For those who wish to know the health consequences of the Fukushima catastrophe, the answers are to be found within this volume and in the radiation risk model of the ECRR. The data presented at the 2009 Lesvos conference of the European Committee on Radiation Risk (ECRR) show the real world effects of living in areas contaminated with the dispersed contents of an exploded nuclear reactor. Twenty five years of studies of people living on the Chernobyl contaminated territories has been enough to quantify in detail the cancers, the heart disease, the loss of lifespan, the congenital illnesses, even the changes in sex ratio, in childhood intelligence and in mental health that follow the exposures to radioactive contamination from fission products, activation products and uranium fuel particles.

All of these are described in this volume in great detail, by the eminent scientists who have studied them. As Edmund Burke famously said, Those who don't know history are doomed to repeat it; but the true history of the health effects of exposure to the radioactive substances released by both the Chernobyl and Fukushima catastrophes have been covered up by the power of the nuclear lobby. And the main instrument that has been used for this is the radiation risk model of the International Commission on Radiological Protection, the ICRP. But as far as scientific evidence goes, the simplistic ICRP risk model is now bankrupt. It is now clear to all, except governments who depend upon the ICRP model to justify their support of nuclear energy and nuclear weapons, that the model is unsafe. With terrifying prescience, the matter was raised in 2009, in a videotaped meeting between the Scientific Secretary of the ECRR Prof. Chris Busby and the just-retired Scientific Secretary of the ICRP, Dr Jack Valentin. In this meeting, and presented in this volume, Valentin states quite unequivocally, that the ICRP model cannot be used to assess the risk from a major accident at a nuclear power station. It is not what it is for, he said. Yet this is just exactly what it is being used for 7 months after the Fukushima catastrophe.

This is a political issue, an issue of democracy. It is also an issue for those involved, deciding whether to evacuate their children from the contaminated areas. Perfect political decisions require accurate information. For those decision-makers and members of the public who want to know what will happen to the people of Fukushima and wider areas of Japan, the information is here.

The cornerstone of Science Philosophy is the *Canon of Agreement*, which states that *the antecedent conditions of a phenomenon, when repeated, will produce the same phenomenon.* Let no one doubt that the Chernobyl experiment, repeated in Fukushima, will cause the same result, a result reported in these proceedings in all its terrifying clarity.

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ECRR

Fukushima and Health: What to Expect

## Fukushima and Health: What to Expect



Proceedings of the 3rd International Conference of the European Committee on Radiation Risk, Lesvos, Greece, May 5th/6th 2009

Edited by: Christopher Busby, Joseph Busby, Ditta Rietuma and Mireille de Messieres \_\_\_||

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## Fukushima and Health: What to Expect

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> > Edited by

Chris Busby, Joseph Busby, Ditta Rietuma

and Mireille de Messieres

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JV: ICRP's position is that it's possible to use it albeit with large uncertainties.

**CB:** How large is large?

JV: Two orders is a very large uncertainty.

**CB:** So it could be in error by two orders for some internal exposures — so we agree?

JV: (laughing) I'd hate for you to go home and say "Jack agreed with me"

CB: but I need an answer

**JV:** Then the answer is I don't agree with you. (laughing)

**CB:** but you just said *Two orders of magnitude* ...

**JV:** Yes but you can find, I'm sure you can find, an exceptional case, a specific case, where there would be that sort of uncertainty but remember it can go in another direction, and I'm sure that you can find in most cases there are uncertainties which are less than one order of magnitude, which you would find normally. If we look at the existing evidence I don't think you have enough evidence to prove your case.

**CB:** The existing evidence is three orders of magnitude, if we take the childhood leukaemia clusters around nuclear sites; three orders.

JV: That's what you are claiming on the basis of a handful of cases.

**CB:** I'm claiming it on the basis of the German study, Aldermaston, Sellafield, Harwell and many others [...] #

The full meeting was videotaped and can be seen on:

www.youtube.com/watch?v=minY5smeLGKw

Shortly after this meeting Busby addressed the Swedish radiation protection institute SRM. Deputy Director Carl Magnus Larsson said the ICRP model cannot be used to predict the health consequences of accidents. He added that for elements like Strontium and Uranium which bind to DNA national authorities would have the responsibility to assess the risks. Another SRM member said that the Secondary Photoelectron Effect was well recognised, also that in 1977 the ICRP had considered a weighting factor "n" for elements which bind to DNA but had not implemented it. Carl Magnus Larsson was sent to Australia where he still (Oct 2011) is.

