Health effects of the Chernobyl catastrophe

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To the memory of Solange Fernex (1934-2006)

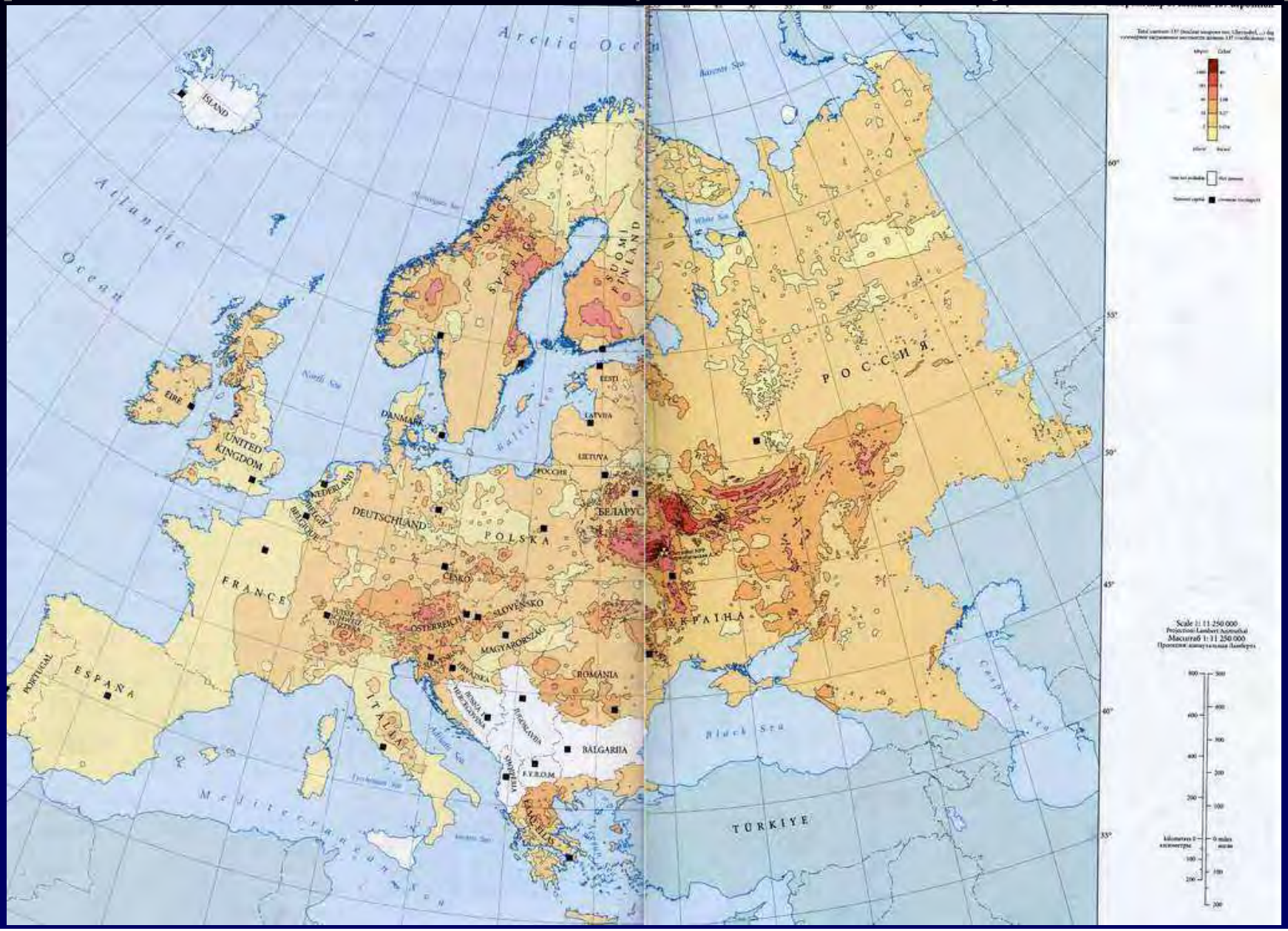
a prominent French pacifist activist and politician,

the former member of the European Parliament,

for her stubborn struggle for the full information on the health and other effects of the Chernobyl catastrophe in all the affected countries, including France, and for development of the adequate health assistance to affected populations.

