Strahlentelex mit ElektrosmogReport ISSN 0931-4288 No. 626-627, Feb. 7, 2013
www.strahlentelex.de
English version

Increased leukemia rates in children from Belarus after Chernobyl

Alfred Körblein alfred.koerblein@gmx.de
February 2013

A trend analysis of data from Belarus finds a statistically significant 33% increase in the incidence of leukemia in children in 1987, following the Chernobyl nuclear disaster in 1986 (RR=1.33; P=0.004). The increase is much greater in children less than a year old (RR=2.68, P=0.0004). Another increase occurs in 1990-1992. The findings contradict the results of former studies and statements in two UNSCEAR reports that no evidence of an increased incidence of childhood leukemia in Belarus was found after Chernobyl.

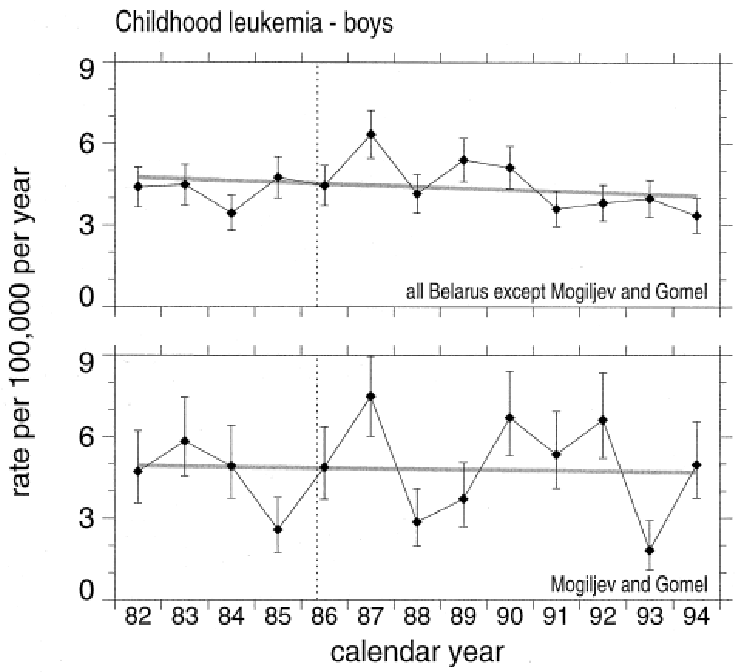
Introduction

Excess rates of acute childhood leukemia are known to occur relatively soon after radiation exposure ~~and~~ even after comparatively small doses. Childhood leukemia is widely considered the most likely indicator of health effects from radiation exposure.

However, following the Chernobyl exposures in 1986, several studies from Belarus [1], [2] reported no statistically significant increases in childhood leukemia in Belarus and its seven major regions (oblasts). This conclusion was repeated by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) [3], [4].

Figure 1 below is reproduced from Ivanov et al [1]. It shows annual childhood leukemia incidence rates and corresponding regression lines for boys aged <15 years in Mogiljev and Gomel combined (lower panel) and in the remainder of Belarus (upper panel). The only significant increase is found in 1987, the year after the Chernobyl accident in 1986.

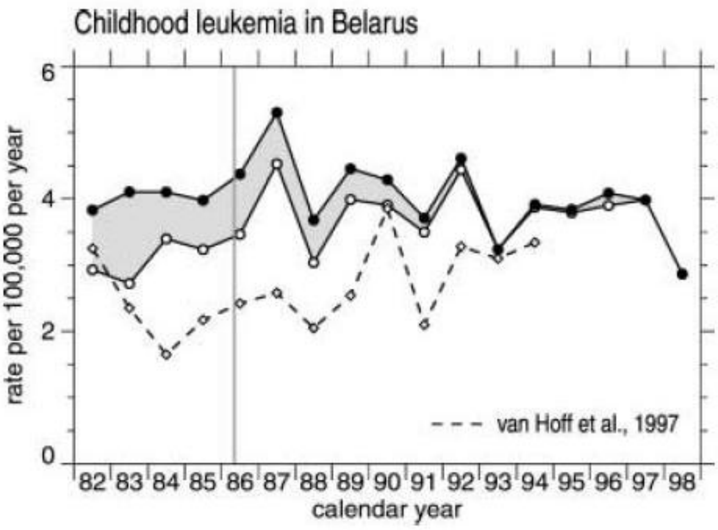
Figure 1



Similarly, the Gapanovich et al study [2] of childhood leukemia rates in Belarus between 1982 and 1998 revealed a peaks in 1987. This study compared childhood leukemia incidence data from the Belarus Institute of Haematology and Blood Transfusion (black line ICD 204–208, dotted line ICD 204–207) and data from the Belarussian State Cancer Registry (broken line ICD 204–207).