**Table 1.1.** Some examples of the development of cancer and other ill health in populations exposed to internal radionuclides which the current radiation risk model of the ICRP fails to predict or explain

Example	Effect	Error factor	Note
Global	Cancer epidemic,	300-500 for	Cancer increases easily seen
atmospheric	infant mortality,	cancer	in populations of Wales and
tests	heart disease		England [1,3]
Chernobyl	Infant leukemia in	400	Published in two journals,
	Germany, Greece,		discussed by CERRIE [2,3]
	Scotland, Wales,		No other explanation
	Belarus		
Chernobyl	Cancer in Sweden	600	Study by Tondel et al [6]
			shows increased cancer risk
			of 11% per surface
			contamination of 100kBqm <sup>-2</sup> .
			Effect predicted by ECRR
			model [3]
Chernobyl	Global health	Vary. Many	Report by Yablokov et al in
	effects	effects not	New York Academy of
		predicted by	sciences [4]
		current	
		models	
Nuclear Test	8-fold Child	Not predicted	Similar high congenital
veterans	congenital	by current	anomalies in Fallujah Iraq
	anomalies	models	due to Uranium weapons
			[9, 10]
Uranium	Very large	1000 to	Cancer in Gulf veteran now
effects in Iraq	increases in cancer	10,000	(2009) linked to DU
Gulf veterans,	and birth defects		exposure by a coroner jury in
Balkans			UK [11]
peacekeepers			
Childhood	Sellafield and	1000 to	No other explanation
cancer	many others. Most	10,000	
nuclear sites	recent is KiKK		
	study		
Irish Sea	Sharp increase in	1000 to	Very high statistical
coastal	cancer risk near	10,000	significance. Inhalation of
contamination	coast		particulates



*Figure 3* - Alpha particle decays – Micron diameter particles of Plutonium in a rat lung: 'Alpha Stars'

![](_page_8_Figure_2.jpeg)

Figure 4 - Some DNAP dimensions

The internal doses to human populations from various processes have been calculated and are listed in the literature, e.g. UNSCEAR reports. One obvious way forward is therefore to employ weighting factors for the different internal exposures: this was the approach taken by ECRR2003.

## Non cancer illnesses and conditions in areas of Belarus contaminated by radioactivity from the Chernobyl Accident

### Prof. Yuri Bandashevsky

Mykolas Romeris University, Vilnius, Lithuania

The ecological environment influences the health of people and regulates the development of human society. Ignoring the considerable overall global progress in the business of protection of the environment (and therefore the health of people) there are countries in which there are serious environmental problems. First of all are the countries of the former Soviet Union. The aspiration to catch up and overtake the military and economic development of Western countries forced the former Soviet Union administration to introduce new industrial technologies that left a fatal impact on the environment and therefore the health of people. First of all, it is necessary to consider the Nuclear weapons tests of the USSR.

Pollution by radioactive elements of huge territories in Belarus, Lithuania, Latvia, Estonia, the Ukraine and Russia since the 1960s is the direct consequence. The population of these countries had no information on the existing radiation factor, and it could therefore not naturally protect itself from its influence in any way.

#### The Radio-ecological problem in Belarus

Since the beginning of the 1960s there have been a great number of Cs-137 radionuclides found in foodstuffs consumed by the inhabitants of these Soviet states for many years [1]. Although the contamination of Belarus by the Chernobyl catastrophe is well known (Fig1) what is less well known is the prior contamination by the weapons test fallout. I present a number of pieces of evidence of the contamination of areas of the USSR in Figures 2.2-2.4. Fig 2.2 shows how, prior to the Chernobyl disaster, Cs-137 levels were high in the 1960s and fell regularly after the atmospheric bomb tests were banned in 1963. For example, cow's milk is one of the basic products containing high levels of Cs-137 radionuclides for inhabitants of Belarus and the Baltic lands. A "Milk-Caesium Map" was created – the largest Cs-137 radionuclides contained were observed from 1967 to 1970 in Gomel region of the Republic of Belarus.

![](_page_10_Figure_0.jpeg)

Fig 2.6 Demographic index for the Republic of Belarus, 1950-2004

![](_page_10_Figure_2.jpeg)

Fig 2.7 The dynamics of the death-rate of the population in different districts of Belarus

![](_page_11_Figure_0.jpeg)

Fig 2.15 Number of children without ECG modifications as a function of Cs-137 concentration in the organism (Bandashevsky and Bandashevsky).

