Introduction to epidemiology of atomic bomb radiation in Hiroshima and Nagasaki

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Hiroshima and Nagasaki were attacked by atomic bombs in August of 1945. The cities were totally destroyed and people were injured by blast, heat, and radiation, then about 30 to 40% of people living at the time of bombings died within the year. Late health effects of atomic bomb radiation emerged and have been investigated by the long-term epidemiological studies. Atomic bomb radiation consisted of two major categories of “initial radiation,” released at the time of explosion as originated from nuclear fission, and “residual radiation” including induced radiation by neutrons and radioactive fallout. The biological stage at radiation exposure is important in development of late health effects. People who were exposed to radiation after conception, i.e., in the mother's womb (*in utero*) or after birth, showed health effects, such as developmental impairments and increased risks of cancer and some non-cancer diseases. In contrast, people who conceived after their parental exposure to radiation did not show, in the current knowledge, any explicit health effects related to their parental radiation exposure. However, radiation effects on mother’s reproductive organs may disturb pregnancy and delivery, which may cause children’s health disorders. In the epidemiological studies, observed health effects of atomic bomb radiation were not likely confounded with other risk factors because people were not selectively exposed to radiation. But, some pre-existent spatial factors and socioeconomic damages due to atomic bombings may work as confounding in some situations. Finally, more important is that those health effects and socioeconomic influences need to be ameliorated by public health and welfare activities to which results of epidemiological observations have contributed.

Biography

Kotaro Ozasa was trained in public health and community-based epidemiology. He was working in the Department of Epidemiology, Radiation Effects Research Foundation, during 2008-2022, then has been in the current work in Kyoto.

Radiation risks of malignant neoplasms among atomic bomb survivors

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The Radiation Effects Research Foundation continue follow-up study of atomic bomb survivors named the Life Span Study (LSS) with 1950 as the starting point for mortality succeeded from its predecessor, Atomic Bomb Casualty Commission. Increase of leukemia was noted by a physician in his clinical practice in Hiroshima, which led to the establishment of a registry of leukemia in the early 1950s. This registry enables risk analysis of hematologic malignancies, not only in terms of mortality but also incidence, starting from 1950. An increased risk of leukemia has been observed in LSS since the 1950s. According to a report by Hsu et al., a linear-quadratic dose response model fit the risk of all leukemia combined well, with an excess relative risk (ERR) of 1.74 at 1Gy. In the analysis by leukemia subtypes, three major leukemia subtypes exhibited statistically significant associations with radiation exposure. In collaboration with the city's medical association, a registration for solid cancers was also launched in Hiroshima in 1957 and in Nagasaki in 1958. Increased risks of solid cancers have been reported in mortality study since in the late 1960s. The risk increase was also becoming significant in analyses by cancer sites and showing significant increases in many cancer sites including lung, colon, breast and so on. The ERR for all solid cancers reported in the last cancer incidence study series was 0.47 per Gy. Cancers of the prostate, brain/central nervous system, pancreas (for female only), and uterine corpus, which had not previously shown a significant increase, showed significant increase. In collaboration with pathologists of city hospitals, studies with histological reviews of cancer cases have also been conducted for liver, salivary glands, skin, ovary, thyroid, central nervus system, breast, lung, lymphoid system, uterus, soft tissue and born. These studies re-diagnosis using consistent diagnostic criteria and risk analyses by histological subtypes.

Biography

Ritsu Sakata is an epidemiologist and has been involved in radiation risk analysis in the Department of Epidemiology, Radiation Effects Research Foundation, since 2006. She is currently in charge of follow-up of the cohorts and management of baseline information records.

Radiation risks beyond cancer among atomic bomb survivors, with emphasis on cardiovascular disease

Tomoki Nakamizo (1)

1 : Department of Clinical Studies

Studies of atomic bomb survivors have revealed associations between radiation exposure and several non-cancer diseases. In this presentation, we will review these associations from the LSS and AHS cohorts, primarily focusing on cardiovascular diseases.

Biography

Tomoki Nakamizo worked as a neurologist specializing in stroke before joining RERF in 2019. He earned an MPH in Biostatistics in 2010. He is currently working on clinical epidemiology based on health examinations for atomic bomb survivors and their children.