The data are shown as black dots in Figure 2 which reproduces a plot in the Gapanovich et al study. However these authors in their conclusions did not discuss the peak in 1987 but merely compared the average rates 1982-1986 (pre-Chernobyl) with the average rates 1987-1996 (post-Chernobyl) and found them not to be higher. (1997 and 1998 were excluded from this comparison since they were preliminary).

Figure 2



Ivanov et al [5] in 1998 also looked at infant leukemia rates in Belarus. In the result section the authors stated: *"Utilizing the same temporal cohorts as Petridou et al., one finds a rate ratio 1.26 for all Belarus with 95% CI 0.76–2.10 (17 cases in the 'exposed' and 89 in the control group). For the most highly contaminated regions of Gomel and Mogiljev taken together, the rate ratio is 1.51 with 95% CI 0.63–3.61 (6 cases in the 'exposed' and 27 in the control group). For Gomel alone, the rate ratio is 1.25 with 95% CI 0.37–4.23. While there is, as in the two other reports, a trend of increased infant leukemia rate in the 'exposed' cohort, there is no indication of a larger excess than the one observed in Greece or Germany."*

Ivanov et al's later study [5] contains (in their table 3) the numbers of infant leukemia cases in Belarus between 1982 and 1994 and corresponding incidence rates. A logistic regression of these rates by the present author (AK) finds a significant 89% increase in infant leukemia in 1987 relative to the trend of the remaining years, 1982-1994 (P=0.019), see Figure 3 below. Therefore the information on the 1987 peak was plainly available 15 years ago, but it was not discussed.

Recently, the present author received new data on infant leukemias between 1980-2008 in Belarus, originally presented by Malko et al. at a Minsk conference in 2011 [6]. With an extended study period of nearly 30 years, it is possible to determine the trend of the data and any increase following Chernobyl much more precisely than was done in 1998.

Data and Methods

All leukemia cases in Belarus are first reported to the Oblast oncological dispensaries which, in turn, send notifications to the Belarussian National Cancer Registry in Minsk. The cases are then submitted to the Institute of Haematology and Blood Transfusion. Case numbers were obtained from this Institute and population data were obtained from the population census of the Republic of Belarus.

These data were analyzed with a linear logistic regression, see Figure 3 below. As in [6], the time window for possible Chernobyl effects was defined as 1987-1992. The difference of deviances obtained in regressions with and without the 1987-1992 data was used to determine the significance of any Chernobyl effect (chi square test with 6 degrees of freedom). The effect in each year of the time window was estimated by dummy coding (d87 through d92). The statistical package R was used for data processing und plotting.