# Bystander effects and genomic instability Part 1: From the gene to the stream

#### Prof. Carmel Mothershill, Prof. Colin Seymour

McMaster University, Hamilton, Ontario, Canada

#### Editors Note:

Prof Motherhill gave a powerpoint presentation and also later on a paper. Since the presentations and remarks at the conference were so interesting we reproduce the elements of the presentation as Part I and following this as the paper in Part 2

I will present our recent research on the phenomena known as **genomic instability** and the **bystander effect**. Many scientists now refer to these areas as Non Targeted Effects NTE. I will consider some aspects and findings relating to Non Targeted Effects:

- The fish model
- Case studies
- Serotonin
- DNA repair
- Legacy/ delayed effects
- Multiple stressors
- Implications
- Ecological
- Evolutionary

The old view of the introduction of genetic damage into somatic cells to cause cancer and other effects was that there was a fixed mutation, a hit, and this expanded through the normal replication of the cell to increase the number of descendants carrying this mutation. This was called the clonal expansion theory.

### Nanoparticles and Radiation

Andreas Elsaessar, Chris Busby, George McKerr, C. Vyvyan Howard

Centre for Molecular Biosciences, University of Ulster

(These results were originally given as a poster: Elsaesser A, Busby C, McKerr G and Howard CV (2007) Nanoparticles and radiation. EMBO Conference: Nanoparticles. October 2007 Madrid and also: Elsaesser A, Howard C. V., & Busby C. (2009) The biological implications of radiation induced photoelectron production, as a function of particle size and composition. *International Conference; Royal Society for Chemistry NanoParticles Liverpool 2009*)

#### **Interaction of Radiation and Matter**

Electromagnetic radiation and matter interact predominantly by three different mechanisms: Compton scattering, the photoelectric effect and pair production. Compton scattering basically describes the loss of incident photon energy by the scattering of shell electrons. Pair production is the simultaneous production of an electron and a positron and occurs at energies above 1.022MeV, which is equivalent to the invariant mass of an electron plus positron. With the photoelectric effect electrons absorb the incident photon energy and are either emitted or lose energy in secondary processes. For energies below 1MeV the photoelectric effect is the predominant one. The cross section  $\sigma$  for the photoelectric effect is proportional to Z (atomic number) to the power 5 and roughly proportional to the incident photon energy to the power -7/2.

$$\sigma = Z^5 E_{\gamma}^{-7/2}$$

Most of the photoelectrons produced in an absorbing material lose their energy though electron-electron scattering and Bremsstrahlung (breaking radiation). Therefore the escape depth of photoelectrons generated in solids is usually a few nanometers [1].

Hence, irradiated particles with diameters in the range of a few nanometres will emit most of the generated photoelectrons without internal absorption. Therefore nanoparticles are likely to emit the largest quantity or secondary electrons in proportion to their mass. Furthermore, secondary electron emission of high Z

![](_page_14_Figure_0.jpeg)

**Fig 7.2** Secondary electron production by 100keV primary photons within the target and escaping electrons overlayed by the target geometry for water (a), gold (b) and Uranium (c). Fig 2 d-f (lower) shows the corresponding energy deposition. Note that these are projections in two dimensions: tracks out of the plane of the paper are not shown. For water the scale is 100 times greater i.e. 100,000 photons produce the 4 tracks compared with 1000 photons producing the tracks shown in the Uranium and Gold case.

# Childhood cancer near German nuclear power plants: The KiKK study

#### Sebastian Pflugbeil and Alfred Körblein

Munich Environmental Institute, German Society for Radiological Protection, Berlin

The KiKK study is an epidemiologic study of childhood cancers near German nuclear power plants. It was commissioned by the Federal Office for Radiation Protection (*Bundesamt für Strahlenschutz*), and conducted by German Childhood Cancer Registry (GCCR) between April 2003 and December 2007. It comprised an external advisory expert commission of 12 people, and after the results were published in an American scientific journal in 1999, the wide media coverage forced the German Federal Office of Radiation Protection to take action. In 2001 it commissioned a new study which was meant to investigate the causes for possible increased cancer rates near NPPs. The study design differed from a purely ecological study – the distance from the plant was included as a proxy of the radiation exposure[1].

The design of the study follows:

- Case-control study (3 controls per case, matched by age, sex and reactor site)
- All cancers, sub group: leukaemias
- All German commercial NPPs
- Children below age < 5
- Longest possible study period (1980-2003)
- One-tailed statistical test
- Proxy of radiation exposure: Inverse distance of place of residence at diagnosis
- Main question: Increase of cancer rates with decreasing distance from NPP?
- Additional test: Cancer rate greater for r < 5 km than for r > 5 km? Cancer rate greater for r < 10 km than for r > 10 km?
- Linear logistic regression model:

![](_page_16_Figure_0.jpeg)

Figure 8.3 – Cancer risk (study region)

![](_page_16_Figure_2.jpeg)