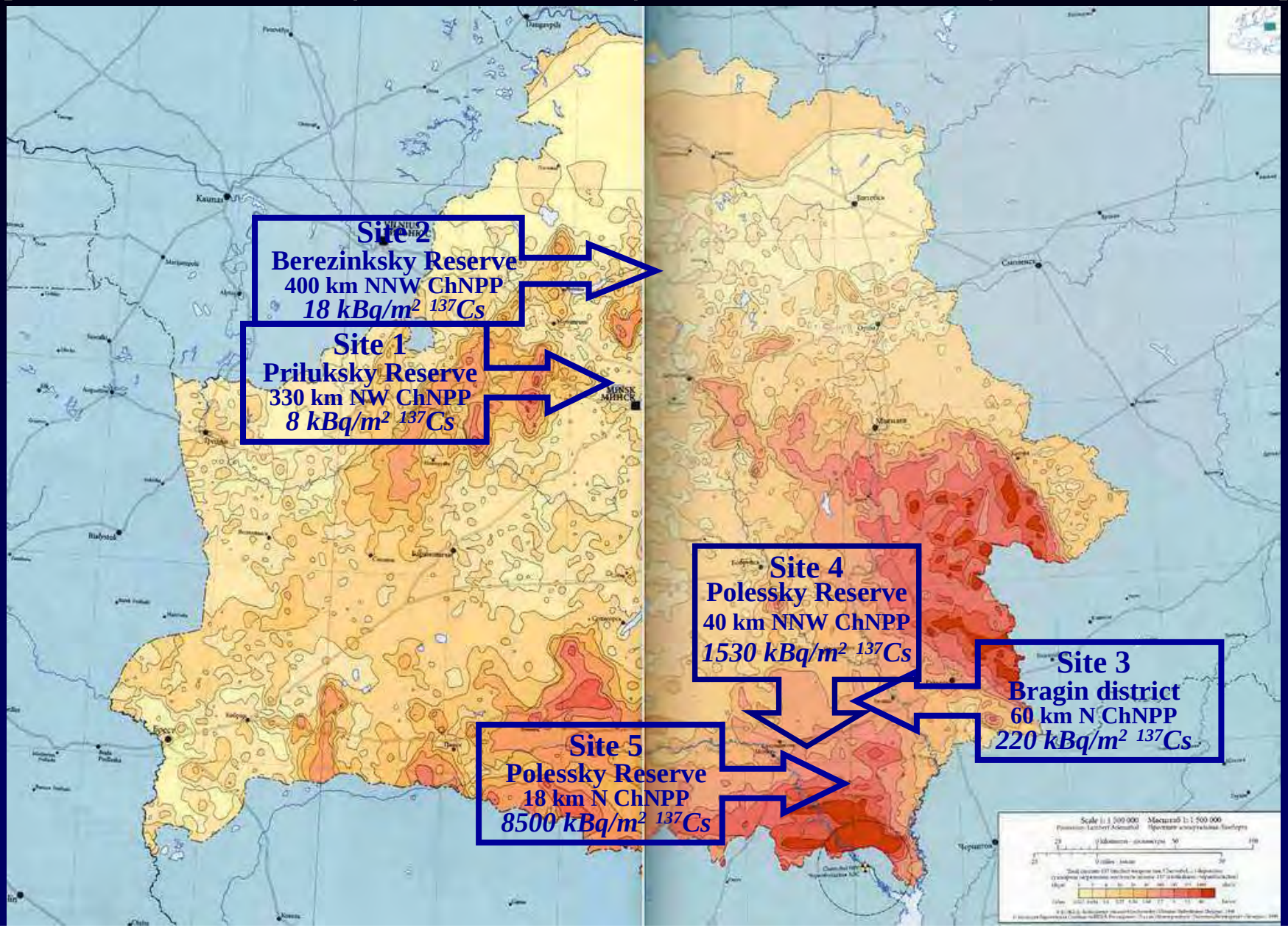
Europe

[Atlas of caesium deposition on Europe after the Chernobyl accident, 1998]



