

## **Infant mortality in Japan after Fukushima**

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10 January 2013

### **Summary**

Following the nuclear disaster at Fukushima Dai-ichi in March 2011, Japanese infant mortality monthly data exhibit distinct peaks in May 2011 and December 2011, 2 and 9 months respectively after the disaster. After Chernobyl, an analysis of early infant mortality data in West Germany found significant peaks in June 1986 and February 1987, i.e. at similar time lags after the Chernobyl disaster in April 1986. In December 2011, 9 months after Fukushima, there is also a significant deficit in the number of live births in Japan. A similar decline in birth numbers was found in February 1987 in southern Bavaria, the German region most affected by Chernobyl fallout. In Japan as well as Bavaria, the effect is limited to a single month.

### **Background**

The first health effects from the catastrophic accident at the nuclear power plant in Fukushima Dai-ichi on 11 March 2011 might be expected to be seen in infant mortality data. A German study [1] after the Chernobyl accident in April 1986 showed noticeable increases in early infant mortality (ie mortality within 0-6 days of birth) in June 1986 and at the beginning and the end of 1987. The maximum in February 1987 is interpreted [1] to be due to damage to the embryo at a critical stage of pregnancy. From the German experience, a similar increase in infant mortality in Japan after Fukushima could be expected.

### **Data and Methods**

Monthly data of infant mortality from Japan can be found on the website of the Japanese Ministry of Health and Labour, <http://www.mhlw.go.jp/toukei/list/81-1a.html>. An English translation of the required data, i.e. the numbers of live births and infant deaths, was provided by Dr Masao Fukumoto. German monthly data of early infant mortality data for 1980 to 1993 were obtained from Statistisches Bundesamt in Wiesbaden, <https://www.destatis.de/DE/Startseite.html>.

Monthly infant mortality rates from January 2002 to March 2011 are analyzed with linear logistic regression. Seasonal variations are modeled by dummy variables for February through December, with January as the reference month. The course of the data from April 2011 to May 2012 is compared with the extrapolated trend of the data before Fukushima.

Using Poisson regression, data of live births are analyzed to test for a possible drop in December 2011, 9 months after the disaster in March 2011. As above, 11 dummy variables account for seasonal effects.

## Results

### (a) Infant mortality

The regression model yields a good fit to the data from 2002 to March 2011 (deviance = 86.0, df = 98). Figure 1a shows infant mortality rates and the long-term trend. After Fukushima, pronounced peaks in infant mortality are found in May 2011 (observed cases (O) = 247, expected cases (E) = 208.9, excess = 38.1) and in December 2011 (O=240, E=203.3, excess=36.7). Figure 1b displays the residuals, i.e. the differences between observed and expected rates, in units of standard deviations. The broken lines indicate the range of 2 standard deviations in which 95% of the data points should normally lie.

Figures 2a and 2b show the results of a combined regression analysis of the data from Fukushima prefecture and from Japan without Fukushima. A significant 3-fold increase of infant mortality is found in Fukushima prefecture in May 2011 (O=9, E=3.1, P=0.0014).

The Japanese results were compared with the results of an analysis of monthly data of early infant mortality in West Germany, 1980 to 1993 (Figures 3a, 3b). Significant increases are found in June 1986, February 1987, and November 1987.

The mortality peaks in February 1987 and November 1987 in the German data are shown in [1] to be associated with peaks of cesium burdens in pregnant women. In particular, the November 1987 peak follows an increase in the cesium content of cows' milk during the winter 1986/87 when-cows were fed cesium-contaminated silage [1].

The peaks in the Japanese data in May 2011 and December 2011, two and nine months after the nuclear disaster, parallel mortality peaks in the German data in June 1986 and February 1987 after the Chernobyl disaster on 26 April 1986.

### (b) Decline in numbers of live births

Interestingly, there are also statistically significant reductions in the number of live births in December 2011 in Japan as a whole (minus 4.7%, P=0.0072, see Figures 4a, 4b) and, more pronounced, in Fukushima prefecture (minus 15.1%, P=0.0001). In the previous month (November 2011) and the following month (January 2012), birth numbers are not significantly decreased.