*Figure 8.4* – *Cancer risk (r < 25km)* 

## Estimation of Residual Radiation Effects on Survivors of the Hiroshima Atomic Bombing, from Incidence of the Acute Radiation Disease

#### Prof Shoji Sawada

Nagoya University, Japan

**Abstract :** The effects of exposure due to radioactive fallout on the survivors of the Hiroshima atomic bomb are estimated by analyzing the incidence rates of acute radiation diseases, depilation, purpura and diarrhea, among the survivors. It is found that the effects of radiation exposure due to the fallout exceeds, on the average, the primary radiation effects in people who were beyond about 1.2 km from the hypocenter of the Hiroshima bomb. The average effects of radiation exposure from the fallout increases with distance from the hypocenter, reaches a peak at around 1.2 km, and then decreases gradually for farther distances but remains even at about 6 km. The peak value of estimated effective exposure from the incidence rate of acute diseases are significantly larger than physically measured residual radiation doses suggests that the main effects resulting from residual radiation were caused through internal exposure, especially intake of radioactive small particles among fallout by ingestion and inhalation.

![](_page_18_Figure_0.jpeg)

![](_page_19_Figure_0.jpeg)

*Figure 9.8* - *Measurement of Pu239 in soil brought by fallout rain of Nagasaki bomb (Bq/kg soil)* 

In Nagasaki, as opposed to in the contamination after Hiroshima, the fire rain was much less powerful. As a result, the radioactive fallout matter did not wash out.

![](_page_20_Figure_0.jpeg)

## *Figure 9.9* - *Estimation of Exposure due to the Fallout of Nagasaki Bomb in terms of Incident Rate of Acute Radiation Disease*

Combined Analysis of Examination of Acute Diseases for Nagasaki City (<4.5 km) by Nagasaki Medical College 194. For Enlargement of Designated Region of A-Bombing. Peripheral of Nagasaki City (Av. 9.5 km) by Government of Nagasaki City. Surroundings of Nagasaki City (Av. 11.3 km) Local Gov. Town & Village)

In Figure 9, the closed circles, squares and triangles show incident rates of epilation, purpura and diarrhea, respectively as the acute diseases among survivors of Nagasaki city (< 4.5 km from the hypocenter) examined in 1945 by the Nagasaki Medical College and those incident rates examined by the local government of

### Risk assessment of radiation-induced stomach cancer in the population of Belarus

#### Prof. M.V. Malko

Institute of Power Engineering, National Academy of Sciences of Belarus, Minsk, Belarus

#### Abstract

Results of analysis of the incidence in stomach cancers in the Belarusian population are described in the present report. They were established by using a modified ecological method based on the analysis of temporal patterns of the crude incidence in stomach cancers in different regions of Belarus in 1970-2006. It was found that approximately 2047 additional stomach cancers appeared in Belarus in 1991-2001 (95% CI from 1,472 to 2,630 cases). The number of stomach cancers registered in Belarus in this period is about 42,587 cases (40,540 expected cases).

The performed analysis shows that the numbers of additional stomach cancers manifested in different regions of Belarus are proportional to collective equivalent doses of the whole body irradiation delivered as a result of the Chernobyl accident and the relative risk, RR, is a linear function of the population dose of the whole body irradiation caused by this accident. These findings indicate that additional stomach cancers manifested in regions of Belarus after the accident at the Chernobyl NPP .were caused by radiation.

Assuming radiation origin of additional stomach cancers time-averaged radiation risks were assessed for the period 1991-2001 in the report. According to assessment the relative risk, RR, estimated for the entire Belarusian population is 1.050 (95% CI from 1.036 to 1.065). The excessive absolute risk of stomach cancers, EAR, averaged for this period is assessed as 85 cases per  $10^4$  PYSv (95% CI from 60 cases to 110 cases per  $10^4$  PYSv). The averaged excessive relative risk, ERR, is estimated equal to 2.4% per 1 mSv (95% CI from 1.7 to 3.1% per 1 mSv) and the averaged attributive risk, AR, is assessed equal to 5.0% (95% CI from 3.6 to 6.5%).

#### Introduction.

The accident at the Chernobyl NPP caused a quasi-acute irradiation of the thyroid gland and a long-term irradiation of the whole body of affected populations.

![](_page_22_Figure_0.jpeg)

*Figure 10.5* - *Time-averaged (1992-1001) relative risk of the incidence in stomach cancers in regions of Belarus.* 

![](_page_22_Figure_2.jpeg)

*Figure 10.6* - *Numbers of additional stomach cancers in regions of Belarus in 1991-* 2001.

