A Model for Marginal Relative Survival

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Abstract

Background: When quantifying the probability of survival in cancer patients using cancer registry data, it is common to estimate marginal relative survival, which under assumptions can be interpreted as marginal net survival. Net survival is a hypothetical construct giving the probability of being alive if it was only possible to die of the cancer under study and enables comparisons between populations with differential mortality rates due to other causes. Marginal relative survival can be estimated non-parametrically (Pohar Perme estimator) or in a modeling framework. In the modeling framework, even when just interested in the marginal survival in a population it is necessary to model covariates that affect the expected mortality rates (e.g. age, sex and calendar year). The marginal relative survival function is then obtained through regression standardization. Given that these covariates will generally have non-proportional effects, the model can become complex even before other exposure variables are considered.

Methods: This paper proposes a flexible parametric model incorporating restricted cubic splines that directly estimates marginal relative survival and thus removes the need to model covariates that affect the expected mortality rates. In order to do this the likelihood needs to incorporate the marginal expected mortality rates at each event time taking account of informative censoring. In addition time-dependent weights need to be incorporated into the likelihood. An approximation is proposed using data expansion which enables the marginal model to be fitted using standard software. Additional weights can be incorporated when needing to standardize to an external reference population.

Results: The methods are illustrated using English cancer registration data. In addition a simulation study has been performed comparing estimation using a non-parametric approach, regression-standardization and the new marginal model showing that the method has good statistical properties.

Conclusion: The approach enables estimation of standardized marginal relative survival without the need to model covariates that affect the expected mortality rates and thus avoids potential model misspecification problems.

Full Text

This preprint is available for download as a PDF.

Figures

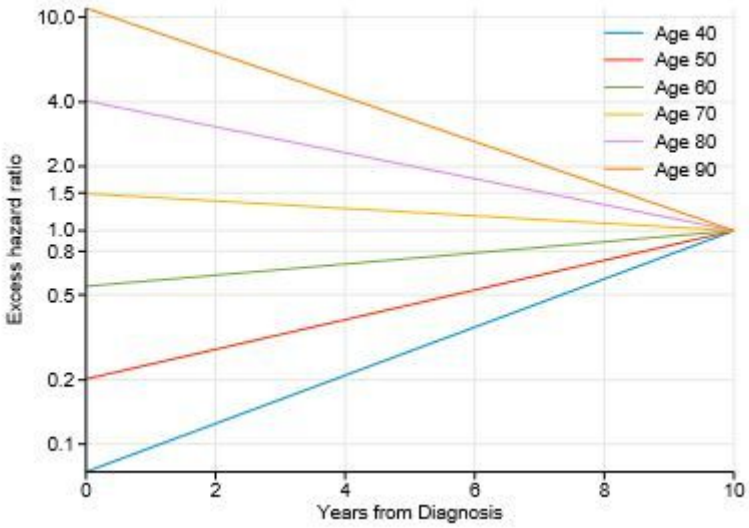

Figure 1

rue excess hazard ratio for selected ages. The mean age at diagnosis, 66, is the reference.

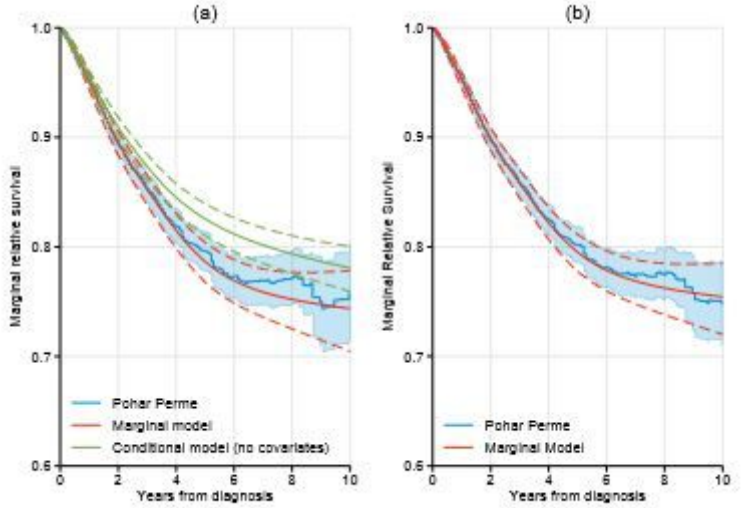

Figure 2

Estimates of marginal relative survival: Panel (a) shows internally age-standardized estimates using the non-parametric Pohar Perme method and the marginal relative survival model. Also shown is the estimate from the conditional relative survival model with no-covariates. Panel (b) shows externally age-standardized estimates from the non-parametric Pohar Perme method and marginal relative survival model.

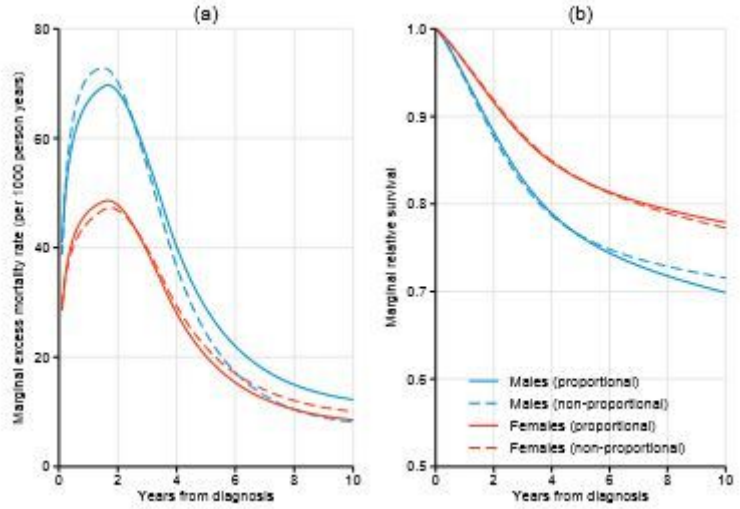

Figure 3

Estimated marginal hazard function (panel (a)) and marginal relative survival functions (panel (b)) for proportional and non-proportional models. Estimates have been standardized to the age distribution of the males.

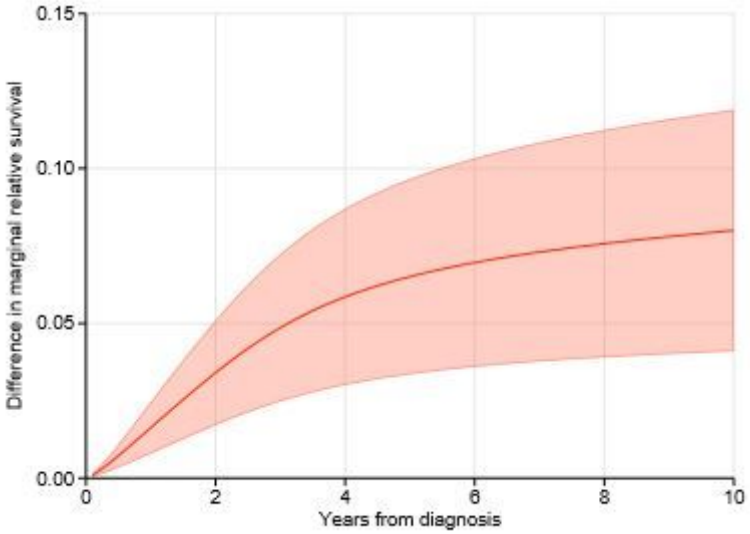

Figure 4

Difference in marginal relative survival comparing females to males.