Risks | Risks of Health Effects of Radiation

Risks

- The magnitude of the influence of damage
- The possibility of any damage (probability)
- The combination of the magnitude of the influence and the possibility (probability)

Quantitatively expressed probability, not focused on the actual existence of damage

In particular, when considering stochastic effects of radiation,

Risks =
The probability (of contracting cancer or dying of cancer)

Having risks ✖ (Surely) being subject to damage

The term "risk" generally means "dangerousness" or "degree of hazard." However, more strictly, the term is used to refer to "the magnitude of the influence of damage," "the possibility of any damage (probability)," or "the combination of the magnitude of the influence and the possibility (probability)." The focus is not on "whether or not there are any risks" but on "to what extent or by how many times risks increase."

On the other hand, what causes damage is called "hazard." It is important to clearly distinguish hazard information on the existence or non-existence of hazards and risk information on the degree and probability of damage, and properly communicate and utilize these two types of information.

When considering health effects of radiation, in particular, stochastic effects of radiation, it is common to use the term "risk" in the sense of "the probability (of contracting cancer or dying of cancer)."

In this case, it should be noted that "having risks" is not equal to "(surely) being subject to damage."

Included in this reference material on February 28, 2018

Risks Relative Risks and Attributable Risks

	Factors	Incidence		Total
		Yes	No	
	Exposed group	A	B	A+B
	Non-exposed group	C	D	C+D

How many times factor exposure would increase the incidence of an individual:

$$\text{Relative risk} = \frac{\text{Incidence risk among an exposed group}}{\text{Incidence risk among a non-exposed group}} = \frac{\dfrac{A}{A+B}}{\dfrac{C}{C+D}}$$

Relative risk larger than 1 represents that risks have increased due to factor exposure.

The value obtained by subtracting 1 from the relative risk is an excess relative risk, showing an increased amount of risks.

How many times factor exposure would increase the incidence rate of a group:

$$\text{Attributable risk} = \text{Incidence risk among an exposed group} - \text{Incidence risk among a non-exposed group}$$

$$= \frac{A}{A+B} - \frac{C}{C+D}$$

A relative risk represents how many times a certain factor increases the risk of an individual exposed thereto. In epidemiology, the term "risk" normally refers to a relative risk. The value obtained by subtracting 1 from the relative risk is an excess relative risk and shows an increased amount of risks compared with a group free from risk factors. There is also an attributable risk that represents how much a certain factor increases the incidence or mortality rate of a group.
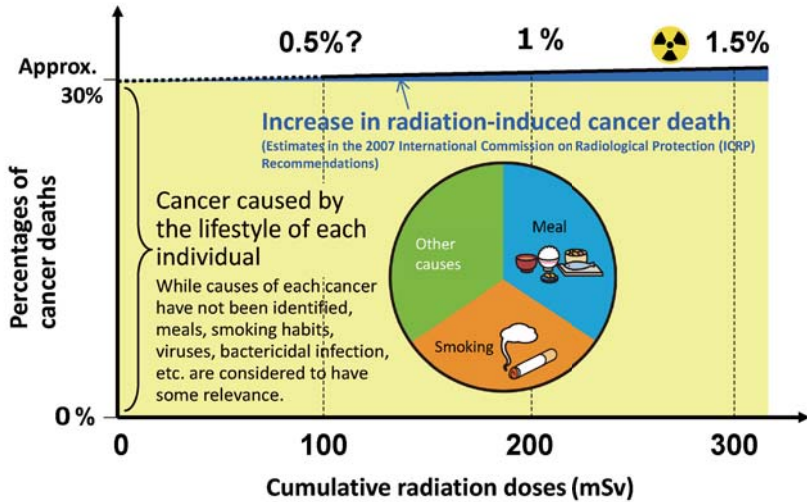
Suppose a group is exposed to some risk factor while another group is not, and there are 2 patients of a certain disease among one million people in the non-exposed group, while there are 3 patients among one million people in the exposed group.