Monitoring sites in our study

[Atlas of caesium deposition on Europe after the Chernobyl accident, 1998]



Densities of radionuclide contamination (kBq/m^2) at monitoring sites in our study

Site	^{137}Cs	^{134}Cs	^{106}Ru	^{144}Ce	^{90}Sr	^{239,240}Pu	^{238}Pu	^{241}Pu	^{241}Am
Before the accident									
Belarus on average	**1.5 – 3.7[a]**	**No**	**–**	**–**	**0.74 –2.59[b]**	**0.037 – 0.059[c]**		**–**	**–**
	April – May 1986				**August 1996**				
1	8	4	5	0	3.81	0.094	0.044	2.98	0.14
2	18	9	12	0	5.12	0.14	0.072	5.1	0.19
3	220	140	150	440	38.56	1.26	0.60	48.76	1.73
4	1526	1020	1090	3050	117.24	2.35	1.17	86.67	3.21
5	8500	5650	5790	17200	1200	11	4.9	420	15

(a) Marei et al., 1970
(b) National Report, 2001
(c) Hardy et al., 1973

[N. I. Ryabokon, I. I. Smolich, V. P. Kudryashov, R. I. Goncharova // Radiation and Environmental Biophysics, 2005]

Collective thyroid doses for two age groups in Belarus

Region	Collective dose for children and adolescents (0—18 at the time of the accident), person-Gy	Collective dose for adults (19 years and older at the time of the accident), person-Gy	Total collective doses of Belarusian population, person-Gy
Brest	21129	24042	45171
Vitebsk	1164	1560	2724
Gomel city	36998	38236	75234
Gomel	112812	171939	284751
Grodno	3329	4453	7782
Minsk city	15063	19244	34307
Minsk	6404	8121	14525
Mogilev	22328	27694	50022

[20 Years after the Chernobyl Catastrophe:
the consequences in the Republic of Belarus and their overcoming.
National Report, 2006]

Collective cumulative effective doses (excluding thyroid doses) for two time periods

for territories of Belarus with density of cesium-137 contamination over 37 kBq/m²

Time period	Collective effective dose, person-Sv		
	external	internal	cumulative
1986—1995	9636	5504	15140
1986—2005	11900	6800	18700

