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Estimating relative survival: An analysis of bias introduced by outdated life tables

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Background

- relative survival defined ...
  - The ratio of the observed survival in a group of people diagnosed with cancer to the expected survival of a comparable group of people—*free from the cancer under study*—in the general population. (Ederer 1961)
- population life tables corresponding to the most recent calendar years of cancer patient follow-up may not be readily available
- practice has been to extend the latest available life tables to cover the remaining years for which an estimate of expected survival is required

Background continued

- assumption is that any bias introduced into the estimation of expected survival, and hence, into the relative survival ratio (RSR), will be negligible
- however, published empirical studies of this bias are scarce
- current presentation based on:
  - Ellison LF. Estimating relative survival for cancer: An analysis of bias introduced by outdated life tables. Health Reports 2014; 25(2):13-19
  - http://www.statcan.gc.ca/pub/82-003-x/2014002/article/11903-eng.pdf

Objectives

- to empirically examine the impact of using historical rather than current life tables to estimate expected survival in calculations of RSRs

- to study the various factors which play a role in determining the size of the resulting bias in RSRs

Data sources

- incidence data are from the Canadian Cancer Registry
  - a dynamic, person-oriented, population based database compiled from reports from each provincial/territorial cancer registry and maintained by Statistics Canada
  - October 2011 file version (includes cases from 1992 to 2009)
- mortality follow-up was carried out by record linkage to the Canadian Vital Statistics Death Database (excluding deaths registered in the province of Quebec), and from information reported by the provincial/territorial cancer registries
- life tables from Statistics Canada's Demography Division

Analytical techniques

- Predicted RSRs for 2005-2007 were derived using life tables centred on the 2006 Census of Population to estimate expected survival
  - these RSRs were considered the *gold standard*
  - Ederer II method used for expected survival
- the analysis was repeated using life tables centred on the 2001 Census and on the 1996 Census
- differences in percentage units between the gold standard RSRs and the corresponding RSRs ascertained through the use of earlier life tables were determined

Main results

- deriving expected survival from life tables 5 years out of date resulted in increases in RSRs for all cancers
- these increases became greater with lengthening survival duration
  - e.g., increases in 1-, 5- and 10-year RSRs were 0.2, 0.8 and 1.7 percentage units, respectively, for all cancers combined
- increases in 5-year RSRs were highest for prostate (2.0) and bladder cancer (1.6); among males (1.2); and among people aged 75 to 99 at diagnosis (1.9 overall)
- differences were approximately double when life tables 10 years out-of-date were used

Prostate cancer results

- using life tables 5 years out-of-date
  - 5-year RSR, all ages: 2.0 percentage unit increase
  - 5-year RSR, ages 75-99: 4.6
  - 10-year RSR, all ages: 4.7

- using life tables 10 years out-of-date
  - 10-year RSR, all ages: 10.2

Role of changes in life expectancy

- bias was related to gains in life expectancy
  - between 2000-2002 and 2005-2007, life expectancy in Canada rose by 1.3 years for males, and by 0.8 years for females
  - increases between 1995-1997 and 2005-2007 were twice as large for males (2.8 years) and females (1.7 years)

- gains in individual age-specific probabilities of surviving from one age to the next over these periods rose with advancing age among people aged 55 or older

Complex interrelationships

- strongest bias was observed for prostate cancer
  - a male-specific cancer with an older-than-average mean age at diagnosis
- yet very little bias was associated with esophageal cancer
  - has a male-dominated sex distribution and a slightly higher mean age at diagnosis

Cancer prognoses

- cancers with a better prognosis tended to be associated with relatively large differences, while cancers with a poorer prognosis tended to be associated with relatively small differences
- hypothetical example
  - Observed survival: cancer I—80%, cancer II—10%
  - Expected survival (outdated): cancer I and cancer II—80%
  - Expected survival (current): cancer I and cancer II—82%
  - Bias: cancer I—(80/80-80/82) = 2.4 percentage units
  - Bias: cancer II—(10/80-10/82) = 0.3 percentage units

Cancer prognoses

- biggest exceptions were thyroid, Hodgkin lymphoma and cervix, all of which had a good-to excellent prognosis and small differences
  - mean ages at diagnosis—particularly HL—were the lowest among the cancers studied by a wide margin

- less bias emerges when expected survival derived from the various life tables is more similar, and this can outweigh prognosis as a determinant of the magnitude of the bias

Period versus cohort analysis

- RSRs derived using period analyses rely exclusively on expected survival data from the most recent period

- long-term estimates of relative survival based on the cohort method require expected survival data spanning many more years

- period survival estimates would be affected to a greater extent than cohort based estimates by the compensatory use of historical life tables

Life tables at Statistics Canada

- no delay between the production of life tables and the availability of the data on which they are based

- starting with the 2006-2008 version, life tables are now produced on an annual basis

- current life table methodology has been retroactively applied (unpublished) to all single calendar years since the early 1990s (start of the Canadian Cancer Registry)

Conclusions

- Reliance on historical rather than current expected survival data in calculating RSRs for cancer may lead to consequential overestimation of survival.

- The increasing adoption of period survival methodology underscores the need for up-to-date information on expected survival.