

Breast Cancer Mortality After Screening Mammography in British Columbia Women

Andrew J. Coldman, Ph.D.

Norm Phillips, M.Sc.

Lisa Kan, M.Sc.

Linda Warren, M.D.

**Population & Preventive Oncology
BC Cancer Agency**



Why Analyse Service Screening Data?

There are important questions to which screening trials may not provide a clear answer. For example:

- Age at initiation and cessation of screening.
- Frequency of screening. Recommendations vary from annual, biennial, or triennial screening. How does efficacy change across this range?
- Screening of high risk. Do women at higher risk benefit more from screening?

In trying to answer questions such as these, data from service (usual or population) screening can be helpful.



Advantages and Disadvantages of Screening Trials

- **Advantages:** removes selection and assessment biases; well-specified interventions
- **Disadvantages:** large and difficult to fund, mount, and complete; participation may vary
- In contrast, service screening usually provides data on very large numbers of women who actually are screened. Such data offers an opportunity to explore the effects of screening in subgroups if biases can be accounted for.



A Simple Method To Analyse Screening Cohorts Using Population Data

A method (described by Sasieni) used to analyse screening effect in exposed cohorts is to calculate the expected number of deaths, $m(t)$,

$$m(t) = \int_0^t [1 - S(t - u)] \lambda(u + \text{age}) du,$$

where t is the time since started screening, age is the age of that time, and $\lambda(x)$ and $S(u)$ are the incidence and survival rates to be expected if these women had not been screened.



Applying This Method

In most cases the cohort is usually small and population rates for λ (*the incidence*) and S (*the survival*) are used.

In attempting to apply it to cases where screening is common, use of contemporary population rates are not appropriate since they will be biased due to the presence of large numbers of screened individuals.

Thus, there is a need to identify rates that are not biased by the presence of screened subjects.



Breast Screening in British Columbia

British Columbia has a population-based screening program (SMPBC) that was started in 1988. It consists of

- Mammography offered through one of 36 affiliated centres
- Self-referral by women
- Screening available free of charge
- Reminders at 12 months for 40–49 and at 22 months for 50+
- Centralized booking and follow-up
- Currently 262,000 women are screened per year



Applying the Approach to Data from British Columbia

We may attempt to estimate incidence and survival rates in the unscreened using the SMPBC database and the Provincial Cancer Registry as follows:

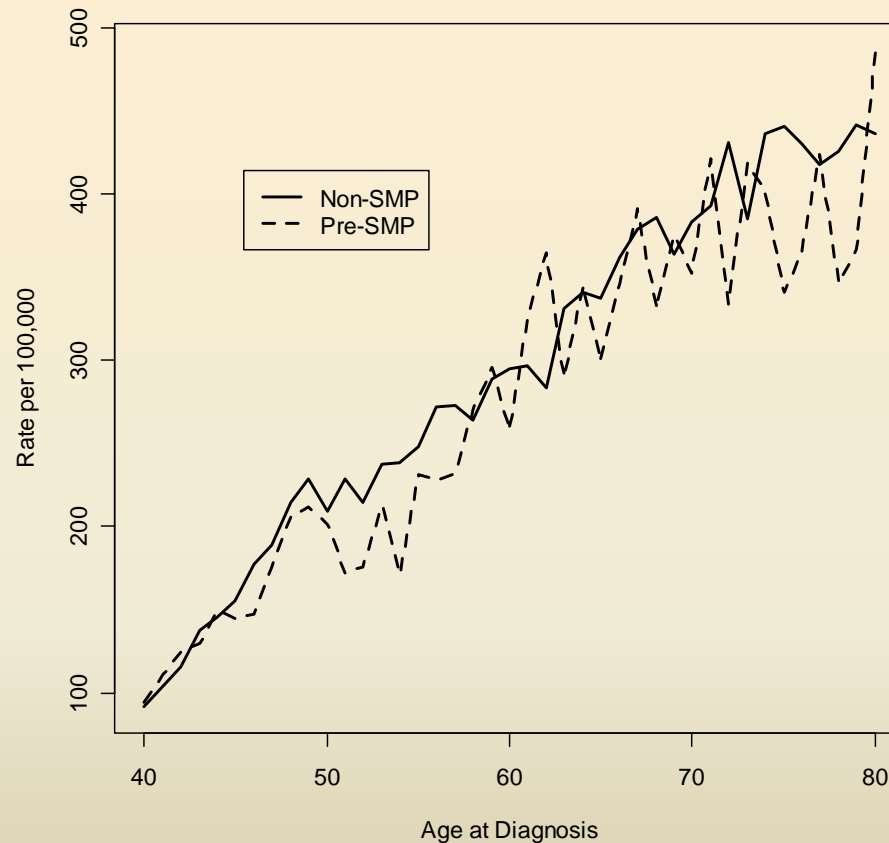
1. Use registry data from pre-SMPBC period (<1988).
2. Match Cancer Registry and SMPBC databases to identify data for contemporary non-participants in SMPBC.



