Segmented Poisson Models

Vidal E[1,2], Pastor-Barriuso R[1,2], Pollan M[1,2], Lopez-Abente G[1,2].

[1] Environmental and Cancer Epidemiology Unit, National Centre for Epidemiology, Carlos III Institute of Health. Madrid, Spain.

[2] CIBERESP, Spain.

Standard dose-response analyses (such as categorical, spline, or nonparametric regression) provide flexible tools to describe the overall shape of the dose-response relation across the entire exposure range, but the identification of trend changes with these methods is subjective. Specific methods are needed to formally test for the existence of change-points in risk trends.

We propose a log-linear model for aggregated data with Poisson variance and free dispersion parameter, in which the predictor function consists of two intersecting straight lines connected at an unknown change-point through a hyperbolic transition function, that allows for abrupt changes or more gradual transitions between the linear trends. The model, that was implemented as an R function, provides a p-value for the existence of a change-point, as well as point and interval estimates for its location and the slopes below and above it.

An application to two different scenarios is presented. First, relationship between Spanish renal cancer mortality (period 1994-2003) and distance to metallurgical facilities (provided by the EPER register) at municipal level was analysed, adjusting by age-group, sex and socio-economic indexes. Second, we look for changes in time trend of breast cancer incidence (adjusted by age) taken from Spanish registries covering 16 of the 50 Spanish provinces in the last 30 years.

The results are as follows: In the first scenario, we found a significant change point (at 5 Km, CI 95% 3 13 Km away from point source) for men. Below this point, relative risk decreased with distance and above it, the trend stabilizes. No change point was found for women. In the second, breast cancer incidence increased in Spain during the 70s, 80s and 90s (at a rate of 2.4 per year) and levelled in the XXI century (change point found at 1999 CI 95% 1996 2001).

As conclusion, it seems that change point models offer a good alternative for the linear dose-response relationships when using regression in a set of different epidemiological situations.

Acknowledgements: Staff from the Cancer Registries of Spain: Nerea Larrañaga, Miren Dorronsoro, Isabel Izarzugaza form the Basque Country, Carmen Martos from Zaragoza, Marcial Argüelles from Asturias, Mª Dolores Chirlaque from Murcia, Eva Ardanaz from Navarra, Mª Dolores Rojas from Canary Islands, Jaume Galcerán from Tarragona, Rafael Marcos-Gragera from Girona, Carmen Martínez from Granada, Isabel Garau from Majorca, Ana Torrella from Castellon, Antonio Mateos from Albacete, Josefina Perucha from La Rioja, Rosario Jiménez-Chillarón from Cuenca.