A similar effect is found after Chernobyl in Bavaria. In February 1987, 9 months after the nuclear disaster, the number of births fell by 8.8% relative to the expected value (P=0.0083). As in Japan, the decrease is limited to a single month (February 1987); no effect is seen in January 1987 and March 1987. In southern Bavaria, where cesium soil contamination was significantly higher than in northern Bavaria, the decline in births is more pronounced (minus 11.5%, P=0.0009, see Figures 5a, 5b) than in northern Bavaria (minus 5.2%, P=0.151). The cause of the falling birth rate could be a radiation-induced loss of zygotes shortly after fertilization.

[1] Körblein A, Küchenhoff H. Perinatal mortality in Germany following the Chernobyl accident. *Radiat Environ Biophys.* 1997 Feb;36(1):3-7.

Available at: <http://www.alfred-koerblein.de/chernobyl/downloads/KoKu1997.pdf>

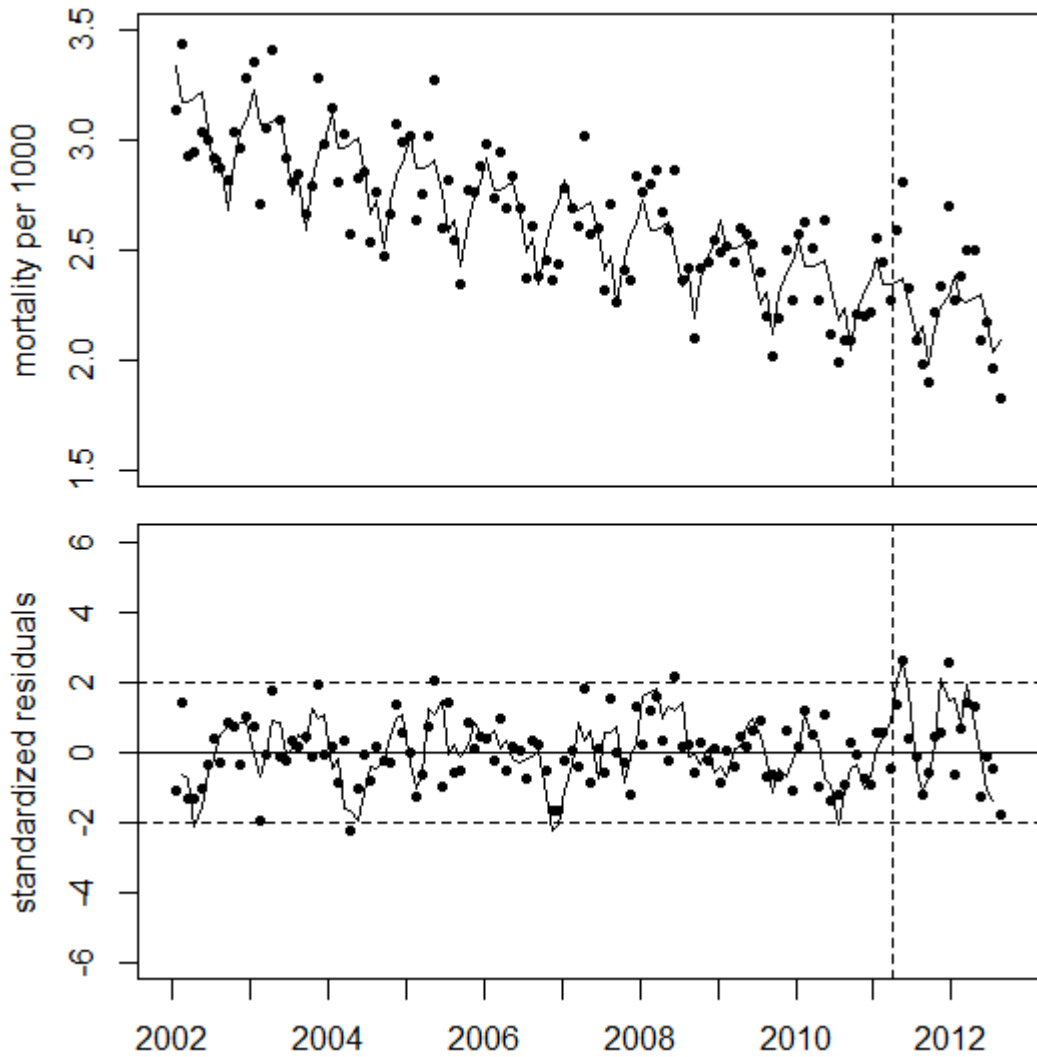


Fig.1a (upper diagram): Monthly infant mortality rates in Japan and trend line. The vertical broken line indicates the end of March 2011.