Incidence Rate of Breast Cancer in British Columbia

Pre-SMP: period before SMPBC screening (1985–87)

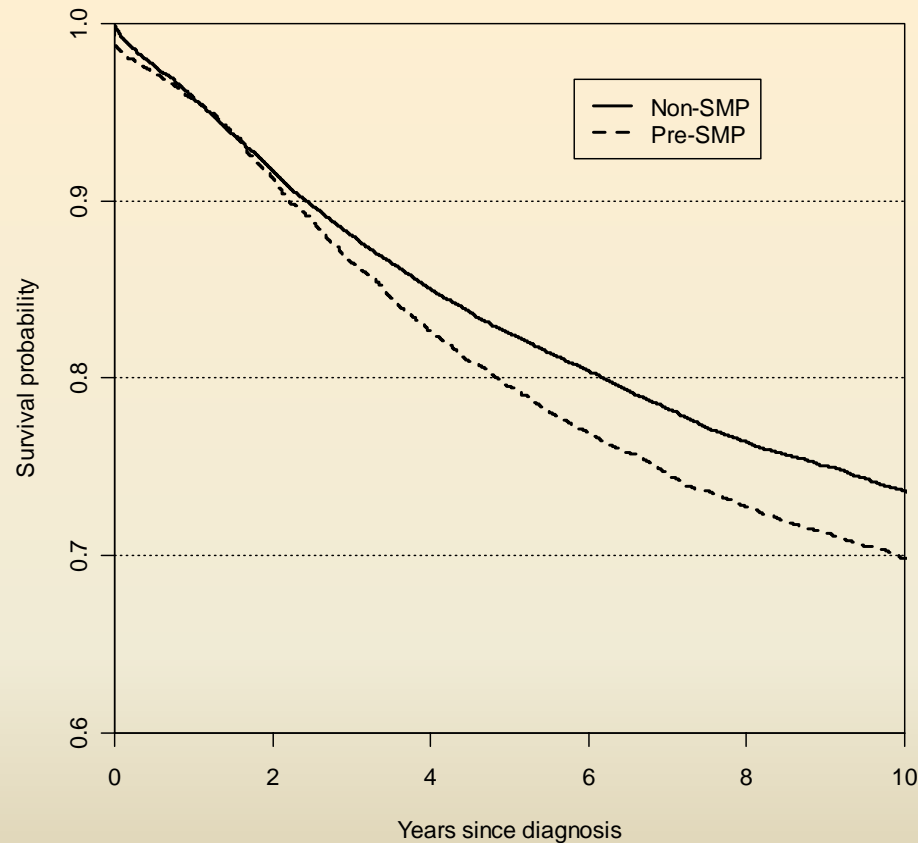
Non-SMP: non-participants in SMPBC (1988–2003)



Survival Rates for Breast Cancers in British Columbia:

Pre-SMP: before SMPBC started (1985–7)

Non-SMP: cancers diagnosed in women not in SMPBC (1988–2003)



Description of the SMPBC Cohort

- 598,721 women presented at an SMPBC clinic for screening between 1988 and 2003
- Average 3.7 screens per woman
- 46% were aged 40–49 at first screen
- 11,732 invasive and 2,515 in-situ cancers were diagnosed in the cohort
- 60% of invasive and 78% of in-situ cancers were screen-detected in cohort
- 19,913 breast cancers were diagnosed in British Columbia 1988–2003 outside of cohort



Application

We applied the Sasieni method to SMPBC data on women over the age of 40 entering the screening program in the period 1988–2003.

We identified the observed breast cancer mortality in the screened cohort using the cancer registry.

We used the incidence rate (λ) and survival rate (S) of unscreened women for 1998–2003 to calculate the expected breast cancer mortality in the screened cohort. A Cox regression was used to control for the effect of age, period, and SES of area of residence on (S).



Results: Observed, Expected Deaths, and Mortality Ratio

Age at First Screen	Observed Deaths	Expected Deaths	Mortality Ratio (95% CI)
40–49	202	333	0.61 (0.52, 0.71)
50–59	194	331	0.59 (0.50, 0.69)
60–69	213	353	0.60 (0.52, 0.70)
70+	147	235	0.63 (0.52, 0.75)