## Tumours of hematopoietic and lymphoid tissues in Chernobyl clean-up workers

## D.F. Gluzman, L.M. Sklyarenko, V.A. Nadgornaya, M.P. Zavelevich, S.V. Koval

R.E. Kavetsky Institute of Experimental Pathology, Oncology and Radiobiology, National Academy of Sciences of Ukraine, Kyiv, Ukraine

The Chernobyl accident on April 26, 1986 remains the worst ever in the history of the nuclear industry. A dramatic increase in the incidence of thyroid cancer has been observed among those exposed to radioactive iodine in most contaminated areas. The question as to whether the incidence of leukaemias and malignant lymphomas among Chernobyl clean-up workers increased is still a point of much controversy. UN Scientific committee on effects of atomic radiation (report to UN General Assembly, 2001) and Chernobyl Forum (Vienna, 2005) reject the possibility of increasing leukaemia incidence in Chernobyl clean-up workers. Nevertheless, this point of view is inconsistent with the results of several descriptive epidemiologic studies in Ukraine, Byelorussia, and Russia.

In 2006, the standardized incidence of leukaemia, lymphomas and multiple myeloma in adults amounted to 16.5 per 100,000 of population (crude data) (National Cancer Registry of Ukraine). The actual incidence rate is underestimated by about 30% since up to the day several categories of myeloproliferative diseases were not classified as "malignant neoplasms" in IDC-10 (1992) and were not included in Ukrainian Cancer Registry. Various categories of MDS (refractory anemia with and without ringed sideroblasts, refractory cytopenia, refractory anemia with excess of blasts, 5q- syndrome) with total annual incidence of 3.0 per 100,000 also were not accounted. We believe that only precise diagnosis of the major types of hematological malignancies among Chernobyl clean-up workers in comparison with the data in general population will be the basis for estimating the relative contribution of the radiation factor to the overall incidence of such pathologies. The conclusions of other authors are mostly based on crude data without delineation of the incidence according to the biological subtypes of leukaemia and lymphoma. The aim of the study is to present the data on the various forms and variants of leukaemia and lymphoma verified by Western standards in the consecutive group of 281 Ukrainian Chernobyl clean-up workers developed in 10-23 years after Chernobyl accident, diagnosed in the Ukrainian Reference Laboratory in 1996-2008 and

- MGG staining of blood and bone marrow smears
- Cytochemical detection of myeloperoxidase, acid phosphatase, alkaline phosphatase, acid non-specific esterase, naphtol-AS-D-chloroacetate esterase, PAS reaction
- Immunocytochemical detection of antigens (ABC-AP, APAAP methods):
- Myeloid cells: CD33, CD13, CD15, CD64, CD16, MPO
- Erythroid and megakaryocytic cells: CD71, CD61, CD62, CD41, CD42, glycophorin A
- T-cells: CD7, CD5, CD3, CD2, CD1a, CD4, CD8, CD45RO, γδTCR
- B-cells: CD19, CD20, CD22, CD10,  $\kappa$ ,  $\lambda$ ,  $\mu$  chains
- Stem cell and markers of commitation: CD34, CD38, CD45RA, HLA-DR
- Figure 12.4 Diagnostic techniques

Type of leukaemia	Absolute number and relative in the brackets)	ute number and relative frequency (percentage brackets)	
	Chernobyl clean-up workers	General population	
Myelodysplastic syndromes	<u>15 (5.34%)</u>	107 (3.70%)	
Acute myeloid leukaemia	44 (15.66%)	732 (27.14%)	
Acute lymphoblastic leukaemia	17 (6.03%)	214 (7.93%)	

*Figure 12.5* - *Summary of malignant diseases of hematopoietic and lymphoid tissues diagnosed in Chernobyl clean-up workers* 

Chronic myelogenous leukaemia	25	178
	(8.90%)	(6.59%)
Polycythemia vera	6 (2.13%)	3 (0.11%)
Essential thrombocythemia	8 (2.85%)	_
Chronic eosinophylic leukaemia/ Hypereosinophylic syndrome	2 (0.71%)	_
Chronic idiopatic myelofibrosis	4 (1.42%)	2 (0.07%)
Chronic myelomonocytic leukaemia	8 (2.85%)	84 (3.11%)
Chronic lymphocytic leukaemia	75	791
	(26.96%)	(29.32%)
B-cell prolymphocytic leukaemia	4 (1.42%)	23 (0.85%)
Hairy cell leukaemia	11	118
	(3.91%)	(4.37%)
Multiple myeloma	18	108
	(6.41%)	(4.00%)
Non-Hodgkin's lymphoma	34	296
	(12.13%)	(10.97%)
in leukemization phase		
Sezary syndrome	3 (1.07%)	8 (0.29%)
T-cell prolymphocytic leukaemia	2 (0.71%)	3 (0.11%)
Large granular lymphocytic leukaemia	5 (1.77%)	3 (0.11%)

