

Trends in the Lifetime Risk of Developing Cancer in Ontario, Canada

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Outline

- 1 Background
- 2 Method
- 3 Results: Projections
- 4 Results: Lifetime Risk Estimates
- 5 Sensitivity Analysis
- 6 Conclusion and Discussion

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Background

- The lifetime risk reflects the risk over the course of a person's lifetime.
- The lifetime risk of developing cancer of 1 in 2 is a commonly cited cancer statistics.
- The risk is estimated based on a population's experience with developing cancer or dying from cancer.
- Cancer incidence and mortality rates are closely monitored to track the burden of cancer and its evolution in populations in Ontario.

Research Objectives

- 1) Calculate the estimates of the lifetime risk of developing cancers in Ontario for a birth cohort born from 50s to 80s.
- 2) Compare the estimates using current probability method with cumulative risk method.
- To do this, one needs to project cancer incidence and mortality rates, as well as the population growth up to year of 2067.

Data Sources

- Cancer data from year 1969 to 2012 were retrieved from the Ontario Cancer Registry, a population-based registry of all cancer cases and deaths in Ontario.
- Forecasted population counts by five-year age groups from age 0-4 to 90+ for the years 2013 to 2041 were obtained from the Ontario Ministry of Finance.

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Age-Period-Cohort Regression Model for Projections

$$R_{a,p} = (A_a + P_p + C_c + D_p)^5$$

The APC model is modified slightly:

- Instead of standard log link, a “power 5” link function is used
- The coefficients are to be estimated for age (A), period (P), cohort (C) and drift (D)
- Due to colinearity among age, period and cohort, linear effects of period and cohort cannot be estimate simultaneously – a common linear trend (“drift”) is estimated instead
- Predictions assume future period effects are equal to last estimated effect in the fitted model

Prediction of Population

- “Spline smoothing” is used to predict population counts from year 2043 to 2067;
- The method applies spline function to fit a smooth curve to the set of observed data points.

Lifetime Risk Estimate

Current probability method to estimate the lifetime risk

$$\hat{S}_0(i) = \exp\left(-\sum_{j=0}^i (\lambda_j)\right)$$

$$\lambda_i = r_i + m_i - d_i$$

$$l_i = \hat{S}_0(i) \times r_i \times \frac{1 - \exp(-\lambda_i)}{\lambda_i}$$

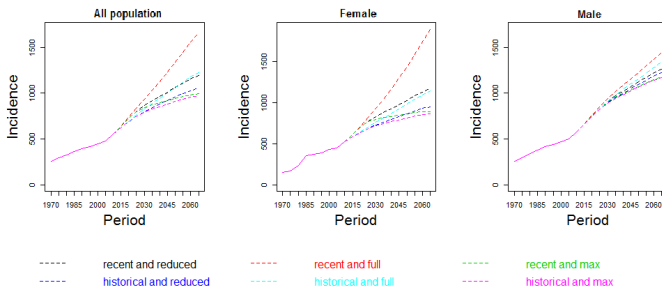
- l_i : the contribution to the life time risk at age group i
- $\hat{S}_0(i)$: the probability of being at risk (i.e. alive and without a previous diagnosis of cancer) at age group i
- λ_i : the hazard of no longer being alive and cancer free
- r_i : incidence of all cancers
- m_i : all-causes mortality rates
- d_i : cancer mortality rate

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Results of Incidence Projections

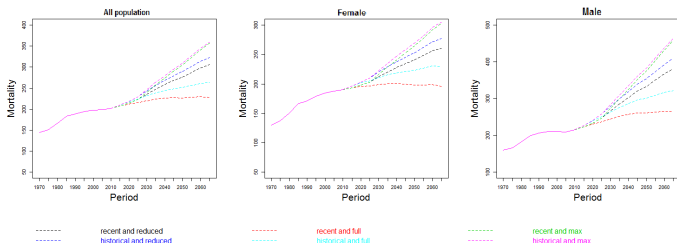
Figure: Incidence projections for all cancer combined (1968-2067)



- Predicted cancer incidences increase with years
- Men have a higher cancer incidence than women