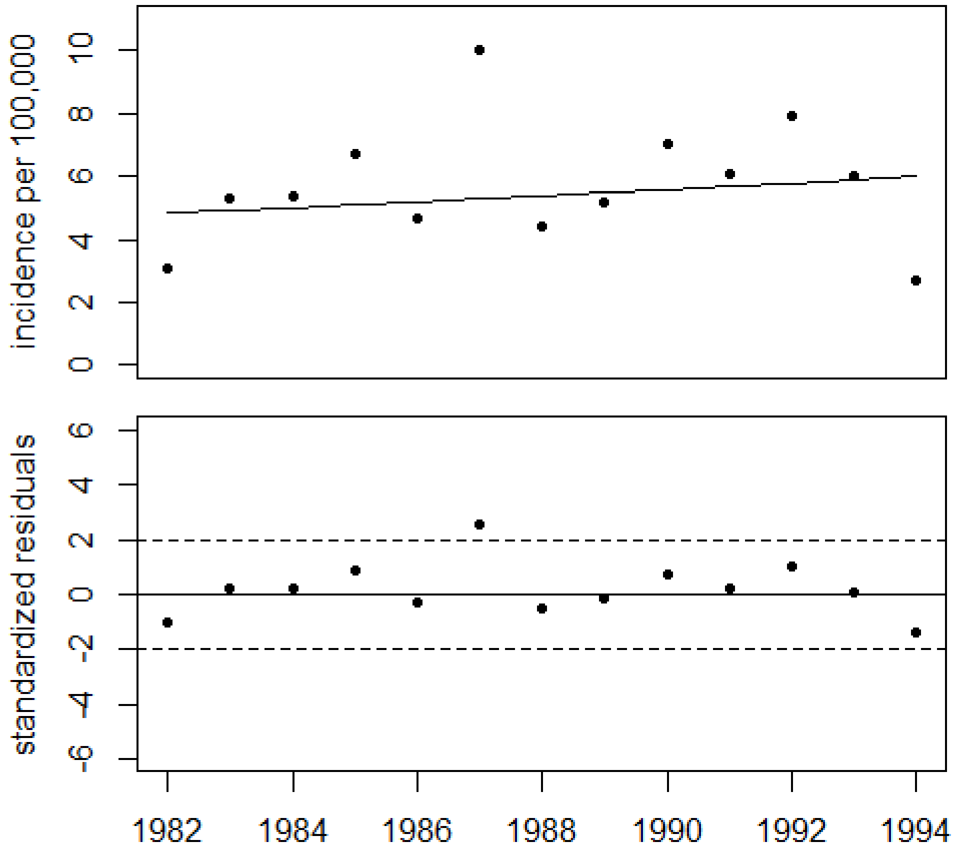


Figure 3: Infant leukemia rates in Belarus, 1982-1994 (from [5] Table 3). The upper panel shows the result of a regression by the present author. The lower panel shows the deviations between observed and expected rates in units of standard deviations (standardized residuals).

Results

(1) Leukemia in children (0-14 years)

A linear logistic regression of the data, 1980 to 2008, yields a deviance of 33.90 (df=27); without the data for 1987-1992, the deviance is 17.29 (df=21). Thus the overall leukemia rates in 1987-1992 differ significantly from the trend in the remaining years (P=0.0109, chi square test with df=6). The results of the regression (estimates, standard error (SE), the z-values, and P-values) are given in Table 1 below.

Table 1: Regression results for leukemia in children (0-14 years)

parameter	estimate	SE	z value	P value
(Intercept)	-10.078	0.0443	-227.65	<0.0001
t	-0.0125	0.0028	-4.434	<0.0001
d87	0.2816	0.0969	2.907	0.0037
d88	-0.0413	0.1122	-0.368	0.7128
d89	0.1278	0.1037	1.233	0.2177
d90	0.2041	0.1002	2.037	0.0417
d91	0.0773	0.1068	0.724	0.4692
d92	0.2352	0.0999	2.354	0.0186

The course of the data is shown in the upper panel of Figure 4 below. The deviations of leukemia rates from the trend, in units of standard deviations (standardized residuals) is shown in the lower panel. In 1987, the leukemia rate is increased by 33% (RR=1.33, P=0.0037). From the difference between observed and expected numbers of cases, 86.5 additional cases of leukemia are determined during 1987-1992.