*Figure 12.6* - *Summary of malignant diseases of hematopoietic and lymphoid tissues diagnosed in Chernobyl clean-up workers* 

### Radiation induced genetic effects in Europe after the Chernobyl nuclear power plant catastrophe Prof Hagen Scherb, Dr Kristina Voigt

Institute of Biomathematics and Biometry, German Research Center for Environmental Health, Neuherberg, Germany

#### Genetic

#### Effects

Muller carried out experiments with varied doses of X-rays to Drosophila, and a connection between radiation and lethal mutations emerged. By 1928, others had replicated his results, expanding them to other model organisms such as wasps and maize. A genetic effect, as a definition, may be the result of radioactivity or substances that cause damage to (the genes of) a reproductive cell (sperm or egg), or a somatic cell, which can then be passed from one generation to another, or may induce disease (e.g. cancer) in an individual. Examples can include Sex odds, birth defects, stillbirths, leukaemia or thyroid cancer.

(http://www.doh.wa.gov/Hanford/publications/overview/genetic.html) Muller HJ (1927). Artificial transmutation of the gene. Science 66: 84-87

Genetic theory for the human sex odds at birth

Irradiated parents and offspring gender

Fathers only	⇒	
Mothers only	=>	sex odds
Both parents	=>	???

![](_page_27_Figure_0.jpeg)

*Figure 14.9* - Sex odds and fallout (dose) in Germany (1984-1991, long-term dose dependent jump heights 1986-1991)

![](_page_27_Figure_2.jpeg)

10 Bloot-Contaminuted Districts	<sup>HE</sup> Ca kBipm <sup>2</sup>	10 Least-Contaminated Districts	<sup>ser</sup> Cs kögw
Nugdrurg, City	61.7	Subweight, Obj	5.3
Ser thingsten	51.3	MR, OBy	5.2
Gamlach-Participation	415	Miturburg	4.9
Mentilipet, Oly	402	Main-Spenart	47
Disalgha	35.5	Woldwa, Obr	4.5
kupburg	323	Wughung	4.6
lagan	31.8	Rhim-Grabhield	6.4
ki/ach-Priedberg	22.4	Biel Kleatigen	3.9
imbinglash	21.2	Weider, City	2.7
Neutrop-Schrubenhausen	217	Schweinfult	21

Fig. 5: Birth prevalences of two congenital heart malformations (ICD7454+ICD7455, n = 2797) in Bavaria: stratification according to contamination of districts (see Table 1)

*Figure 14.10* - Congenital malformation of the heart (1984-1991, long-term dose dependent jump heights 1987-1991)

Similar effects on the sex odds as recently published have already been observed in the USA and in Europe on a global scale in the 1960s and 1970s, but have not yet been acknowledged as possible effects of atmospheric atomic bomb test fallout.

Note, the "missing boys" in the "sex ratio literature" may be "less missing girls" from the 1970s onward, after the atmospheric atomic bomb test ban.

![](_page_28_Figure_2.jpeg)

Figure 14.11 – Sex odds and atmospheric atomic bomb testing

M Martuzzi, N Di Tanno, R Bertollini. Declining trends of male proportion at birth in Europe. Archives of Environmental Health, 56(4):358 364, Jul- Aug 2001.

TJ Mathews and BE. Hamilton. Trend analysis of the sex ratio at birth in the united states. Nat Vit Stat Rep, 53(20):1 17, Jun 2005. Nat Cent for Health Stat.

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![](_page_29_Figure_0.jpeg)

Figure 14.14 – Sex odds in Western Europe – less exposed

![](_page_29_Figure_2.jpeg)

*Figure 14.15* – *Sex odds in Central and Eastern Europe – moderately or highly exposed* 

![](_page_30_Figure_0.jpeg)

Figure 14.21 – Sex odds in Belarus

![](_page_30_Figure_2.jpeg)

Figure 14.22– Sex odds in Denmark

![](_page_31_Figure_0.jpeg)

Figure 14.20 – Sex odds in the Former Yugoslavia

![](_page_31_Figure_2.jpeg)

Figure 14.21 – Sex odds in the Russian Federation

![](_page_32_Figure_0.jpeg)

*Figure 14.26* – Down syndrome in Europe before and after Chernobyl (1)

# In Utero exposure to Chernobyl accident radiation and the health risk assessment

#### Prof. Angelina Nyagu

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We must first ask a question: what do we know about the qualitative and quantitative effects of ionizing radiation on the developing embryo?

