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Health effects study of the nuclear industry workers in Japan

Epidemiological Study Group of Nuclear Workers (Japan)[1]
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Abstract

To clarify the effects of low-dose and low-dose-rate exposure to the human body, study on the health effects of the nuclear industry workers in Japan was conducted since 1990 by the Institute of Radiation Epidemiology, the Radiation Effects Association, which had been entrusted by the Science and Technology Agency of the Japanese Government.

In the first phase analysis between 1986 and 1992, the study population was selected from among persons who were engaged in radiation work at nuclear power plants and associated facilities, and registered in the Radiation Dose Registration Center for Workers. The cohort consisted of 114,900 persons who satisfied the criteria of nationality, age, sex, etc. The average follow-up period was 4.6 years, and the average cumulative dose per person was 13.9 mSv. The total number of deaths among the study population was 1,758, including 661 deaths due to all malignant neoplasms.

The Standardized Mortality Ratio of various death causes was compared. Furthermore, the cohort was grouped by five different dose levels, and the O/E was calculated to test whether there is a trend for the death rate to increase with dose.

Among nuclear workers no significant increase in deaths nor any relationship with radiation dose was found, except the pancreatic cancer with 10 - years lag. Since many previous studies of nuclear industry workers have demonstrated no significant association between exposure dose and pancreatic cancer, we cannot immediately conclude a causal relationship between with radiation.

Introduction

Although it has been well established that radiation exposure after high doses causes an increased risk of cancer in many organs, there remain many important questions about the effects of low-dose chronic exposures. Recently, a direct assessment of the carcinogenic effects of long-term low-level radiation exposure in humans can be made from studies of cancer risk among workers in the nuclear industry, and some reports already published[1-4].

In these circumstances, an epidemiological study of radiation workers at nuclear power plants and associated facilities in Japan had been initiated by the Institute of radiation Epidemiology, the Radiation Effects Association, under the trust of the Science and Technology Agency of the Japanese Government[5].

Materials and Methods

1. Characteristics of the cohort

114,900 persons who had been registered in the "Radiation Dose Registration Center

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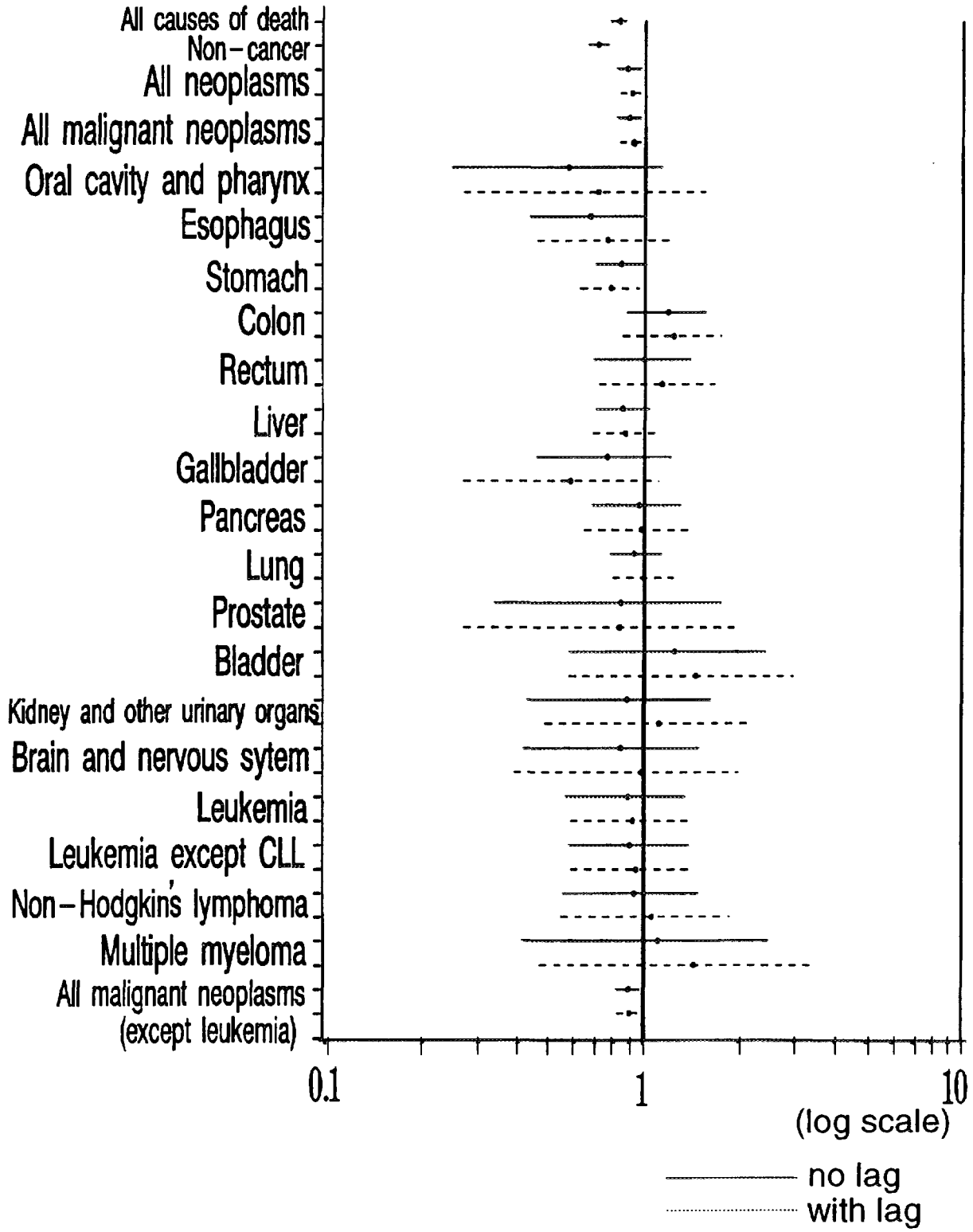
SMRs of various death causes for nuclear workers in Japan, with 95% confidence intervals, using Japanese male as the standard population.