Fig.1b (lower diagram): Deviations of infant mortality rates from the expected trend in units of standard deviations (standardized residuals) and 3-month moving average (solid line). The horizontal broken lines show the range of two standard deviations.

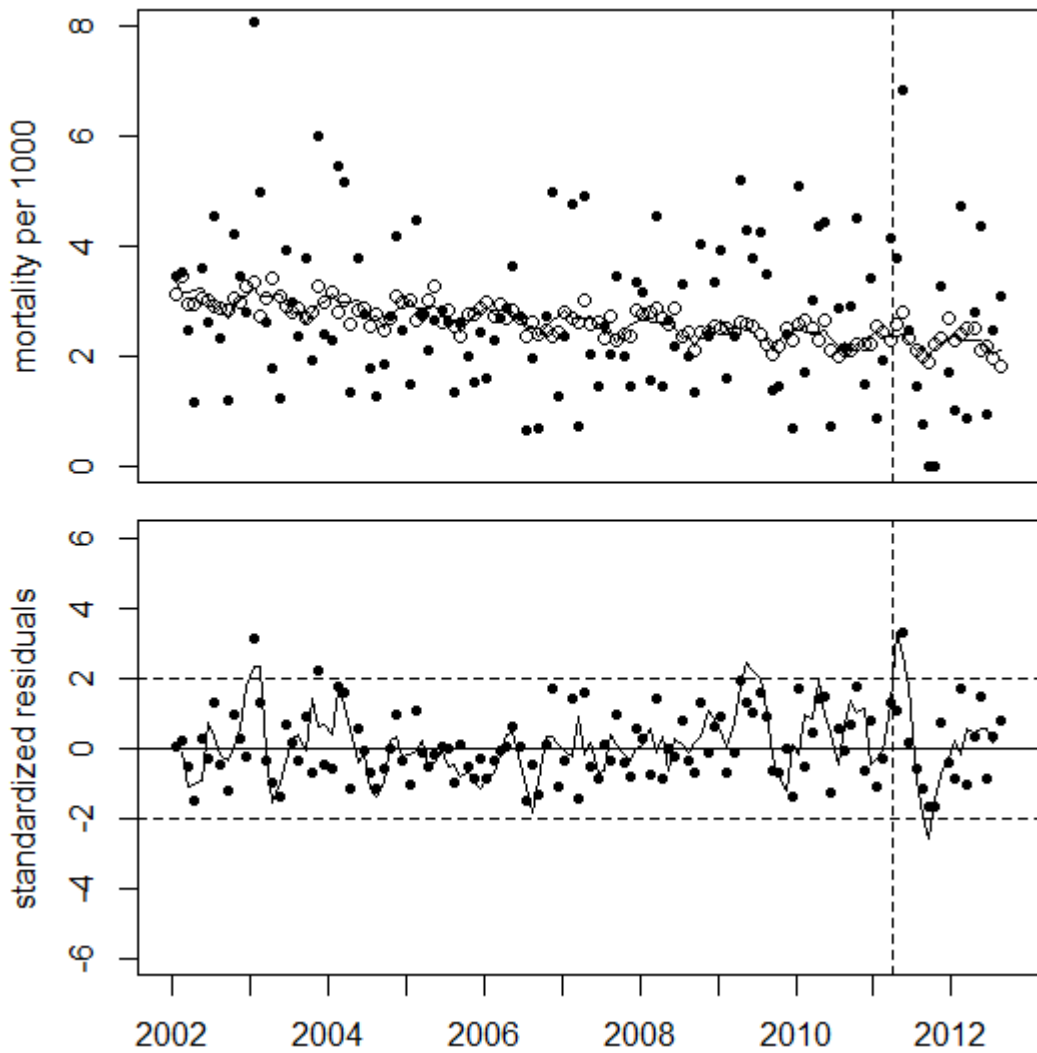


Fig.2a: Monthly infant mortality rates in Fukushima prefecture (black dots) and in Japan without Fukushima (open circles).