![](_page_33_Figure_4.jpeg)

*Figure 15.1* - Specific radiation effects on foetus: mental retardation, microcephaly - Japanese study

The study shown in Figure 1 shows that those exposed at a gestational age of 8–15 weeks were most at risk. Survivors of the atomic bombing in Japan who were exposed in utero during this sensitive period show a linear increase in the frequency of mental retardation with radiation dose (40% per Gy). There were 2,800 people in this study.

However, there is evidence that radiation affects intelligence (Figs 2-3). John Gofman writes:

"In-utero irradiation during the vulnerable period causes the brilliant to become less brilliant, the average to become "below average," and the retarded to become more retarded. And by pushing more people over the heavy vertical line into the realms of mental retardation and sever retardation, such exposure automatically increases the There are 20 children from Pripyat (13.2%) who had been exposed in utero >100 mSv – the threshold for medical abortion due to prenatal irradiation (European Commission, 1998; ICRP Publication 84, 2000).

![](_page_34_Figure_1.jpeg)

Figure 15.9 - Dose on embryo and foetus distribution (ICRP-88)

![](_page_35_Figure_0.jpeg)

Figure 15.23 - Wechsler Intelligence Scale for Children (WISC): Full scale IQ

![](_page_35_Figure_2.jpeg)

Figure 15.24 - Intelligence of children (WISC): Verbal IQ

![](_page_36_Figure_0.jpeg)

Diseases of the Nervous System (ICD-10)

Figure 15.34 – As titled

![](_page_36_Figure_3.jpeg)

Figure 15.35 – As titled

## The real effects of the Chernobyl accident and their political implications

#### Alexey V. Yablokov

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I start by calling to attention our publication in Volume #1171 of the Annals of the New York Academy of Sciences, which will be published in English (enlarged and revised) in the book "Chernobyl: Consequences of the Catastrophe for People and Nature" by A. Yablokov, M. Nesterenko and A.Nesterenko (St. Petersburg, "Nauka" Publ.,2007, 372 p.) Hundreds of individuals and organizations help us made this mega-review. This is very likely the broadest scope and undoubtedly the most up-to-date monograph about the Chernobyl consequences.

Among reasons complicating an estimation of the impact of the Catastrophe on health, singular is the Official secrecy and falsification of the USSR medical statistics for the first 3½ years after the Catastrophe. These created difficulties in estimating true individual doses in view of a reconstruction of doses in the first days, weeks, and months; uncertainty as to the influence of "hot particles"; problems accounting for spotty contamination and an inability to determine the influence of each of many radionuclides, singly and in combination. The demand by IAEA and WHO experts to require "significant correlation" between the imprecisely calculated levels of individual radiation (and thus groups of individuals) and precisely diagnosed illnesses as the only iron-clad proof to associate illness with Chernobyl radiation is not scientifically valid.

Objective information on the impact of the Catastrophe on health can be obtained comparing: morbidity / mortality of territories having identical physiographic, social, and economic backgrounds and differ only in radioactive contamination; the health of the same group of individuals during specific periods after the Catastrophe; the health of the same individual in regard to disorders specifically linked to radiation (e.g., stable chromosomal aberrations); health of individuals living in contaminated territories by the level of incorporated radionuclides; and by correlating pathological changes in particular organs by measuring their levels of incorporated radionuclides.

![](_page_38_Figure_0.jpeg)

*Figure 16.1* - All solid cancers in Bryansk and Kaluga provinces and Russia (Ivanov et al., 2004)

Among specific disorders associated with Chernobyl radiation, there is increased morbidity and prevalence in the blood and the circulatory system; endocrine system; immune system ("Chernobyl aids," increased incidence and seriousness of all illnesses); respiratory system; urogenital tract and reproductive disorders; musculoskeletal system (including composition of bones: osteopenia and osteoporosis); central nervous system (changes in frontal, temporal, and occipitoparietal lobes of the brain, leading to diminished intelligence and behavioural and mental disorders); eves (cataracts, vitreous destruction, refraction anomalies); digestive tract; congenital malformations and anomalies (including previously rare multiple defects of limbs and head); thyroid cancer (Chernobyl thyroid cancers rapid and aggressive, striking children and adults); leukaemia (not only in children and liquidators, but adult population) and other malignant neoplasms. Amongst other health consequences of the Catastrophe, exist Intensified infectious and parasitic diseases (e.g., viral hepatitis and respiratory viruses), premature aging in both adults and children, multiple somatic and genetic mutations and most common within these is polymorbidity (people are often afflicted by many illnesses at the same time).