[20 Years after the Chernobyl Catastrophe:
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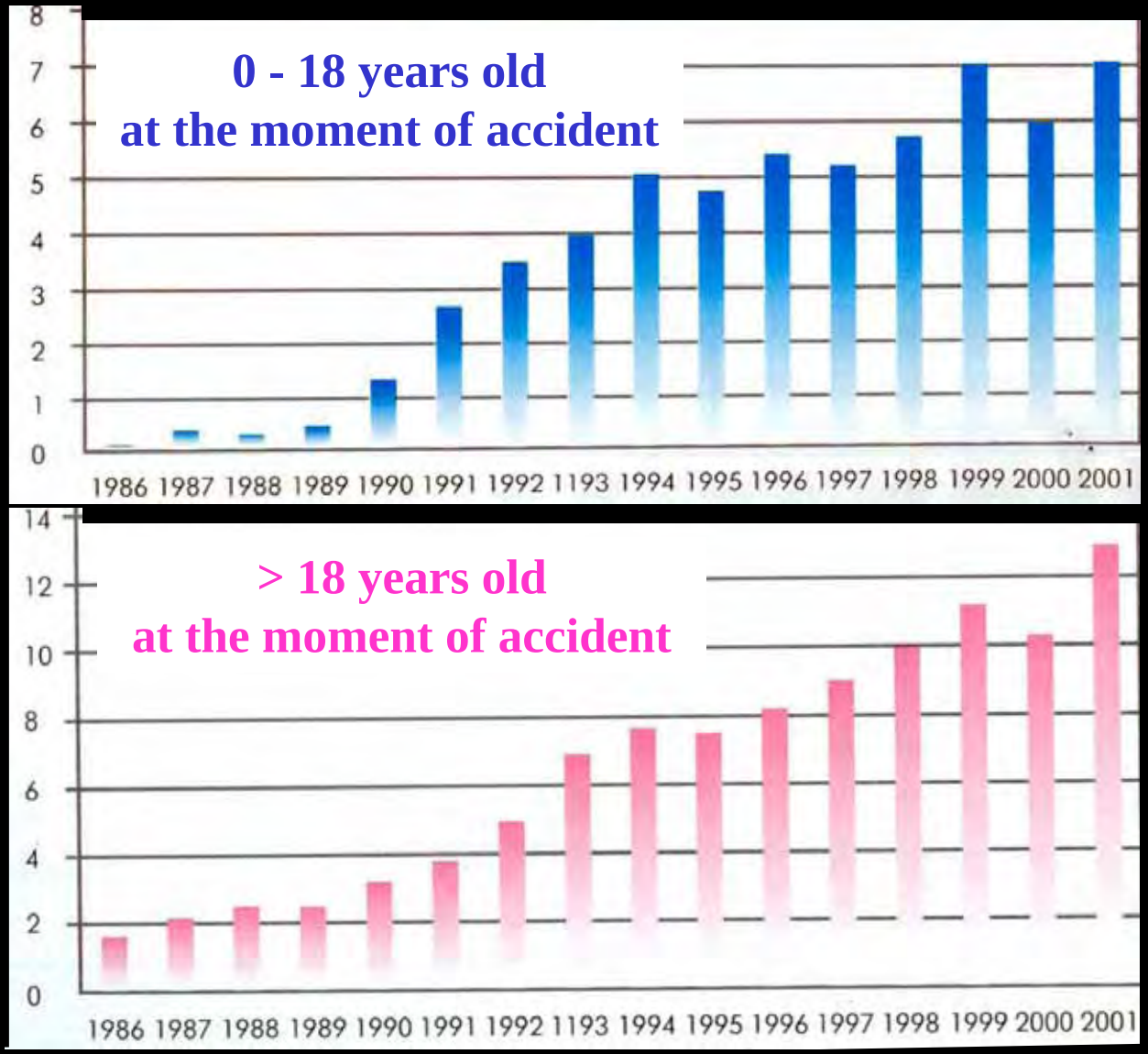
National Report, 2006]

Time course of thyroid cancer incidence in Belarus

Cases per 100 000 persons



Years

Total (1986-2001):
1685 cases

Control for <18 years old
(1971-1985):
14 cases
(1 case / 1 mln persons / year)

Total (1986-2001):
6460 cases

Control for >18 years old
(1973-1985):
1393 cases

[National Report, 2003]

Standardized incidence rate of malignant tumors among the population living on the territories of Belarus with 37-555 kBq/m^2 and in the control group for the period of 1993-2003 (per 100 000 populations)

Tumor site	ICD X code	Male		Female	
		GPR 5	Control	GPR 5	Control
Total	***C00-97***	***542.95****	***487.21***	***359.12****	***301.89***
Stomach	C16	69.55	65.75	29.33	28.22
Colon	C18	23.31*	17.94	16.41	15.43
Lungs	C34	115.91	121.16	8.56	8.81
Skin	C44	57.56*	39.82	47.27*	32.96
Breast	C50			72.29*	59.25
Kidney	C64-65	19.9	20.71	9.26	9.37
Bladder	C67	26.38	24.61	3.37*	2.69
Thyroid gland	C73	6.54*	2.58	22.08*	16.63