Studies of survivors' children and individuals exposed in utero to atomic bomb radiation

Hiromi Sugiyama (1)

1 : Radiation Effects Research Foundation, Department of Epidemiology

The Atomic Bomb Casualty Commission and its successor, the Radiation Effects Research Foundation, have investigated the health effects of atomic bomb radiation among individuals exposed directly or *in utero*, and the survivors' children. We summarize findings from studies of the *in utero* cohort and children of atomic bomb survivors. Among those exposed to atomic bomb radiation in utero, an increased risk of small head size and mental retardation has been associated with high-dose exposure. Although the relationship between radiation dose and childhood cancer remains unclear, a significant increase in solid cancer incidence and mortality in adulthood among females has been observed. An association between radiation exposure and non-cancer mortality has been reported; however, factors such as small head size and low birth weight related to exposure, worsened nutrition, and the loss of parents during or after the war should also be considered. Whether parental exposure affects the health of their children has been a major concern among survivors. Several indicators of potential genetic effects—such as sex ratio, chromosomal aberrations, electrophoretic variants of serum and erythrocyte proteins, and mutation rates—have been investigated, but none have shown associations with parental radiation dose. Furthermore, after adjusting for parental city of exposure, age, reproductive history, consanguinity, sex of the child, and year of birth, no association was found between parental radiation dose and congenital malformations at birth or neonatal mortality. After several decades of follow-up, parental dose and adulthood mortality or prevalence of multifactorial disease (e.g., hypertension) did not show a significant relationship. Individuals exposed in utero and children born to exposed parents were also affected by wartime hardships; therefore, the relationship between atomic bomb radiation exposure and health effects must be interpreted with great caution.

Biography

Hiromi Sugiyama has been with the Radiation Effects Research Foundation since 2004, focusing on radiation epidemiology. She also manages regional cancer registries in Hiroshima and Nagasaki and conducts research projects using data from population-based cancer registries.

Database and epidemiological research on atomic bomb survivors at Hiroshima University

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Hiroshima University's Research Institute for Radiation Biology and Medicine (RIRBM), established in 1961, has accumulated extensive materials and biological specimens related to atomic bomb survivors. Among these resources, the A-bomb Survivor Database is one of the world's largest datasets on radiation-exposed populations, currently containing electronic records for approximately 290,000 individuals. The database integrates multiple historical surveys, including the 1945–46 damage surveys, basic demographic investigations, A-bomb survivor certificate records, family surveys, and subsequent periodic updates. It includes information on survivors' demographics, residential and exposure conditions, as well as linked mortality and vital statistics.

This database has served as essential infrastructure for long-term epidemiological studies on radiation health effects. Previous analyses have demonstrated that overall cancer mortality among survivors is significantly higher than that of the general Japanese population, with risks increasing in proportion to estimated radiation dose. Several studies have also shown elevated risks among early entrants into Hiroshima City after the bombing, particularly for leukemia and certain solid cancers. Recent research has further evaluated geographic patterns of cancer mortality, suggesting that risk distribution cannot be fully explained by direct radiation exposure alone.

Overall, the database remains a critical resource for elucidating long-term radiation health effects and supporting risk assessment across diverse exposure conditions.

Biography

Shinji Yoshinaga started his scientific career in the field of radiation epidemiology at National Institute of Radiological Sciences in 1994. Since 2018, he has been a Professor at the Research Institute for Radiation Biology and Medicine, Hiroshima University, focusing on studies of atomic bomb survivors and low-dose radiation effects.

Follow-up of health management for atomic bomb survivors in a database at Nagasaki University

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1 : Atomic Bomb Disease Institute, Nagasaki University
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The year 2025 marks the 80th anniversary of the atomic bombings, with the average age of survivors now reaching 86. Continued monitoring and support for their health has therefore become increasingly important. The Atomic Bomb Disease Institute of Nagasaki University manages the atomic bomb survivors' database, which has been developed for research for atomic bomb–related health effects. This database has been systematically compiled since 1970, with comprehensive tracking of survivors who have resided in Nagasaki Prefecture. The primary data source has been information provided by the local governments of Nagasaki City and Nagasaki Prefecture. At present, approximately 160,000 survivors hold official survivor certificates, and they are registered in the database as a dynamic cohort. The database is designed to track residential status and to systematically accumulate the results of annual health examinations as well as causes of death. Previous studies have demonstrated that, due to ongoing concerns about their health, atomic bomb survivors have shown a high level of interest in medical check-ups, with more than half having undergone examinations in the past. In recent years, however, as the survivor population has aged, many individuals have developed various diseases and have shifted toward treatment at medical institutions, resulting in a decline in the proportion of relatively healthy individuals undergoing routine health examinations. This report presents the characteristics of individuals who have participated in health examinations for up to 50 years and highlights research findings derived from these long-term data.

Biography

Kenichi Yokota has been engaged in epidemiological research on acute symptoms, the validity of survey data, and the efficacy of health screening among atomic bomb survivors, as well as in the management of the survivors' database at Nagasaki University since 1991.