for Workers" (RADREC) as of March 1989 were selected, and they met the following criteria: (1) persons who had engaged in actual radiation work, (2) male, (3) Japanese nationality, (4) persons who the vital status happened to be issued within five years of the record keeping, (5) age range within the 20- to 85-year-old.

The underlying cause of death was identified by using of the magnetic tapes of National Vital Statistics supplied by the Japanese Ministry of Health and Welfare. In the cohort, there were 1,758 deaths including 661 of all malignant neoplasms.

The mean follow-up period per member was 4.6 years and the total of person-years was 528,540. The mode of the year of birth was in the 1950s, and the mean age as of 1986, when follow-up began, was 39 years.

2. Exposure dose

Exposure doses associated with radiation work for this study were obtained from the annual dosimetry records combining the external and internal dose, for each member of the study population filed in the RADREC from 1957 to 1992. The distribution of cumulative dose groups in the cohort was about 70% at less than 10 mSv and 2.7 % at more than 100 mSv. The mean cumulative dose per individual was 13.9 mSv, the total population dose of the cohort being 1,598.5 person-Sv.

The dosimetry records filed in RADREC reflect changes over time in the concept of radiation dosimetry, the unit of measurement of dose, technical advances in the method of dosimetric measurement, evaluation of exposure dose, and also reflect methodological differences between the respective nuclear power companies. It was reviewed whether the records were adequately consistent to consider the records to be uniform. The results indicated that all aspects of the records were appropriate and proper, and the records were adequately consistent for use in this study.

3. Statistical analysis

External comparisons: The cause-specific death rate by 5-year age groups for Japanese males in general for the period 1986 - 1992, in accordance with the total follow-up period in this study, was taken to be the standard death rate for this purpose. Significant tests for the SMR (Standardized Mortality Ratio) were two-tailed in view of a possible healthy worker effect.

Internal comparisons : The cohort was grouped by cumulative exposure dose into 5 dose categories, i.e., less than 10, 10-, 20-, 50-and 100 mSv or more. The ratio of the actual observed number of deaths to expected deaths, i.e., the O/E ratio, was obtained. Further, one-tailed p values were calculated using score test statistics to test for any trend of an increase in death rate with cumulative dose. In the calculation of score test statistics, the mean cumulative dose was used to represent each dose group.

III. Results

The SMR of all causes of death is 0.83 (95% CI: 0.79 -0.87), and that for non-cancer 0.72 (0.67 - 0.77). For all neoplasms including benign neoplasms and neoplasms of an unspecified nature, the SMR was 0.89 (0.82 -0.96) without lagging and 0.92 (0.84 - 1.01) on a 10-year lag. The SMR of stomach cancer was 0.79 (0.63 -0.97) on a 10-year lag. The SMRs were not significant for any of the other neoplasms (see Figure).

Examination of death rates by cumulative dose groups showed no statistically significant difference for any cause of death. Only the trend in the death rate was significantly found for malignant neoplasm of the pancreas with 10-year lag (p=0.043).

IV. Discussion

The death rates in the cohort due to the following causes of death were found to be significantly lower than in the general population: all causes, non -cancer causes excluding

external causes, all neoplasms, malignant neoplasms, malignant neoplasms other than leukemia, and stomach neoplasm. In stomach neoplasm, the death rate on a 10 - year lag was also significantly lower. These are well known as a "healthy worker effects".[6]

Although a statistical association of pancreatic cancer to radiation dose was noted in the present study, many previous studies of nuclear industry radiation workers have demonstrated no significant association between radiation dose and cancer of the pancreas. The exception is the most recent study of Hanford workers (1945 - 1986) which showed a significant association of cancer of the pancreas with dose on a 2-year lag but not on a 10-year lag. As a result of various considerations, the authors felt that no causal relationship could be inferred[1]. Also the results of atomic bomb survivors[7]and BEIR V Report[8] cite the pancreas to be a relatively radio-insensitive organ. Neither have the 1990 recommendations of ICRP[9] assigned any specific tissue weighting factor to the pancreas. After considering these scientific findings, the statistically significant association noted between cancer of the pancreas and dose in the present study can not be immediately judged as indicating a causal relationship with radiation.

Since the mean follow-up period was only 4.6 years, and the cases of various death causes were relatively small in the present study, further study should be continued to obtain more precise results.

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