Fig.2b: Deviations of infant mortality rates in Fukushima prefecture from the expected trend, in units of standard deviations (standardized residuals), and 3-month moving average (solid line). The horizontal broken lines show the range of two standard deviations.

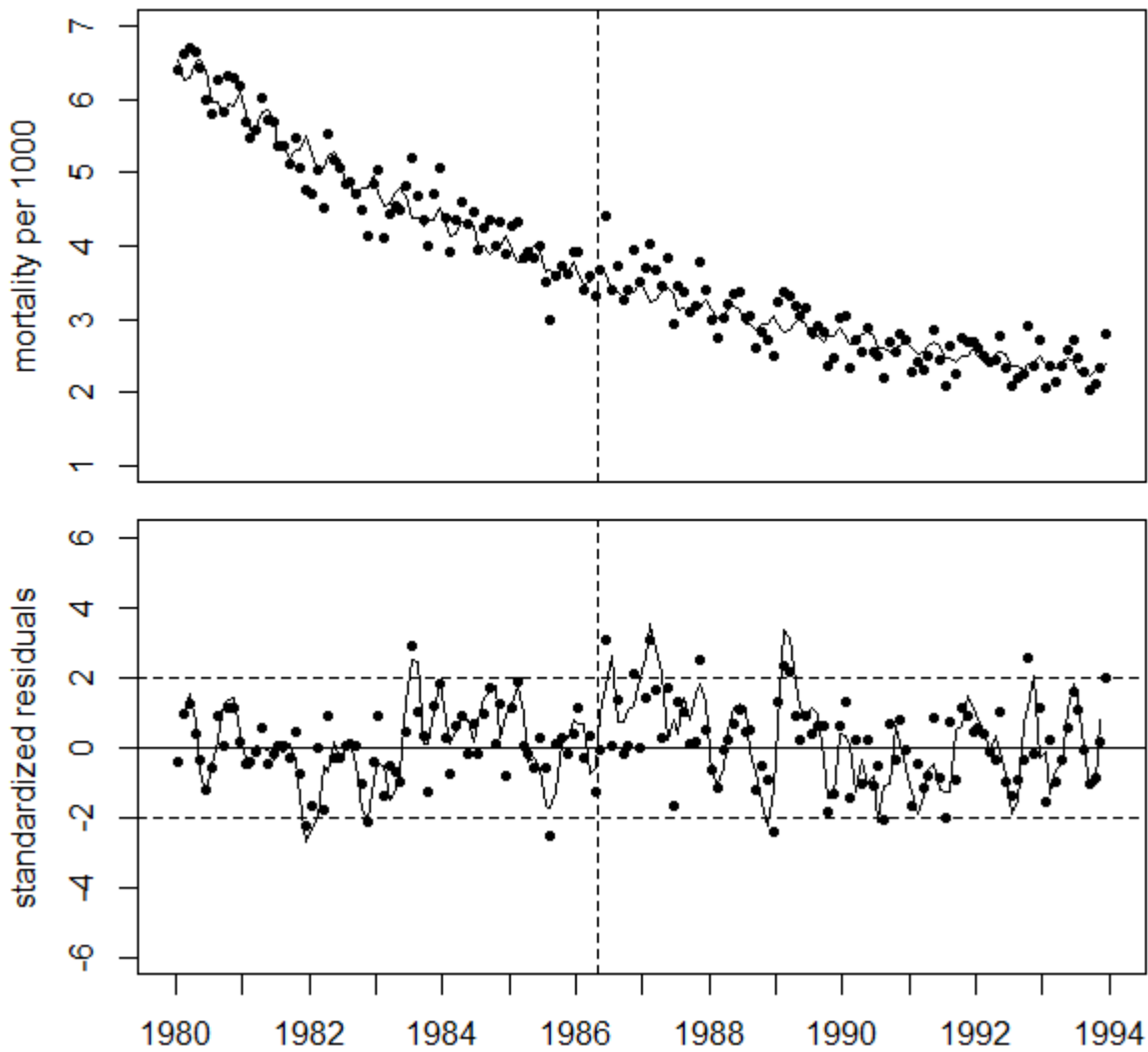


Fig.3a: Early infant mortality rates (0-6 days) in West Germany and trend line. The vertical broken line indicates the end of April 1986.