Results of All-Cancer Mortality Projections

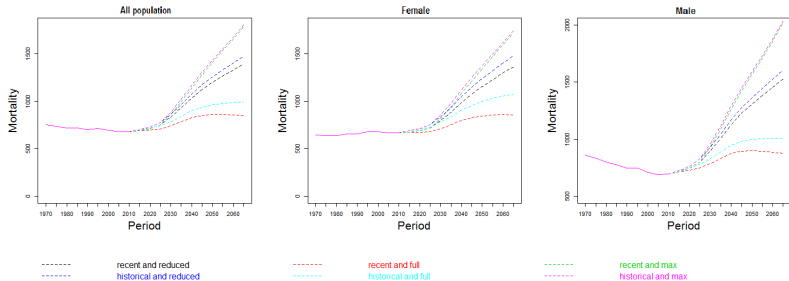
Figure: All cancer mortality predictions (1968-2067)



- Predicted mortalities varies by the options being chosen
- The “recent reduced” option was chosen

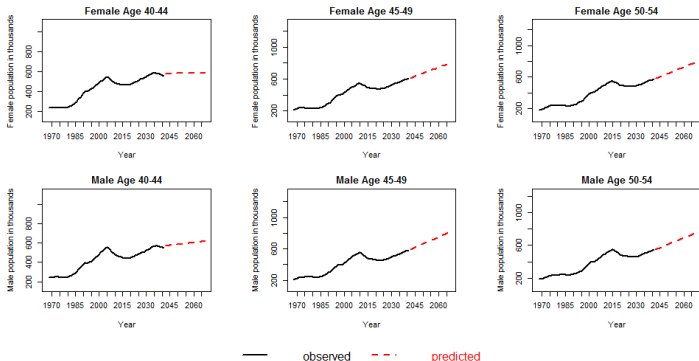
Results of Mortality Projections

Figure: All cause mortality predictions (1968-2067)



- The low option was chosen to reflect the improvement in mortality seen over recent years

Population growth over years by selected age groups

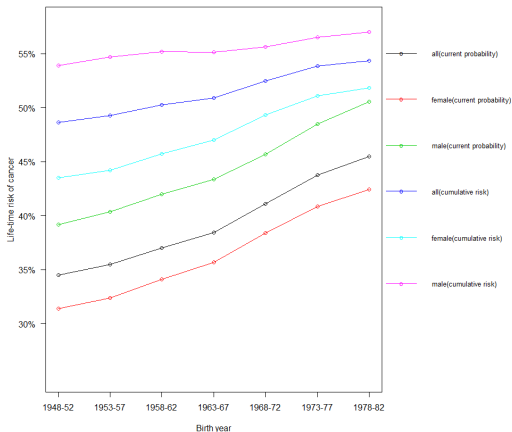


- A moderate increase in population is assumed.

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The comparison for the lifetime risk estimations

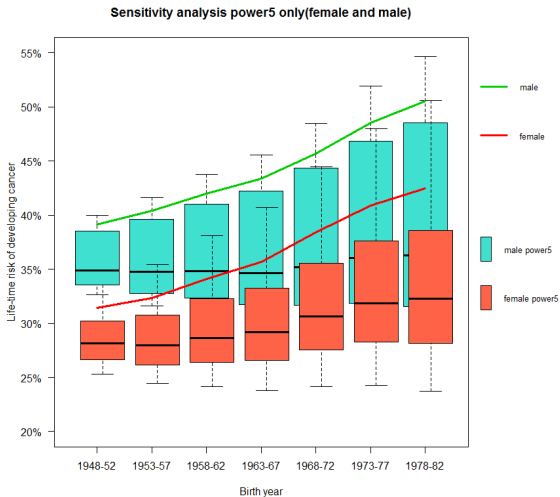


- Comparing with the current probability method, the cumulative probability method tends to overestimate the lifetime risk of cancer.

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Sensitivity Analysis with Different Model Assumptions



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Conclusion and Discussion

- Cumulative risk method tends to overestimate the lifetime risk of cancer.
- The lifetime risk of having cancer has increased from 0.34 to 0.44 for birth cohorts born in 1948-52 and 1978-82, respectively.
- The increase in lifetime risk may be attributed to: early detection of cancer, lower mortality due to causes other than cancer, the increasing life expectancy over time, and possibly changes in the prevalence of cancer risk factors over time.

Selected References

- Ahmad, A., Ormiston-Smith, N. and Sasieni, P. 2015 Trends in the lifetime risk of developing cancer in Great Britain: comparison of risk for those born from 1930 to 1960. *British Journal of Cancer*, 112, 943947.
- Sasieni, P., Shelton, J., Ormiston-Smith, N., Thomson, C. and Silcocks, P. 2011 What is the lifetime risk of developing cancer? : the effect of adjusting for multiple primaries. *British Journal of Cancer*, 105, 460-465.