Trying to elucidate the Effects of Low Dose Radiation

—From the Results of Epidemiological Studies on High Background Radiation Areas—

1. Naturally Occurring Radiation
2. Is it really a high health risk?
3. For Correct Understanding of Radiation Effects

Brief Note: Toshiyasu Iwasaki, Research Scientist, Nuclear Technology Research Laboratory, Radiation Safety Research Center
Naturally Occurring Radiation

All living things on Earth, including human beings, are exposed to naturally occurring radiation everyday from space, from the ground, as well as from the air and from food. As for the amount of natural radiation detected in the ground, the data shows that, in the regions such as Kerala (India), Iran, and Yangjiang (Kwangtung Province, China), the natural radiation levels are much higher than that of Japan. (See figure on cover)

Various epidemiological studies have already clarified how strong radiation (high dose and high dose rate) affects human health. Meanwhile, there has not been much research or evidence on the human health effects of weak radiation (low dose and low dose rate) such as natural radiation.

CRIEPI has conducted epidemiological research involving residents of High Background Radiation Area (HBRA) with a view to elucidating the effects of natural radiation, and have discovered that its effects are different from views that are widely held.

Usefulness of HBRA Research

One example of large scale radiation epidemiological research is the life span study of 120,000 Hiroshima and Nagasaki atomic bomb survivors. However, due to the fact that the study participants were exposed to exceptionally large amounts of radiation and that their extremely severe physical and mental stress from the atomic bombing could not be excluded as confounding factors (non-radiation factor which affects on diseases), the results of this study are not directly applicable to low dose rate radiation risks. While there is also research into occupational radiation exposure involving medical radiation technologists and nuclear plant workers, samples are limited to certain age and sex groups, which means the effects on the elderly, children, and women cannot be assessed.

On the other hand, our research on residents of High Background Radiation Area (hereinafter HBRA) includes samples from both sexes and wide age range groups where participants were leading normal lives without any particular kind of stress. This research is important as it focuses on long-term (lifetime) radiation exposure at low dose rates. At the same time, this kind of resident research requires a large number of participants in order to maintain statistical accuracy - even with small differences - and also requires long-term and regular observations measuring the health effects.

Long-term Research over More Than 30 Years

The Chinese government initially started the HBRA epidemiological study in 1972. In 1991, the study was developed into a large international joint research project conducted by Dr. Tsutomu Sugahara, Emeritus Professor of Kyoto University, with collaboration between the Health Research Foundation in Japan and the research groups in China. It has been further developed since 1998 to include India and Iran. We have taken part in this international joint research project since 2003.

Although no epidemiological study is available yet in Iran due to small HBRA population numbers, research in China has now involved 2 million person-years (number of participants multiplied by years of participation) in total, with participants from both HBRA as well as a control area, while the project in India has involved 740 thousand person-years. We have analyzed the data and have steadily been seeing results which suggest we should revise our long-held beliefs.
Is it really a high health risk?

No Significant Difference in Mortality Found by Research in China

The epidemiological study in China has been conducted in the Yangjiang area, Kwangtung Province. Located 200km from Guangzhou, Yangjiang is an area where the natural radiation levels are high because of the soil and building materials which contain thorium and uranium. For comparison purpose, the neighboring Enping area - with normal radiation levels - was chosen as a control area, and villages with similar living environments were selected from each area. Study participants were limited to Han people whose families had been residing in these areas for more than two generations (Figure 1). Table 1 shows mortality from 1979 to 1998 in these two areas where the average dose rate is 2.6 times higher than that of the other area. As clearly shown by the mortality (relative value, per 1,000 people) in the Table 1, no significant difference was found in mortality between the two areas. Furthermore, in order to evaluate the relative risk of cancer in the control area, we prepared a graph to show the cancer risk rate relative to total exposure dose and calculated the slope. This turned out to be -0.11 per sievert (Sv). Although the value is not significant, this indicates that mortality from cancer in HBRA tends to be slightly lower than in the other area.