Chernobyl has "enriched" medicine with terms and syndromes never seen before:

"Cancer rejuvenescence,"

![](_page_39_Figure_0.jpeg)

*Figure 16.2* - Comparison of the relative level of mortality in six Russian areas contaminated by the Catastrophe provinces with the six less contaminated neighboring areas (Khudoley et al, 2006)

![](_page_39_Figure_2.jpeg)

## Sex ratio of offspring of A-bomb survivors – Evidence of Radiation-induced X-linked lethal mutations

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#### Abstract.

According to genetic theory, females exposed to ionizing radiation before conception will have lower proportion of boys in their offspring. Likewise, males' exposure will result in fewer girls. In 1953, Neel and Schull reported changes in sex ratio (SR- males per 1000 females) in the children born during 1948-53 (Phase I) to parents exposed to radiation from the atom bombs in Hiroshima and Nagasaki. As the findings were in line with the theory, the study was extended for another eleven years (Phase II). According to the latest paper published in 1981, the findings in the second phase contradicted those of the first phase and hence the observed deviations were dismissed as accidental and biologically insignificant. A closer look at two papers of the same study published in 1965 and 1981 reveals that 1819 boys and 753 girls were added to the Phase II database in the 1981 report without any explanation. SR of all children born during 1954-65 was 1071 in 1965 report and 1100 in 1981 report. Even though there were changes in data for the period 1948-53, these were minimal and the effect on SR was marginal. There were two control groups in this study and SR of these groups during Phase I were 1034 and 1089. SR of all children born in Japan during 1950-55 was 1055. Reanalysis of data using the Japanese SR as the reference shows that (a) SR of all children in the study was 1075, significantly different from the reference (Chi square 6.36, p=0.0117) (b) SR of one of the 'unexposed' control groups was 1089, significantly different from the national SR (Chi square 8.54, p=0.0034), (c) the other 'control' group had a lower SR of 1034 and (d) all the nine cohorts in the reanalysis had deviant SR, four of them protheory. The deviances in (b) and (c) above could have been due to the inclusion of fathers and mothers exposed to residual radiation from neutron activation products and fission products respectively. Incidentally, these two groups were treated as control groups in all the genetic studies conducted in the target cities. All genetic studies done in Hiroshima-Nagasaki need be reviewed.

#### Results

Five exposure groups had excess of females and four have excess of males in comparison with the Japanese SR. In the female excess cohorts, the mothers were proximally exposed in three, were distally exposed in one and were NIC in one cohort. At the same time, the fathers were proximally exposed in one group, NIC in one and distally exposed in three groups. In the four male excess groups, the fathers were proximally exposed in two and NIC in the other two cohorts. The mothers were distally exposed in two and NIC in two groups. The percentage male in total births in the study during 1948-53 is 51.82 as against the reference percentage of 51.34 in Japan and the difference between them is statistically significant (df=1, p= 6.36, chi sq =0.012). Within the groups, the proportion of male in offspring of NIC-NIC couples is 52.12 and this difference is also highly significant. (df=1, p= 8.54, chi sq = 0.0034). An estimated 230 male zygotes and 869 female zygotes were lost from the female excess and male excess cohorts respectively. These represent 2.5% of the male zygotes and 3.3% of the female zygotes conceived during 1948-53.

The main findings of this reanalysis are:

- There has been an arbitrary, sex selective addition of data in the paper published in 1981. This has masked the effect on SR reported earlier.
- SR of both the internal and external control groups differs from the reference SR.
- There is a significant increase in SR in the total sample of the Phase I.
- SR of all the nine cohorts is different from the Japanese SR. The highest aberration (male excess) is found in the children of NIC fathers. The offspring of distally exposed mothers have a lower SR (Fig 11, 12).

#### THE MAIN FINDINGS OF THIS REANALYSIS

• Arbitrary, sex selective addition of data in the 1981 paper masked the effect on SR.

• SR of both internal and external control groups differs from the reference SR.

- The highest male excess is in children of NIC fathers.
- The distally exposed mothers have a lower SR.
- Significant increase in SR in total sample of Phase I.
- SR of all the nine cohorts is different from the Japanese SR.

Fig 17.11 The main results of reanalysis of the data

![](_page_42_Figure_8.jpeg)

Fig 17.12 Deficit/ excess of males per 1000 females 1948-53

#### Discussion

In three out of the five female excess cohorts, mothers were proximally exposed and in two out of the four male-excess cohorts fathers were proximally exposed to instantaneous radiation from gamma rays and neutrons. The female excess could have been due to loss of male zygotes carrying a maternal X chromosome with recessive lethal mutation. Likewise, the male excess may be due to dominant lethal