

Comparison of all solid cancer mortality and incidence dose-response in the Life Span Study¹ of atomic bomb survivors, 1958–2009

In this study, published in 2022, RERF researchers conducted detailed analysis of dose response (rate² of cancer in relation to radiation dose) for the 1958–2009 period to compare results with previous analyses of dose response for all solid cancer³ incidence (rate of new cases of cancer) and all solid cancer mortality (rate of deaths from cancer during a particular period) in the Life Span Study (LSS) population.

Analyses in the past consistently showed a linear relationship (on a graph, a proportional, straight line) in dose response. Two subsequent RERF papers, one published in 2012 (see: <https://www.rerf.or.jp/uploads/2017/08/rr1104-1.pdf>) and one in 2017 (see: https://www.rerf.or.jp/library/rr_e/rr1605.pdf) suggested, in a limited dose range (0–2 gray [Gy]⁴), an upward response curve for all solid cancer mortality calculated for men and women combined and for all solid cancer incidence in men. Reasons for the emergence of the non-linear, curved responses not seen previously were not well understood.

In this new study's comparative analysis for all solid cancer incidence, a statistically significant upward curve in dose response was found among men but not among women. For mortality, a somewhat significant upward curve among men and a significant curve among women were observed. Other findings on incidence and mortality by follow-up period (1958–1987 or 1988–2009) and age at exposure (0–19 or 20–83 years) suggested that, in the study population aged 0–19 at exposure, there were upward curves for both sexes: among men in both follow-up periods and among women in the follow-up period of 1988–2009. The current analysis supports evidence that the upward curve-shaped dose responses observed in the 2012 and 2017 papers are not specific to men; it was thought to be dependent on the site of cancer occurrence and the age at exposure or time since exposure.

A better understanding of changing dose response patterns is important for radiation protection standards, and thus further follow-up studies in the future are considered necessary to clarify the factors and cancer sites related to the curved responses.

Notes

¹ Life Span Study (LSS):

The main purpose of this study is to investigate the long-term effects of atomic bomb radiation on the cause of death and cancer incidence. At the time of the 1950 national population census in Japan, about 94,000 atomic bomb survivors were selected from among those who were confirmed to be in Hiroshima and/or Nagasaki at the time of the atomic bombings and about 27,000 who were not in city at the time. This study has tracked over many years about 120,000 subjects.

² Rate:

Indicates a measure of the frequency with which an adverse event (cancer, specific disease, death, etc.) occurs in a defined study population over a specified period of time.

³ Solid cancer:

Refers to cancer that forms a mass in organs or tissues other than hematopoietic cancers such as stomach cancer, lung cancer, liver cancer, colon cancer, among others.

⁴ Gray (Gy):

Gray (1 gray = 1,000 milligray) is a unit of radiation that represents the amount of radiation dose absorbed by a substance when it is exposed to radiation. The average dose for RERF's LSS participants is around 140–200 milligray (0.14–0.2 Gy). As reference, the average annual amount of radiation we are all exposed to in our daily lives, include medically, is estimated to be around 2–6 milligray (0.002–0.006 Gy).

doi. org/10.1667/RADE-21-00059.1

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RERF's objective with this brief outline is to succinctly explain our research for the lay public. Much of the technical content of the original paper has been omitted. For further details about the study, please refer to the full paper published by the journal.