Then, an increase in the number of patients from 2 to 3 is construed to mean that the relative risk has increased by 1.5 times from the perspective of how much more an individual is likely to develop a disease.

On the other hand, as an attributable risk focuses on increases in the number of patients in a group, the increase is construed as one in a million, that is, an increase of 10^{-6} in risk.

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Risks — Risks of Cancer Death from Low-Dose Exposure

0.5%?   1 %   ☢ 1.5%

Increase in radiation-induced cancer death
(Estimates in the 2007 International Commission on Radiological Protection (ICRP) Recommendations)

Cancer caused by the lifestyle of each individual
While causes of each cancer have not been identified, meals, smoking habits, viruses, bactericidal infection, etc. are considered to have some relevance.

Other causes — Meal — Smoking

Percentages of cancer deaths — Approx. 30% — 0 %

Cumulative radiation doses (mSv)
0   100   200   300

The International Commission on Radiological Protection (ICRP) considers radiological protection based on the idea that in a group of people including both adults and children, the probability of cancer death increases by 0.5% per 100-mSv exposure. This value shows estimated risk of low-dose exposure based on data obtained from atomic bomb survivors (p.117 of Vol. 1, "Relationship between Solid Cancer Deaths and Doses").
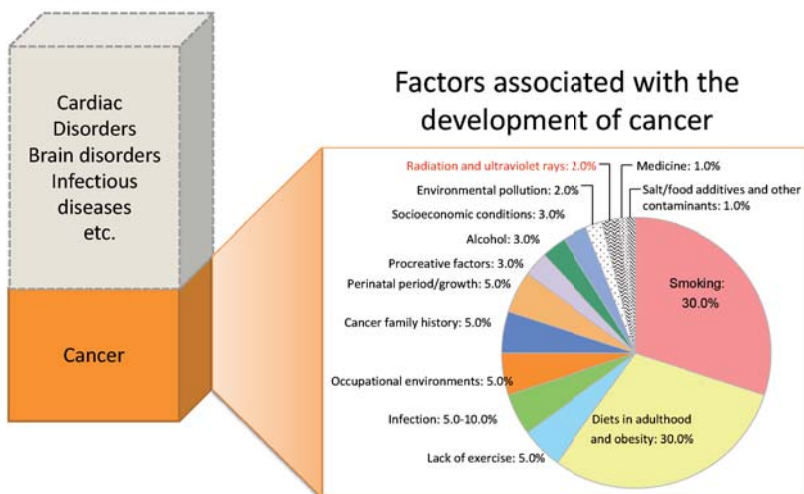
Currently, the leading cause of deaths among Japanese people is cancer, with around 30% of the entire population dying of cancer. That is, 300 people in a group of 1,000 will die of cancer. If the probability of death from radiation-induced cancer is added, it can be estimated that if all people in such group of 1,000 people are exposed to 100 mSv, 305 will die of cancer in their lifetime.

However, in actuality, the value of 300 out of 1,000 people could vary from year to year and from region to region,[1] and no methods have been established yet to confirm if cancer is really attributable to radiation exposure. It is thus considered very difficult to actually detect an increase in cancer deaths among people exposed to not higher than 100 mSv, i.e., an increase of up to 5 people in a group of 1,000.

*1: Comparison of age-adjusted mortality rates among prefectures in Japan in FY2010 shows that the mortality against 100,000 people varies from 248.8 people (Nagano) to 304.3 people (Aomori) for females and from 477.3 people (Nagano) to 662.4 people (Aomori) for males. The mortality rate from cancer also varies from 29.0% (Okinawa) to 35.8% (Nara) for males and from 29.9% (Yamanashi) to 36.1% (Kyoto) for females.

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Risks **Factors Associated with Carcinogenesis**

Cardiac
Disorders
Brain disorders
Infectious
diseases
etc.

