

Paper published in *Radiation Research*<sup>§</sup>

**“Lung, Laryngeal, and Other Respiratory Cancer Incidence among Japanese Atomic Bomb Survivors: An Updated Analysis from 1958 through 2009”**

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*Radiat Res* 2017(May); 187(5):538-48

(doi: 10.1667/RR14583.1)

**Study Findings**

This study showed the relationship between radiation dose and incidence of respiratory cancers. The risk of lung cancer was found to have increased with increasing radiation dose. Strong smoking risks were seen for lung cancer, laryngeal, and other respiratory cancers. When the joint effects of radiation and smoking were analyzed, radiation risks for lung cancer were higher among low-to-moderate smokers when compared with heavy smokers.

Due to its size and long-term follow-up, the Life Span Study (LSS) of atomic bomb survivors offers a good opportunity to study the relationship between radiation and the incidence of respiratory cancers.

**Explanation**

We conducted a study on the relationship between lung, laryngeal, and other respiratory cancer incidence and radiation dose among the Life Span Study (LSS) of atomic bomb survivors. Data on cancer occurrence were collected from the Hiroshima and Nagasaki cancer registries, and the follow-up period was 1958–2009. The effects of smoking and radiation were investigated both separately and in combination. Smoking data were collected from periodic mail surveys and surveys conducted during clinical visits.

**1. Study purpose**

An important task of the long-term follow-up of the atomic bomb survivors is to document the occurrence and risks of cancer. Recently, a manuscript was published on the risks of all solid cancers in aggregate; this paper is the first in a series that will document the radiation risks in a specific organ system. More manuscripts are in preparation regarding other organ systems with consideration paid to the effect of lifestyle-related risk factors on individual organ cancers.

**2. Study methods**

LSS cohort members in this study numbered 105,444 and included those alive with no history of cancer as of January 1, 1958, and had a known radiation dose. Incident cancers of the lung, larynx, and other respiratory organs were identified through linkage with the Hiroshima and Nagasaki cancer registries. Follow up was conducted through December 31, 2009. The study used smoking history information based on mail and clinical surveys. Individual radiation doses to the lung were estimated for each cohort member using the revised DS02 dosimetry system (DS02R1). Risks of respiratory cancers as a function of radiation dose, sex, pack-years of smoking\*, age at exposure, and attained age were estimated using statistical models. Estimates of risk were expressed as an excess relative risk (ERR) per unit dose of radiation.

\*When evaluating health impact of smoking, this index is used to indicate “tobacco consumption per day x number of years of smoking.” In Japan, tobacco consumption per day is calculated as number of cigarettes; in the case of Western countries, consumption is typically indicated by number of packs (1 pack = 20 cigarettes).

**3. Study results**

A total of 2,446 lung cancers, 180 laryngeal cancers, and 115 other respiratory cancers (of the trachea, mediastinum, and other ill-defined sites) were observed over the follow-up period. For non-smokers, an ERR of 0.81/Gy was observed for lung cancer. A linear ERR model fit best, and there was

no evidence of curvature for either men or women. The ERR of smoking was estimated to be about 6 per 50 pack-years in both men and women. Of the total number of lung cancers, 113 (5%) could be attributed to radiation. Of the 1,165 lung cancers that occurred among smokers, 886 (76%) could be attributed to smoking. When considering these numbers, one must remember that many in the population smoked (86% of men and 18% of women), but the number of people with very high radiation doses was relatively small.

### **Study Significance**

This study showed that respiratory cancer risks, particularly lung cancer, were increased with radiation exposure from the atomic bombs even more than 60 years after the exposures. We found that smoking increased the risks of all respiratory cancers. Confirming results from a previous study, we found that radiation and smoking acted jointly to increase the risks of lung cancer among light smokers. We found that the excess relative risk due to radiation exposure had a linear response. This paper is the first in a series of organ-specific manuscripts based on already-published data in which the analysis aggregated all solid cancers. Additional manuscripts on other major organ systems are being prepared.

**The Radiation Effects Research Foundation** has studied A-bomb survivors and their offspring in Hiroshima and Nagasaki for around 70 years. RERF's research achievements are considered the principal scientific basis for radiation risk assessment by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and for recommendations regarding radiation protection standards by the International Commission on Radiological Protection (ICRP). RERF expresses its profound gratitude to the A-bomb survivors and survivors' offspring for their cooperation in our studies.

*<sup>§</sup>Radiation Research*, which is an official monthly journal of the Radiation Research Society, publishes original peer-reviewed papers and review articles on radiation effects and related issues in the fields of physics, chemistry, biology, and medicine. (Impact factor in 2015: 3.022)