Smoothed Lexis Diagrams: with Applications to Lung and Breast Cancer Trends in Taiwan

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Abstract

Background: Cancer surveillance research often begins with a rate matrix also called a Lexis diagram, of cancer incidence derived from cancer registry and census data. Lexis diagrams with 3 or 5-year intervals for age group and for calendar year of diagnosis are often considered. This simple smoothing approach suffers from significant limitations; important details useful in studying time trends may be lost in the averaging process involved in generating a summary rate.

Purpose: To construct a smoothed Lexis diagram and to indicate its use in cancer surveillance research. We illustrate our approach by studying the trends in lung and breast cancer incidence in Taiwan.

Method: Assuming the number of people newly diagnosed in a given year at a given age is Poisson with parameter the product of the number of people at risk and the risk (probability) of an individual to be a newly diagnosed. Based on the Lexis diagrams with 1-year intervals for age group and for calendar year of diagnosis, we propose a Bayesian model to obtain the posterior distribution of the risk (probability) of an individual at a given age to be a newly diagnosed at a given year. A carefully designed MCMC algorithm is used to implement the inference.

Results: We conducted a simulation study to examine the numerical performance of this method. We also applied this method to study the trends of lung and breast cancer in Taiwan. We find that for nearly every age group, the incidence rates for lung adenocarcinoma and female invasive breast cancer increased rapidly in past two decades and those for male lung squamous cell carcinoma started to decrease, which is consistent with the decline in male smoking rate started in 1985. Since the analyses indicate strong age, period and cohort effects, it seems that both lung adenocarcinoma and breast cancer will become more important public health problems in Taiwan. This method should be useful in cancer surveillance research.

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A Simulation Study

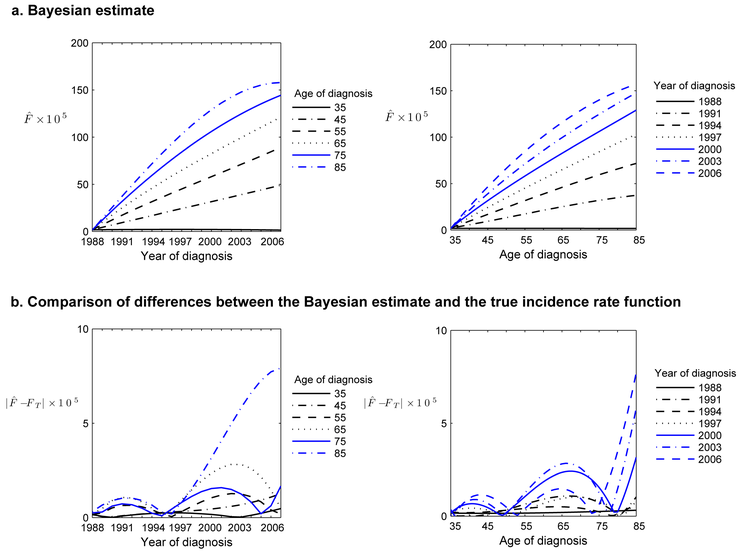

Figure 1. Simulation study results. Upper panel: the graphic displays of the estimate $\hat{F}$. Lower panel: the absolute values of the difference between the estimate $\hat{F}$ and the true incidence rate F_T.

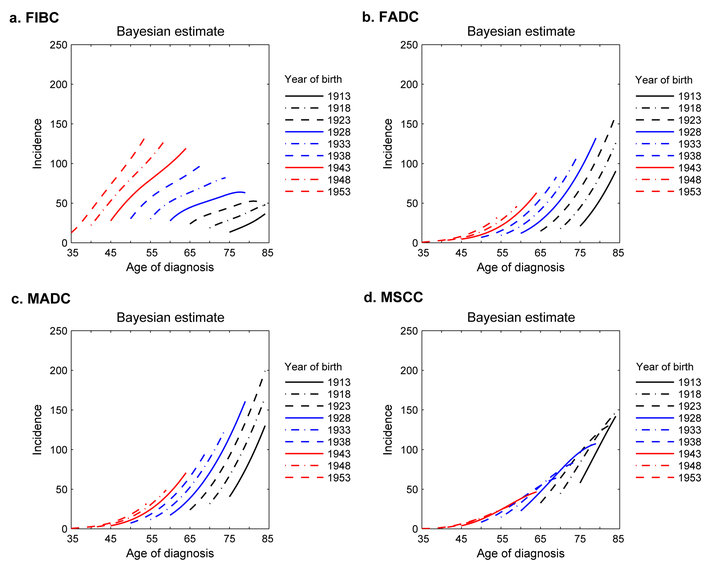

Figure 3. Age-specific rates by year of birth (rates versus age of diagnosis, observations within each birth-cohort are connected).

Application to Lung and Breast Cancer Incidence Data

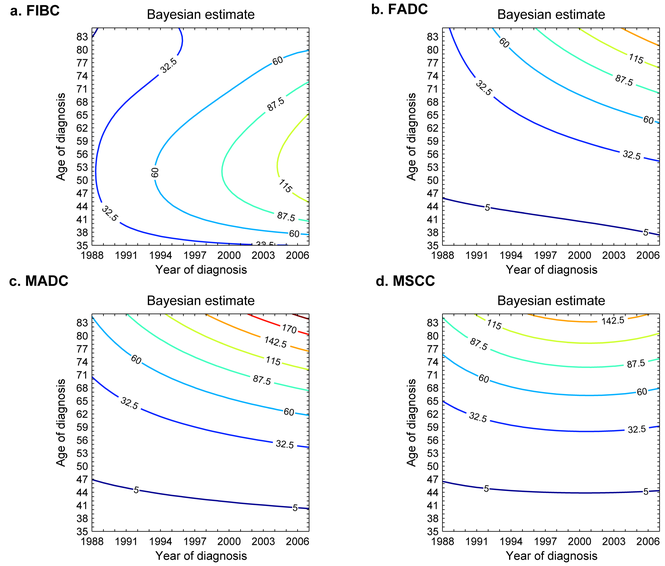

Figure 2. Contour plots. The number on each contour curve shows the incidence rate for each point on the curve.

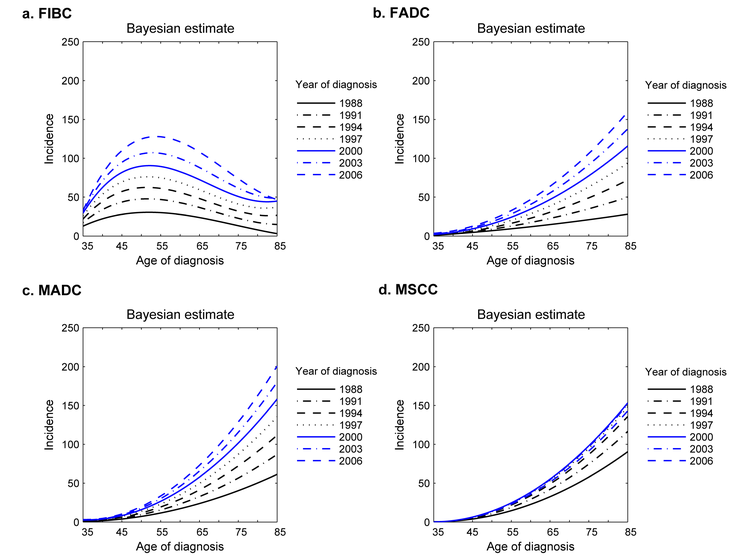

Figure 4. Age-specific rates by year of diagnosis (rates versus age of diagnosis, observations within each year are connected).