From this result we can assume that lifetime exposure to radiation does not have significant health effects. We will continue to work on the confounding factors (non-radiation factors) for further analysis.

Research in India

The Karunagapalli area, located in the coastal region facing the Arabian Sea in the state of Kerala in the south west tip of India, is also known as an HBRA. In this coastal region there is a black beach with a mineral called monazite which contains radioactive elements. The gamma rays from radioactive material in monazite result in this area’s high level of natural radiation.

In 1990, the local cancer center in Kerala state started a research on the incidence of cancer. The research has grown into an international joint research project. This research selected four districts with high background radiation in the Karunagapalli area as HBRA, along with two other districts in the same area for comparison (Figure 2). The six selected districts cover almost half of the 380,000 population of the entire Karunagapalli area. This research – which has observed the incidence of cancer - is regarded as more detailed, as well as more accurate, than the research of mortality observed in China.

The research measured the external exposure dose due to natural radiation except for sources such as food. The results have shown that, while the world average is 0.9mSv, the average dose in the control areas was 0.77mSv and the average dose in HBRA was 2.10mSv, three times higher than that of control areas.

Table 1. Analysis of Target Groups in China (1979-1998)

<table>
<thead>
<tr>
<th>Item</th>
<th>HBRA (Yangjiang area)</th>
<th>Control Area (Enping area)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>89,694</td>
<td>35,385</td>
<td>125,079</td>
</tr>
<tr>
<td>Person-years</td>
<td>1,464,929</td>
<td>528,010</td>
<td>1,992,939</td>
</tr>
<tr>
<td>Total deaths</td>
<td>8,905</td>
<td>3,539</td>
<td>12,444</td>
</tr>
<tr>
<td>Cancer deaths</td>
<td>855</td>
<td>347</td>
<td>1,202</td>
</tr>
<tr>
<td>Mortality (1/1,000)</td>
<td>6.08</td>
<td>6.70</td>
<td>6.24</td>
</tr>
<tr>
<td>Cancer mortality (1/100,000)</td>
<td>58.36</td>
<td>65.71</td>
<td>60.31</td>
</tr>
</tbody>
</table>

Figure 2. Research Areas in India
Similar Results Observed in China and India

According to the research results on the health effects in India, while leukemia risk showed a slight but not significant increase as exposure dose increased, there was no increase in relative risk for other cancers, regardless of total exposure dose or annual dose rate. Likewise, we calculated the slope from the graph of total dose (Fig. 3). This turned out to be -0.13, which is not significant, but still shows decreasing tendency of cancer risk, as observed in China.

We also examined some specific cancers, but no significant increases of the risks were observed consistently in China and India. Further analysis focusing on diseases other than cancer showed no significant health effects either.

However, since the research in India is on a smaller scale than that in China, we will expand the target area to encompass the entire Karunagapalli area and continue collecting and analyzing data.

The Importance of ongoing studies

The long-term epidemiological studies of HBRA in China and India have revealed that radiation doses from three to five times higher than normal levels of natural radiation had no significant impact on human health. Even though radiation is often considered as cancer-causing agent, no matter how small the dose, we found no solid research results to support this view.

As for epidemiological studies, it is important to continue to follow them up over the long term. It is also necessary to promote international collaboration so that we can coordinate with data obtained from other areas and do increase statistical power.

We will actively continue to work on this research project.

Brief Note

Since even very small amounts of radiation can be detected, we tend to focus on it once it is shown - even if the amount is only small. It is useful, however, to bear in mind when we are considering even the slightest radiation effects, that these results indicate that natural radiation three to five times greater than normal surrounding us actually has no significant health effects. At the Radiation Safety Research Center, further detail studies are under progress. We continue to look for results that will elucidate mechanisms which underlie the phenomena and lead to a correct understanding of radiation.

Figure 3. Risks of All Cancers Except Leukemia

Related Report

“Review of epidemiological and cytogenetic studies on high background radiation area residents”
CRIEPI Report: L07003 (in Japanese)