

■ Radiation effects on gonads (reproductive cells)

◎ Gene mutations

Changes in genetic information in DNA
(point mutation)

◎ Chromosome aberrations

Structural chromosomal aberrations

* Increases in hereditary diseases in the offspring have not been proved among human beings.

■ Risks of heritable effects (up to children and grandchildren)

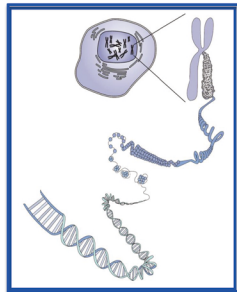
= **Approx. 0.2%/Gy** (Two out of 1,000 people per gray)
(2007 Recommendations of the International Commission on Radiological Protection (ICRP))

This value is indirectly estimated using the following data:

- Spontaneous incidences of hereditary diseases among a group of human beings
- Average spontaneous gene mutation rate (human beings) and average radiation-induced mutation rate (laboratory mice)
- Correction factor for extrapolating potential risks of induced hereditary diseases among human beings based on radiation-induced mutation rate among laboratory mice

■ Tissue weighting factor for gonads (ICRP Recommendations)

0.25 (1977) → 0.20 (1990) → 0.08 (2007)



Data on Atomic
Bomb Survivors

Stable chromosome aberrations among children of atomic bomb survivors

Sources of aberrations	Number of children with chromosome aberrations (percentage)	
	Control group (7,976 children)	Exposed group (8,322 children) Average exposure dose: 0.6 Gy
Derived from either of the parents	15 (0.19%)	10 (0.12%)
Newly developed cases	1 (0.01%)	1 (0.01%)
Unknown (Examination of parents was not possible.)	9 (0.11%)	7 (0.08%)
Total	25 (0.31%)	18 (0.22%)

Source: Prepared based on "Chromosomal Aberrations among Children of Atomic Bomb Survivors (1967 - 1985 surveys)" on the website of the Radiation Effects Research Foundation (https://www.rerf.or.jp/programs/roadmap/health_effects/geneefx/chromeab/)

Survey of Children of Childhood Cancer Survivors

	Children of childhood cancer survivors (6,129 children)		Children of siblings of childhood cancer patients (3,101 children)	
	Number of cases	Frequencies	Number of cases	Frequencies
Cytogenetic abnormality	7	0.1%	6	0.2%
Mendelian disorders	14	0.2%	8	0.3%
Malformation	136	2.2%	97	3.1%
Total	157	2.6%	111	3.6%

* The average gonadal dose among cancer survivors is 1.26 Gy for females and 0.46 Gy for males.

Source: Prepared based on Green DM et al: J Clin Oncol Vol.27, 2009: 2374-2381

© 2009 American Society of Clinical Oncology
Green DM et al: Journal of Clinical Oncology 2009 27:14, 2374-2381
<https://ascopubs.org/doi/10.1200/JCO.2008.21.1839>

Wolters Kluwer Health, Inc. and its Societies take no responsibility for the accuracy of the translation from the published English original and are not liable for any errors which may occur.

**Abnormalities at Birth among Children of Atomic Bomb Survivors
(Malformations, Stillbirths, Deaths within Two Weeks)**

		Father's dose (Gy)			
		<0.01	0.01-0.49	0.5-0.99	>=1
Mother's dose (Gy)	<0.01	2,257/45,234 (5.0%)	81/1,614 (5.0%)	12/238 (5.0%)	17/268 (6.3%)
	0.01-0.49	260/5,445 (4.8%)	54/1,171 (4.6%)	4/68 (5.9%)	2/65 (3.1%)
	0.5-0.99	44/651 (6.8%)	1/43 (2.3%)	4/47 (8.5%)	1/17 (5.9%)
	>=1	19/388 (4.9%)	2/30 (6.7%)	1/9 (11.1%)	1/15 (6.7%)

Other Epidemiological Surveys of Children of Atomic Bomb Survivors

- **Deaths from leukemia or possibly hereditary tumors, etc. developed by the age of 20**

The follow-up survey of 41,066 subjects revealed no correlation between parents' gonadal doses (0.435 Sv on average) and their children's deaths.

(Source: Y. Yoshimoto et al.: Am J Hum Genet 46: 1041-1052, 1990.)

- **Incidence rate of cancer (1958 - 1997)**

As a result of the follow-up survey of 40,487 subjects, development of solid tumors and blood tumors was found in 575 cases and 68 cases, respectively, but no correlation with parents' doses was observed (the survey is still underway).

(Source: S. Izumi et al.: Br J Cancer 89: 1709-13, 2003.)

- **Incidence rates of lifestyle-related diseases (2002 - 2006)**

The clinical cross-sectional survey of approx. 12,000 subjects revealed no correlation between parents' doses and their children's incidence rates of lifestyle-related diseases (the survey is still underway).

(Source: S Fujiwara et al.: Radiat Res 170: 451-7, 2008.)