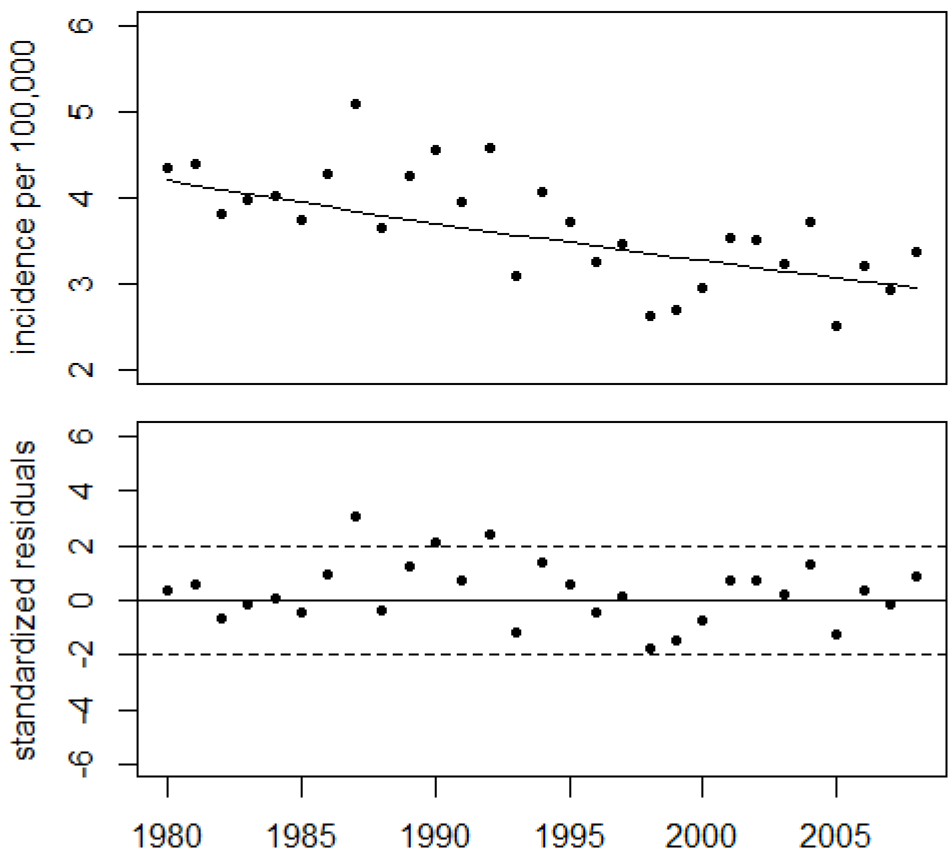


Figure 4: Upper panel: Leukemia incidence in children from Belarus and trend line. Lower panel: deviations (standardized residuals) of the observed rates from the trend of the years 1980-2008 without 1987-92. The broken lines show the range of 2 standard deviations.

Regression with only one dummy variable for the period 1987-1992 (d8792) results in a statistically significant 16.5% increase (RR=1.165, P=0.0016) relative to the trend of the remaining years.

(2) Leukemia in infants (0-1 year)

Annual infant leukemia rates are shown in Figure 5 below. Between 1999 and 2006 there are 6 years with zero cases. This raises doubts about the reliability of the data for these years, therefore the data are only evaluated until 1998.

A linear logistic regression of the data, 1980 to 1998, yields a deviance of 23.74 (df=17) with the data from 1987 to 1992; without the data for 1987-1992, the deviance is 4.23 (df=11). Thus the leukemia rates in 1987-1992 differ significantly from the trend in the remaining years (P=0.0034, chi square test with df=6). Table 2 shows the regression results.

Table 2: Regression results for infant leukemia (0-1 years)

parameter	estimate	SE	z value	P value
(Intercept)	-9,9867	0,1819	-54,91	<0,0001
t	-0,0325	0,0216	-1,504	0,1325
d87	0,9859	0,2797	3,525	0,0004
d88	0,3237	0,3768	0,859	0,3903
d89	-0,0523	0,4682	-0,112	0,9111
d90	0,7498	0,3497	2,144	0,0320
d91	0,7508	0,3708	2,025	0,0429
d92	1,0153	0,3497	2,904	0,0037

In Figure 5 below, the lower panel shows the standardized residuals. In 1987, the leukemia rate is increased by 168% (RR=2.68, P=0.0004). From the difference between observed and expected case numbers, 29 additional cases of leukemia are determined in 1987-1992.

Regression with only one dummy variable for the period 1987-1992 (d8792) results in a highly significant 95% increase (RR=1.95, P=0.0005) relative to the trend of the remaining years.

Discussion

The main finding of this study is that annual data on childhood leukemia and of infant leukemia incidences in Belarus, 1980-2008, clearly reveal statistically significant peaks in 1987 and 1992. This study also finds highly significant increases in childhood leukemia (+16.5%) and infant leukemia (+95%) when the rates in 1987 through 1992 are compared with the trend of the remaining data (the analysis method used in the older Belarus studies).

In 2001, when the Gapanovich et al study [2] was published, childhood leukemia data up to 1998 were available and clearly shown (see Figure 2). Therefore the highly significant increases in infant leukemia should have been noted and discussed then. The fact that neither occurred raises questions.