Fig.3b: Deviations of early infant mortality rates in West Germany from the expected trend in units of standard deviations (standardized residuals), and 3-month moving average (solid line).

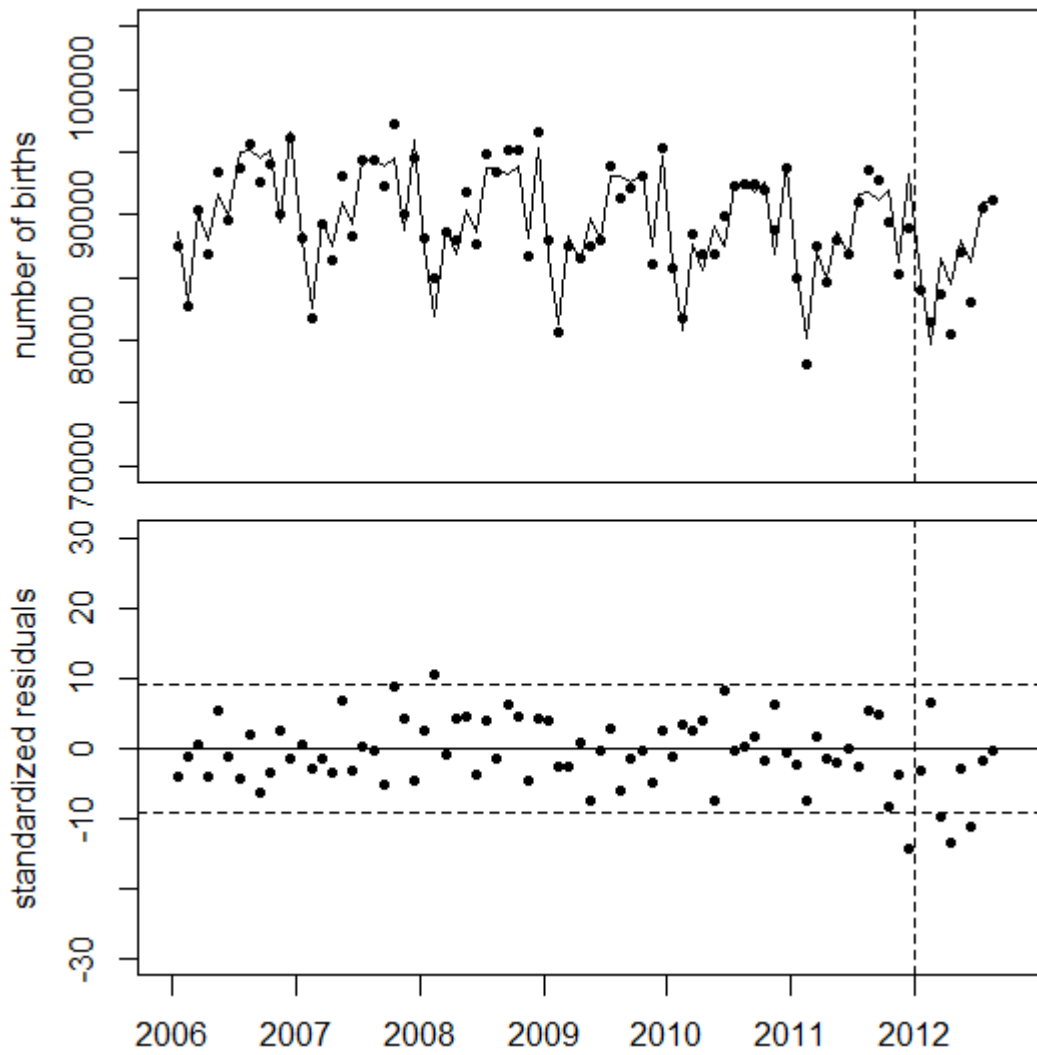


Fig.4a: Monthly numbers of live births in Japan

Fig.4b: Deviations of the numbers of live births from the expected numbers, in units of standard deviations (standardized residuals). The horizontal broken lines show the 95% prediction limits.