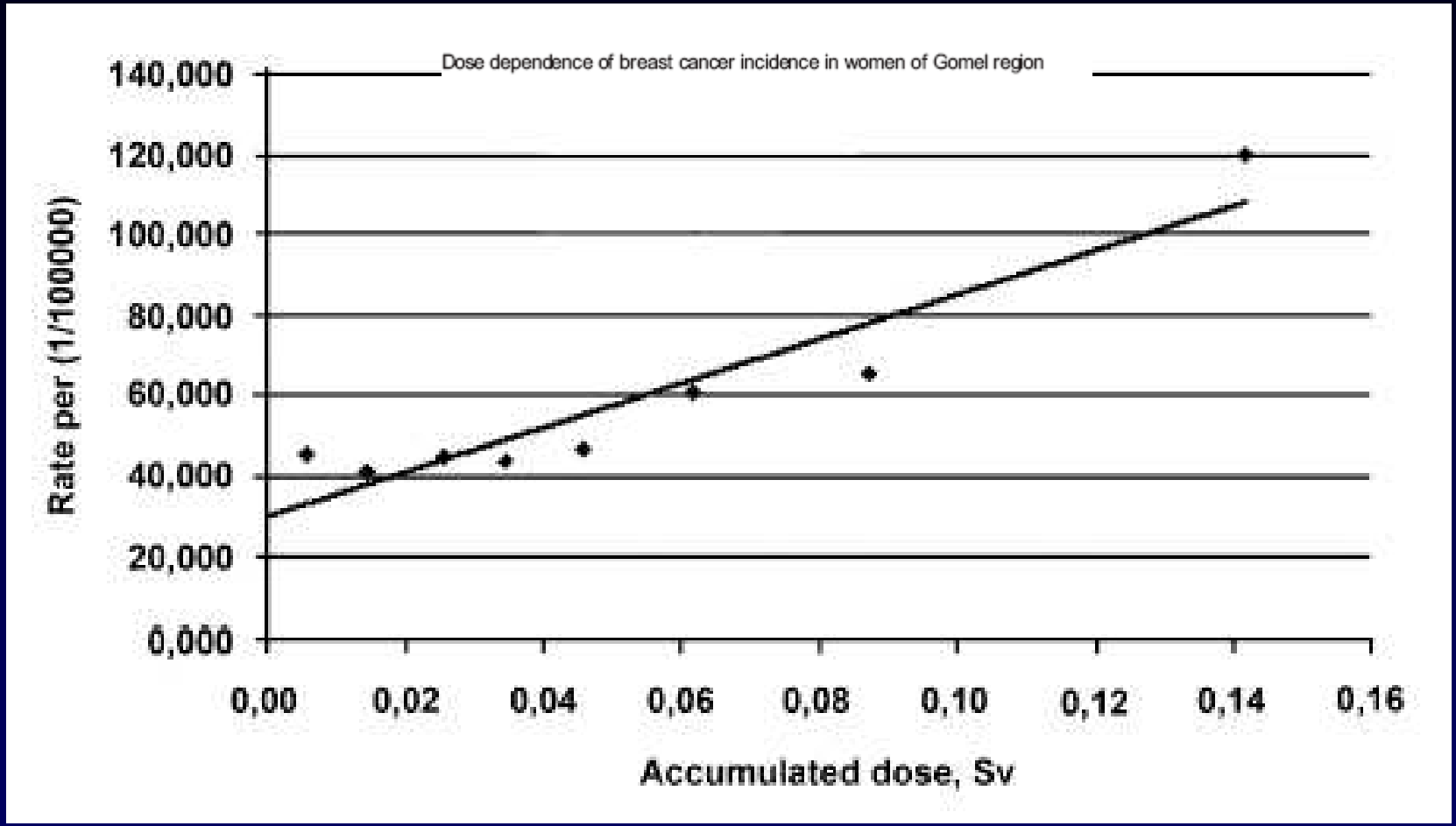
[Okeanov A.E.//Zum int. Kongress “20 Jahre Leben mit Tschernobyl, 2006]

Relative risk of malignant tumors incidence among the population living on the territories of Belarus with 37-555 kBq/m²

Tumor site	ICD X code	1993-1996		1997-2003	
		RR	95% CI	RR	95% CI
Total	C00-97	**1.09**	1.07 – 1.12	**1.15**	1.13 – 1.17
Stomach	C16	**1.03**	0.97 – 1.09	**1.03**	0.96 – 1.07
Colon	C18	**1.01**	0.91 – 1.12	**1.23**	1.15 – 1.32
Lungs	C34	**0.91**	0.86 – 0.97	**0.93**	0.89 – 0.98
Skin	C44	**1.26**	1.18 – 1.35	**1.48**	1.42 – 1.54
Breast	C50	**1.16**	1.08 – 1.26	**1.25**	1.18 – 1.32
Kidney	C64-65	**1.04**	0.91 – 1.18	**0.94**	0.86 – 1.02
Bladder	C67	**1.05**	0.93 – 1.19	**1.05**	0.97 – 1.15
Thyroid gland	C73	**1.45**	1.23 – 1.71	**1.46**	1.33 – 1.59