Cancer

Factors associated with the development of cancer

Radiation and ultraviolet rays: 2.0% — Medicine: 1.0%

Environmental pollution: 2.0%
Salt/food additives and other contaminants: 1.0%

Socioeconomic conditions: 3.0%

Alcohol: 3.0%

Procreative factors: 3.0%

Perinatal period/growth: 5.0%

Cancer family history: 5.0%

Occupational environments: 5.0%

Infection: 5.0-10.0%

Lack of exercise: 5.0%

Smoking: 30.0%

Diets in adulthood and obesity: 30.0%

Source: Prepared based on Cancer Causes Control 1996.7.S55-S58

We are surrounded by various risk factors for cancer in our lives. The pie chart above provides U.S. data, which gives an idea that meals and smoking habits are closely associated with the development of cancer. If having been exposed to radiation, risks due to radiation are to be added to these factors. Accordingly, it is best to avoid radiation exposure from the viewpoint of reducing risks of cancer.

It may be possible to refuse X-ray examinations or avoid taking flights, but that would make early detection of diseases impossible and make life inconvenient, and such efforts would not dramatically reduce the risks of developing cancer due to the existence of various cancer-causing factors other than radiation in our lives.

(Related to p.102 of Vol. 1, "Risks of Cancer (Radiation)," and p.103 of Vol. 1, "Risks of Cancer (Life Habits)")

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Risks of Cancer (Radiation)

Radiation doses (mSv)	Relative risks of cancer*
1,000 ~ 2,000	1.8 [estimated to be 1.5 times per 1,000 mSv]
500 ~ 1,000	1.4
200 ~ 500	1.19
100 ~ 200	1.08
Less than 100	Difficult to detect

Source: Prepared based on the information available on the website of the National Cancer Center Japan

* Risks of developing radiation-induced cancer are based on the data (solid cancers only) obtained from the analysis of instantaneous exposure due to the atomic bombing in Hiroshima and Nagasaki, and are not based on the observation of long-term exposure effects.
* Relative risks indicate how many times larger the cancer risks are among people subject to certain causes (radiation exposure here).

The table above shows the effects of radiation exposure doses on the relative risks of cancer released by the National Cancer Center Japan.

It is estimated that the relative risk increases by 1.8 times due to radiation exposure doses of 1,000 to 2,000 mSv, by 1.4 times due to doses of 500 to 1,000 mSv and by 1.19 times due to doses of 200 to 500 mSv.

In the case of radiation exposure below 100 mSv, it is considered to be extremely difficult to detect the risk of developing cancer.

(Related to p.103 of Vol. 1, "Risks of Cancer (Life Habits)")

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Risks of Cancer (Life Habits)

Risks

Lifestyle factors	Relative risks of cancer [1]
Smokers	1.6
Heavy drinking (450 g or more/week)[2]	1.6
Heavy drinking (300 to 449 g or more/week)[2]	1.4
Obese (BMI≧30)	1.22
Underweight (BMI<19)	1.29
Lack of exercise	1.15 ～ 1.19
High-salt foods	1.11 ～ 1.15
Lack of vegetable intake	1.06
Passive smoking (nonsmoking females)	1.02 ～ 1.03

Source: Prepared based on the information available on the Website of the National Cancer Center Japan

*1 Relative risks indicate how many times larger the cancer risks are among people subject to certain causes (life habits here).
*2 Alcohol consumption is in ethanol equivalent.

The table above shows relative risks of cancer due to respective life habits as released by the National Cancer Center Japan.

It is estimated that the relative risk of cancer for people who smoke or drink a lot is 1.6 times higher than that for people who do not. It is also estimated that factors, such as obesity, lack of exercise, and lack of vegetable intake, will make the relative risks of cancer higher by 1.22 times, 1.15 to 1.19 times and 1.06 times, respectively.
(Related to p.101 of Vol. 1, "Factors Associated with Carcinogenesis," and p.102 of Vol. 1, "Risks of Cancer (Radiation)")

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