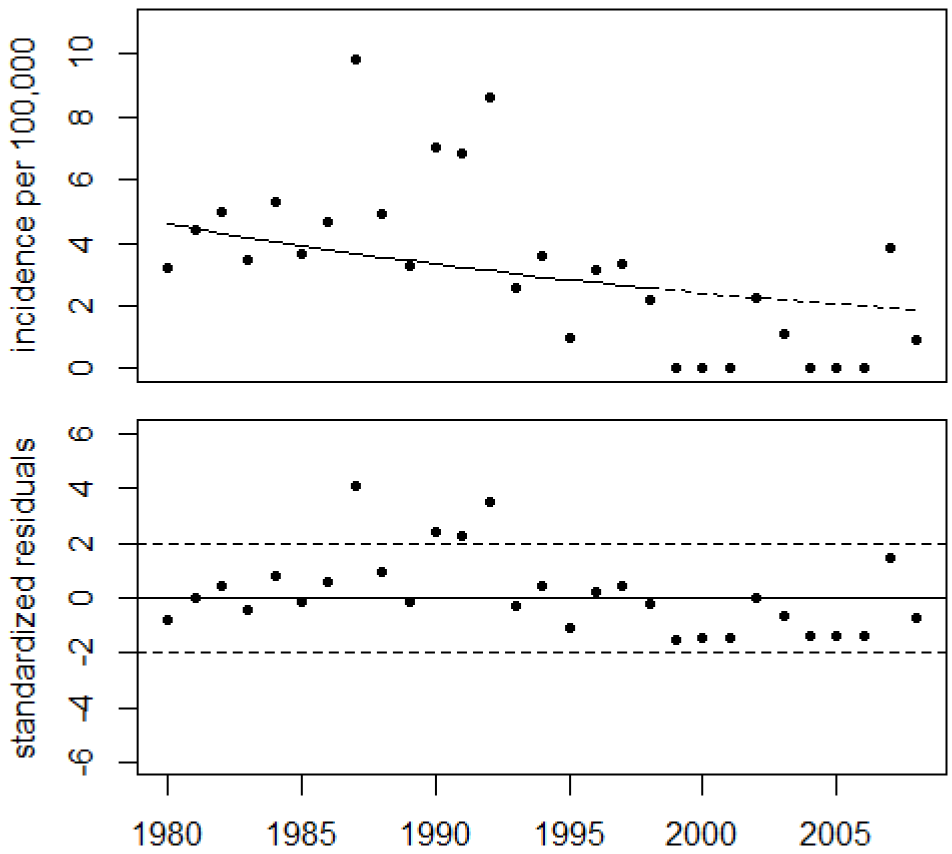


Figure 5: Upper panel: Infant leukemia rates in Belarus, 1980-2008, and trend line. Lower panel: deviations (standardized residuals) of the observed rates from the trend of the data without 1987-92 and 1999-2006. The broken lines show the range of 2 standard deviations.

References

1. Ivanov EP, Tolochko GV, Shuvaeva LP, Becker S, Nekolla E, Kellerer AM (1996) Childhood leukemia in Belarus before and after the Chernobyl accident. Radiat Environ Biophys 35:75–80.
2. Gapanovich VN, Iaroshevich RF, Shuvaeva LP, Becker SI, Nekolla EA, Kellerer AM. Childhood leukemia in Belarus before and after the Chernobyl accident: continued follow-up. Radiat Environ Biophys. 2001 Dec;40(4):259-67.
3. UNSCEAR (2000) Sources and effects of ionizing radiation. United Nations Scientific Committee on the Effects of Atomic Radiation. Report to the General Assembly. Vol.II: Effects, Annex J: Exposures and effects of the Chernobyl accident. United Nations, New York
4. UNSCEAR 2008 Report (2008) http://www.unscear.org/docs/reports/2008/11-80076_Report_2008_Annex_D.pdf
5. Ivanov EP, Tolochko GV, Shuvaeva LP, Becker S, Nekolla E, Kellerer AM (1998) Infant leukemia in Belarus after the Chernobyl accident. Radiat Environ Biophys 37:53–55.
6. Malko MV, Ivanov EP, Terechovich TI, Ivanov VE. Infant leukemia in Belarus before and after Chernobyl (2011). http://elib.bsu.by/handle/123456789/16949

Annex A:

Data of childhood and infant leukemia in Belarus, 2000-2008

data set	childhood leukemia		infant leukemia	
year	N	O	N	O
1980	2184401	95	154432	5
1981	2185220	96	157899	7
1982	2196446	84	159364	8
1983	2215184	88	173510	6
1984	2238730	90	168749	9
1985	2264573	85	165034	6
1986	2290397	98	171611	8
1987	2314080	118	162937	16
1988	2331089	85	163183	8
1989	2344892	100	153448	5
1990	2353946	107	142167	10
1991	2351700	93	132045	9
1992	2339599	107	127971	11
1993	2316682	72	117384	3
1994	2282179	93	110599	4
1995	2235517	83	101144	1
1996	2176313	71	95798	3
1997	2104380	73	89586	3
1998	2012911	53	92645	2
1999	1922525	52	92975	0
2000	1855584	55	93691	0
2001	1785975	63	91720	0
2002	1707691	60	88743	2
2003	1632793	53	88512	1
2004	1562768	58	88943	0
2005	1504105	38	90508	0
2006	1460952	47	96721	0
2007	1432677	42	103626	4
2008	1421557	48	107876	1

N: mid-year population
O: observed cases