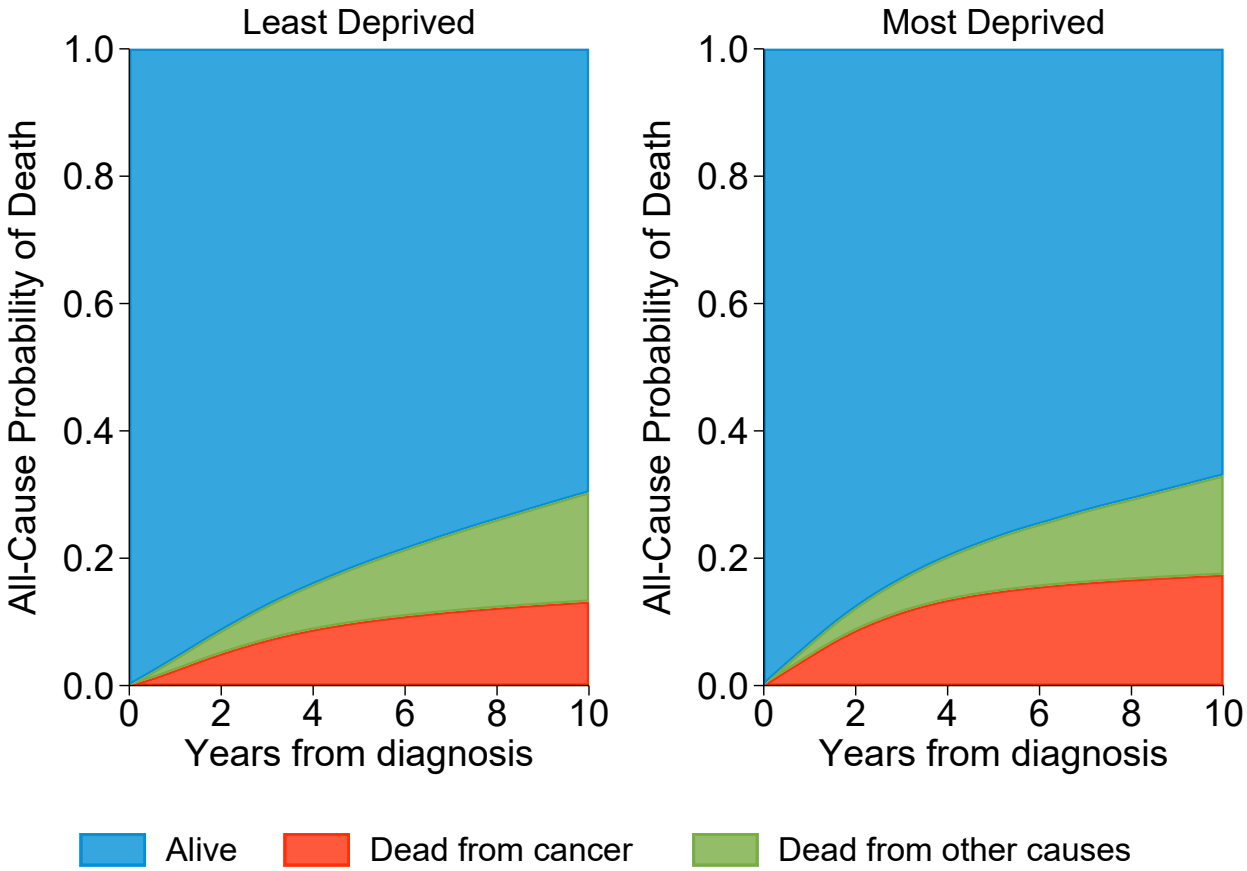


Age Standardization: Most Deprived

Expected Rates: Most Deprived

Fair Comparison: ✓

Stacked Plots



- Reference Adjusted All-Cause Survival
- Reference Adjusted Crude Probability of Death