[Okeanov A.E.//Zum int. Kongress “20 Jahre Leben mit Tschernobyl, 2006]

Dose dependence of breast cancer incidence in women of Gomel region, Belarus



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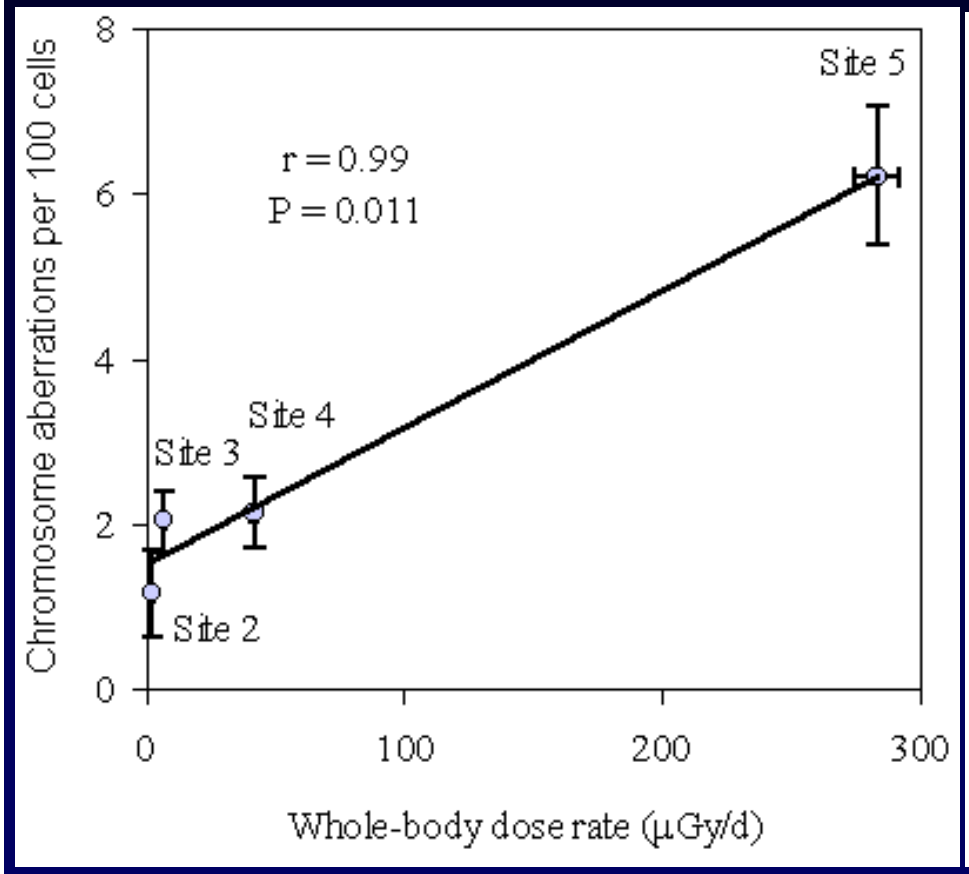
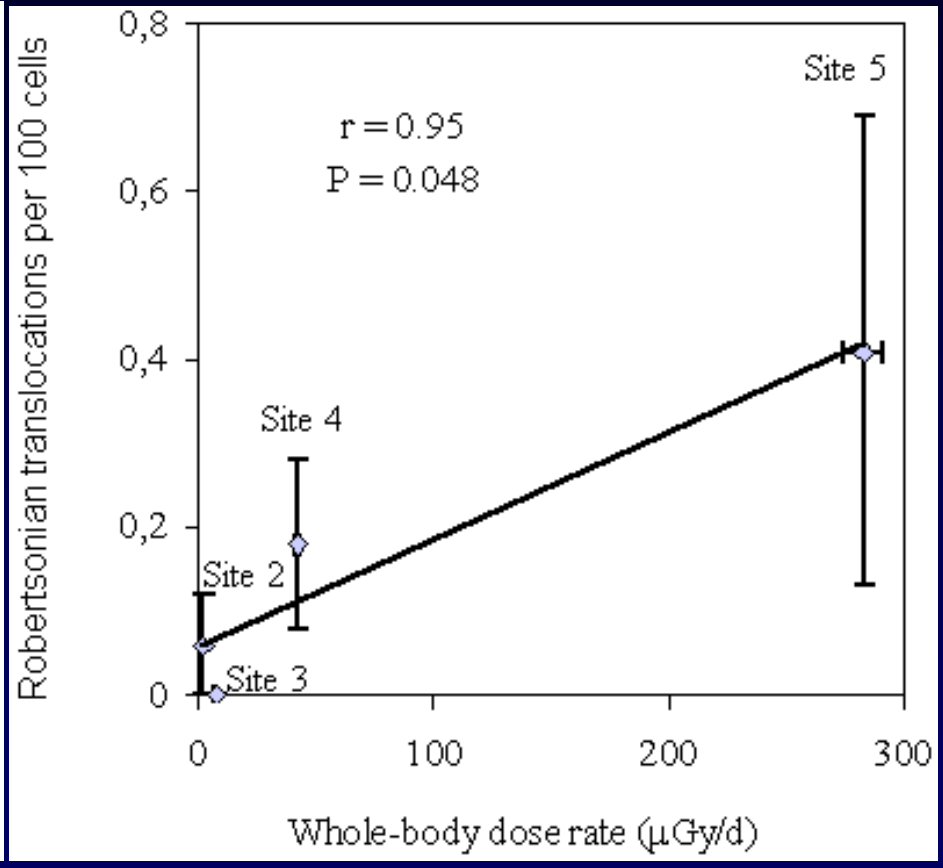
National Report, 2006]