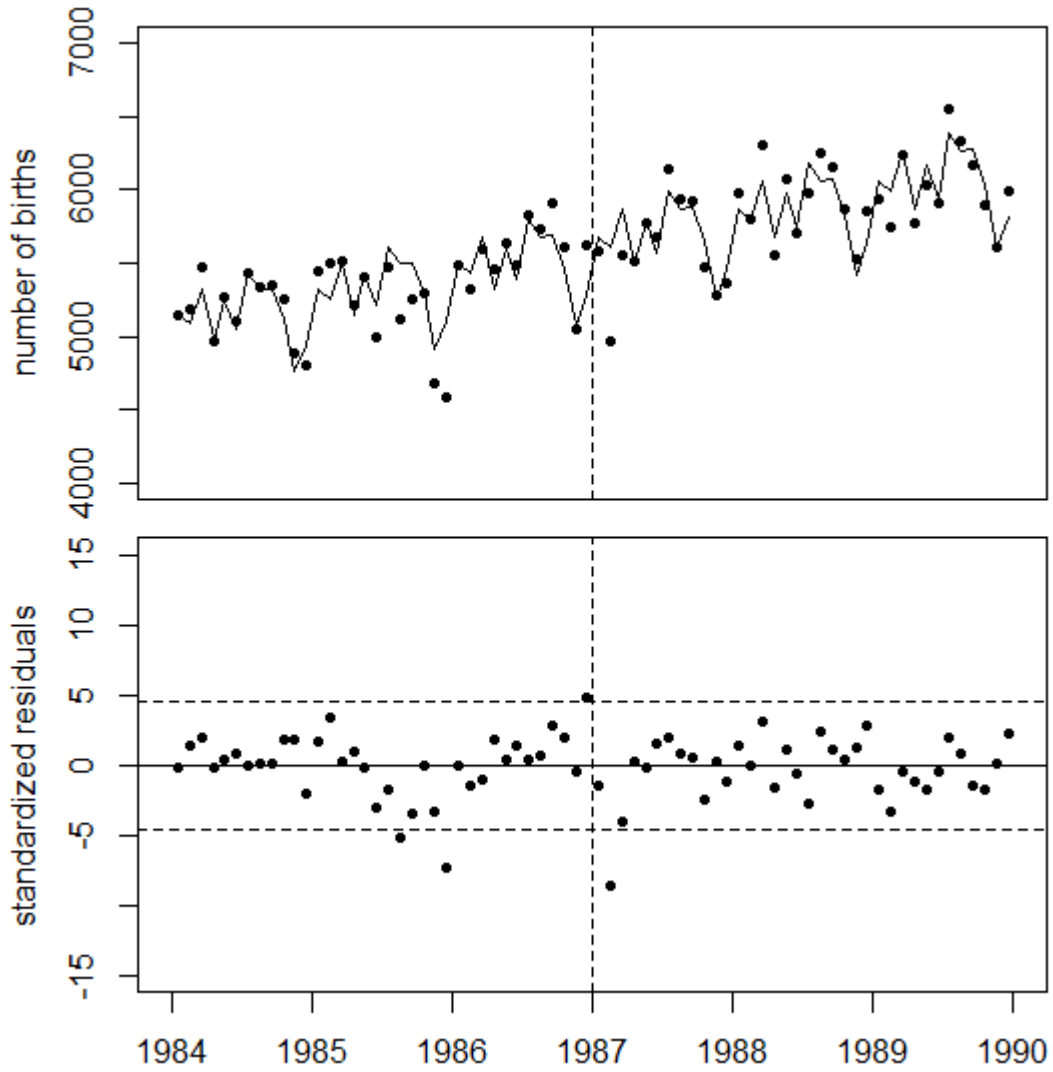


Fig.5a: Monthly numbers of live births in southern Bavaria

Fig.5b: Deviations of the numbers of live births from the expected numbers, in units of standard deviations (standardized residuals). The horizontal broken lines show the 95% prediction limits.