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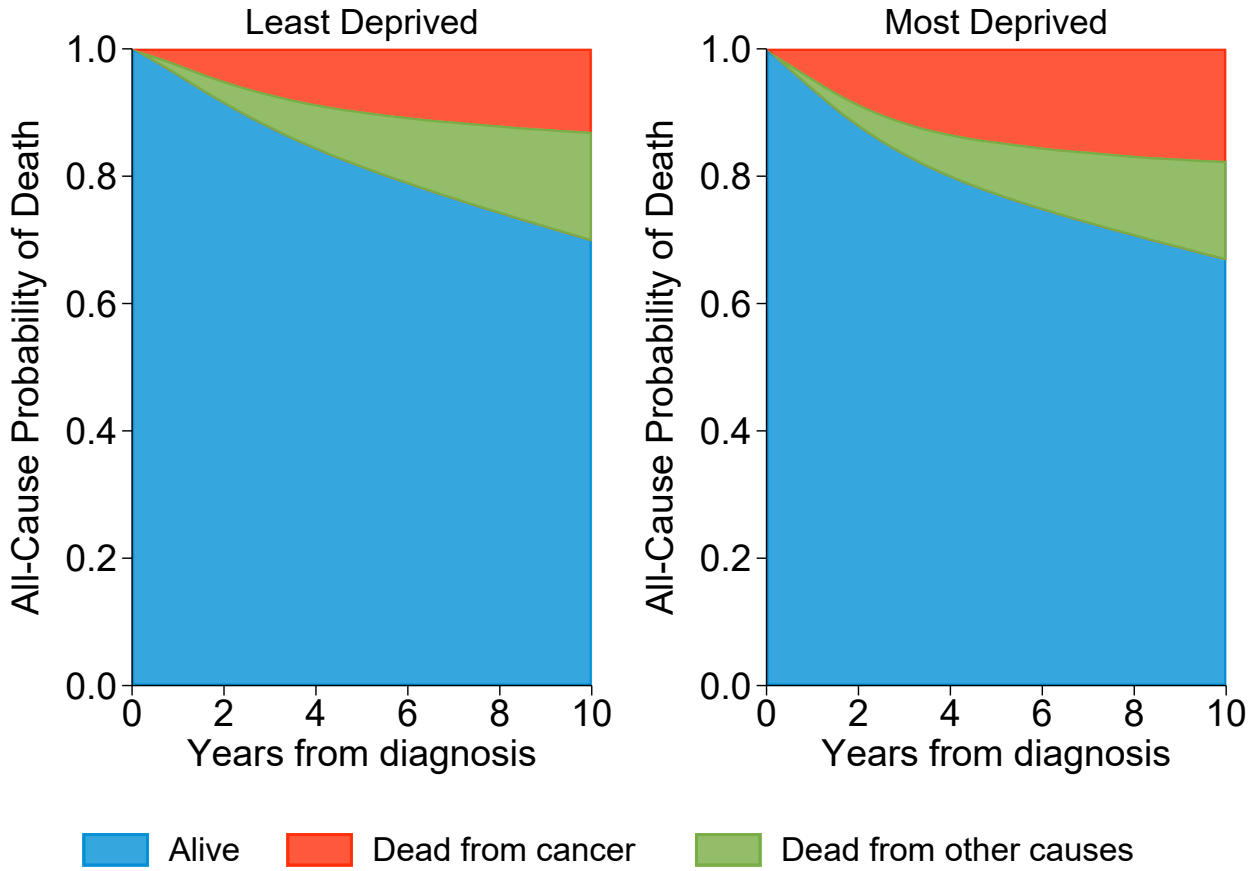

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Summary

- Possible to make fair comparisons using all-cause or crude probabilities.
  - Need to age standardize
  - Need to use reference expected mortality rates.
- Useful alternative/complement to marginal net survival.
- Possible using modelling or life tables.
- Need to think about which age distribution to standardize over.
- Need to think which reference expected rates to use.