Correlation between chromosome aberrations with the whole-body absorbed dose rate in model mammalian species, the bank vole in 1996

a) All types of aberrations

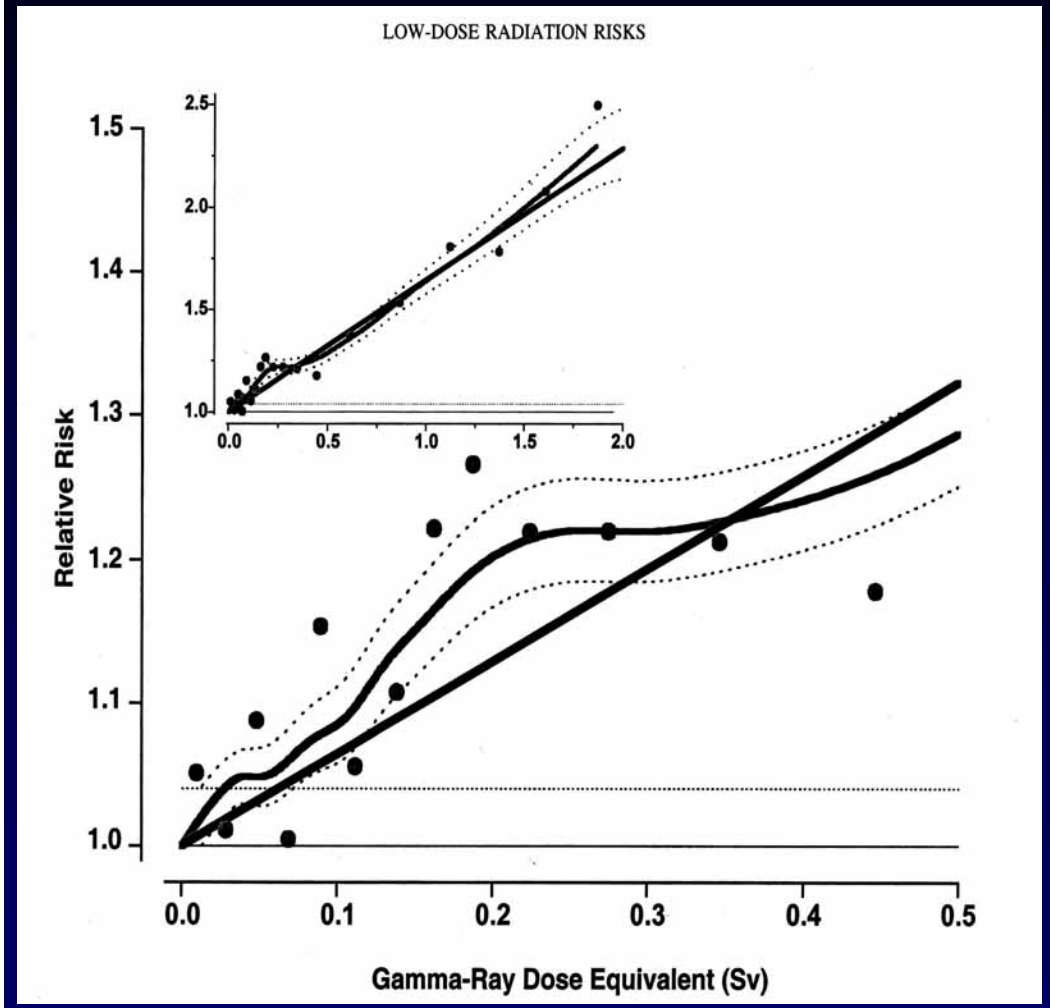


b) Robertsonian translocations



[N. I. Ryabokon, R. I. Goncharova // Radiation and Environmental Biophysics, 2006]

Radiation-related cancer risks at low doses among atomic bomb survivors



Estimated low-dose relative risks. Age-specific cancer rates over the 1958–1994 follow-up period relative to those for an unexposed person, averaged over the follow-up and over sex, and for age at exposure 30. *The dashed curves* represent ±1 standard error for the smoothed curve. *The straight line* is the linear risk estimate computed from the range 0–2 Sv. Because of an apparent distinction between distal and proximal zero-dose cancer rates, *the unity baseline* corresponds to zero-dose survivors within 3 km of the bombs. *The horizontal dotted* line represents the alternative baseline if the distal survivors were not omitted. *The inset* shows the same information for the fuller dose range.

[D.A. Pierce, D.L. Preston // Radiation Research, 2000]

Studies of the mortality of atomic bomb survivors.

Report 12, Part I. Cancer: 1950–1990

Dose category	ERR	ERR per Sv
0.005–0.02	0.03	2.6 ± 2.1
0.02–0.05	0.05	1.6 ± 0.90
0.05–0.10	0.04	0.60 ± 0.40
0.10–0.20	0.06	0.43 ± 0.25
0.20–0.50	0.12	0.38 ± 0.13

D.A. Pierce, Y. Shimizu, D.L. Preston, M. Vaeth, K. Mabuchi // Radiation Research, 1996]

Conclusions

- **The whole body doses** received by exposed populations of the Republic of Belarus are estimated to be in the dose range of 0–0.15 Gy, i. e. **within the range that led to a significant increase in cancer incidence in atomic bomb survivors**.
- **Thyroid cancer incidence continues growing** steadily among adult population of Belarus (National Report, 2006).
- For the period of 1990–2003 there is **a statistically significant increase of breast cancer incidence** among women of the most contaminated Gomel region of Belarus in comparison with appropriate value among women living in the less contaminated areas. Dose dependence between accumulated radiation dose and realized relative risk of breast cancer has been shown.
- According to A. Okeanow's data, among population living in the regions of 37–555 kBq/m^2, **considerable growth of relative risk of cancer incidence occurred in 1997-2003** in comparison with the previous period 1993-1996.
- Summing up all these data allows us to conclude that the Chernobyl accident will result in **a number of unfavorable health consequences for both affected people and coming generations**.
- Particularly, an increased thyroid cancer incidence of children born from irradiated parents chronically exposed due to Chernobyl accident might be **a manifestation of the induced genomic instability**.
- For the establishment of the causal role of low dose radiation exposure due to Chernobyl fallout for the observed increases of many types of cancer in Belarus (National Report, 2006), **health radiation-epidemiological and cohort studies with reconstruction of whole body absorbed doses must be carried out in the future**.
- So far, all declarations on the absence of radiation-linked increases in the incidence of other types of cancer simply mean **the ignoring of data established in Belarus**.