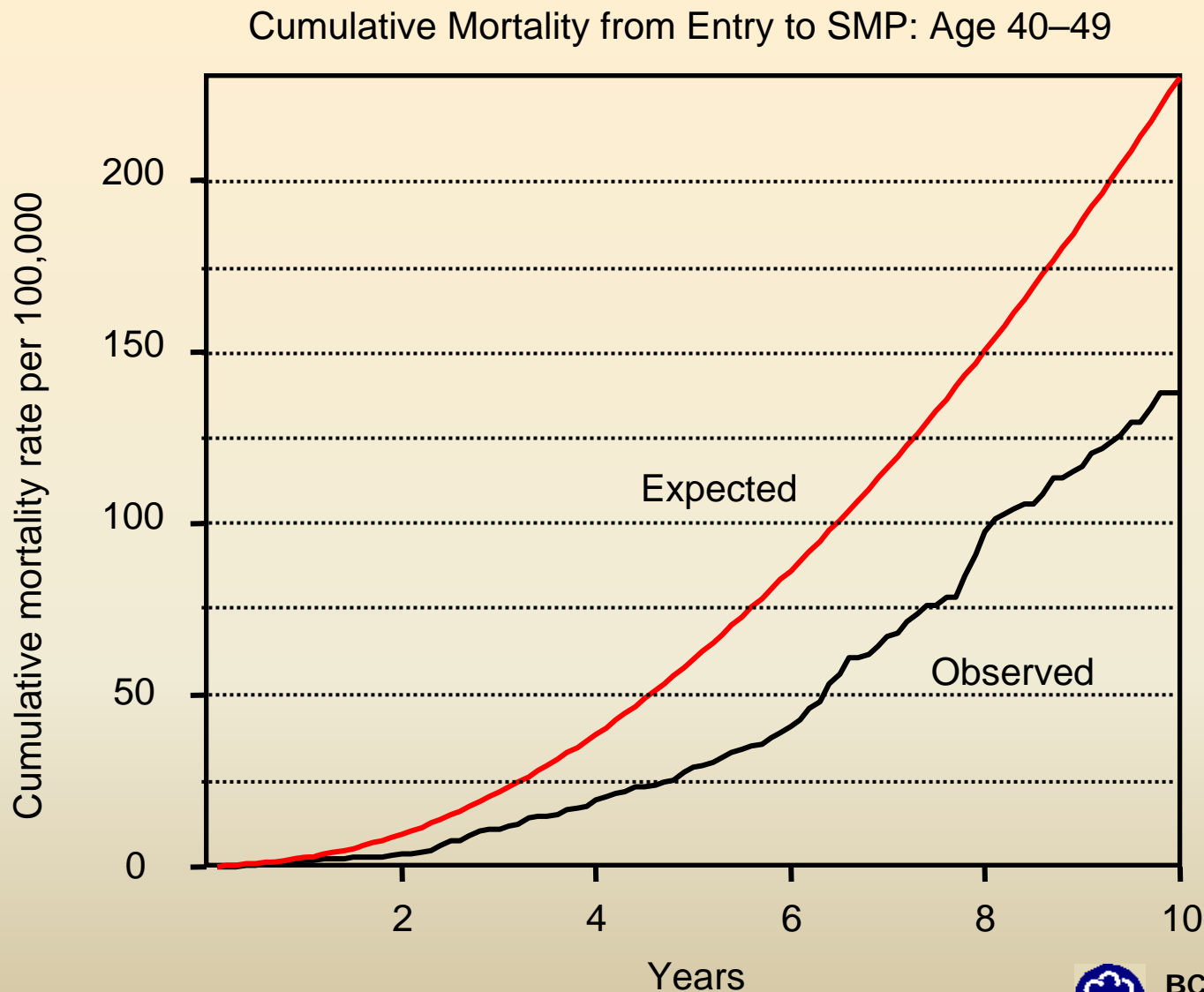
Results: Observed, Expected Deaths, and Mortality Ratio

* Excludes incident case <6 months

Age at First Screen	Observed Deaths*	Expected Deaths*	Mortality Ratio (95% CI)
40–49	195	307	0.64 (0.54, 0.74)
50–59	189	300	0.63 (0.53, 0.75)
60–69	209	324	0.65 (0.55, 0.76)
70+	143	211	0.68 (0.57, 0.81)



Observed and Expected Cumulative Breast Cancer Mortality Rates by Time Since First Screen for Women Aged 40–49 at First Screen



Adjusting for Self-Selection Effects

- Several authors have noted that women choosing not to be screened have greater breast cancer mortality than women not offered screening.
- This effect appears to arise through inferior survival associated with more advanced stage at diagnosis.
- Using data from published by Moss* non-participants are anticipated to have a 26% increased mortality rate compared to participants due to self-selection.
- We may use this to adjust the expected to obtain estimates of mortality reduction adjusting for self-selection.

*Moss, et al. J Epi Comm Hlth 1992 46:362-4.



Results: Expected Deaths and Mortality Ratio Adjusted for Self Selection

Age at First Screen	Expected Deaths	Adjusted Expected Deaths	Adjusted Mortality Ratio
40–49	333	265	<i>0.77</i>
50–59	331	264	<i>0.74</i>
60–69	353	281	<i>0.75</i>
70+	235	187	<i>0.79</i>



Conclusions

- This rather simple method allows exploration of disease-specific mortality in screened subjects without the need for a control group.
- The method may be used to explore the effects of screening at different ages to provide information on questions of screening effect.
- Applying it to British Columbia data indicates that ever-screened women have approximately 25% less expected mortality from breast cancer.
- The same proportional mortality reduction was seen among women 40–49 as among older women.

