

Mortality of A-bomb Survivors in Nagasaki and Hiroshima

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INTRODUCTION

In 1945, two atomic bombs were dropped on Hiroshima and Nagasaki for the first time in human history. Since 1945, many studies (1,2,3,4) have been performed on the effects of the atomic bomb radiation, for example, the physical damage and medical studies of the atomic bomb survivors and so on.

In 1972, the Scientific Data Center for the Atomic Bomb Disaster (renamed as the Division of Scientific Data Registry, Atomic Bomb Disease Institute in 1997) was founded in Nagasaki University to analyze the radiation effects on atomic bomb survivors. Information about A-bomb survivors is generated in many organizations. We have collected information from the City Office, Health Management center and other organizations. We have constructed an A-bomb survivor's Database in 1968 (5).

PURPOSE

A-bomb survivor's Database include personal histories, records of health checks and cause of death. We have published the mortality of non-cancerous disease of A-bomb survivors using old dose estimation system, T65D, elsewhere(6). The mortality of non-cancerous disease was lower than controls for a dose range 0.50-0.99 Gy in male. We reanalyzed the mortality of non-cancerous disease using new dose estimation system, ABS93D. It's result was that the mortality was lower than controls for a dose range 0.31-0.40Gy in male. We compared the results of A-bomb survivors in our database with those of LSS's population, RERF.

METHOD

(1) Atomic bomb survivors are the persons who have been issued the Atomic Bomb Health Handbook from Nagasaki City Government. There were 83,050 persons registered as atomic bomb survivors living in Nagasaki as of 1968. The Health Management Center of Nagasaki City offers a free health examination to atomic bomb survivors twice a year. Since 1968, data of about two and half million health examination items have been stored in a database of a computer in Atomic Bomb Disease Institute in Nagasaki University.

Radiation dose for survivors in Nagasaki have been estimated by Atomic Bomb Survivor 1993 Dose (ABS93D). To study the mortality rates of A-bomb survivors for the period of 1971 through 1994, we selected 2,743 persons (dose estimate available) and age-matched 8,229 persons as control who were alive in 1971. Number of subjects is shown in Table 1. The distribution of these subjects and total deaths (1971-1994) in the exposed group and in the control group are classified according to sex and dose. Expected deaths were estimated from deaths of persons living far from the hypocenter of atomic bomb explosion in Nagasaki, unexposed controls.

(2) Another population is Life Span Study by Radiation Effect Research Foundation (RERF). RERF opened the data accumulated from 1950 to 1985. The sample used is the DS86 subcohort of the RERF Life Span Study cohort. It includes 75,991 persons for whom exposed doses, kerma values after correction for external shielding, are available. The CMDS86.R11 file available from RERF was used. This file contains data on mortality among survivors of the atomic bomb survivors in Hiroshima and Nagasaki during the period from October 1, 1950 through December 31, 1985. The data on deaths are stratified by city, sex, the age at the time of bombing, radiation dose, the observed period and cause of death, yielding 3,640 strata.

Poisson regression methods were used to estimate relative risks of all deaths at different DS86 radiation doses in comparison to deaths of unexposed controls. The numbers of deaths and person-years were counted by estimated dose (0, 0.005-0.05, 0.06-0.09, 0.10-0.19, 0.20-0.49, 0.50-0.99, 1.00-1.99, 2.00-6.00 Gy), age at the time of bombing (<10 years of age, 10-19, 20-29, 30-39, 40-49, 50+), the period of study (1950-1965, 1966-1985), and gender (male,female). Including these variables, the statistical analysis was carried out using the PROC LOGIST in the Statistical Analysis System (7). Number of subjects is shown in Table 2.

Table 1. Number of Subjects (Nagasaki University Survey)

Radiation Dose(Gy)	Male	Female	Total
0	3,159	5,070	8,229
0.006-0.30	540	922	1,462
0.31-0.40	111	139	250
0.41-0.50	69	126	195
0.51-1.00	126	214	340
1.01-5.99	207	289	496
Total	4,212	6,760	10,972

Table 2. Number of Subjects (Life Span Study by RERF)

DS86 shielded kerma (Gy)	Hiroshima	Nagasaki	Total
0	20,346	13,926	34,272
0.005-0.05	12,745	6,447	19,192
0.06-0.09	3,376	753	4,129
0.10-0.19	4,360	812	5,172
0.20-0.49	5,407	1,151	6,558
0.50-0.99	2,911	705	3,616
1.00-1.99	1,422	524	1,946
2.00+	823	283	1,106
Total	51,390	24,601	75,991

RESULTS

(1) Nagasaki University study resulted in that males exposed to 0.31-0.40 Gy showed lower mortality from non-cancerous diseases than that of control, which is statistically significant ($p < 0.05$).

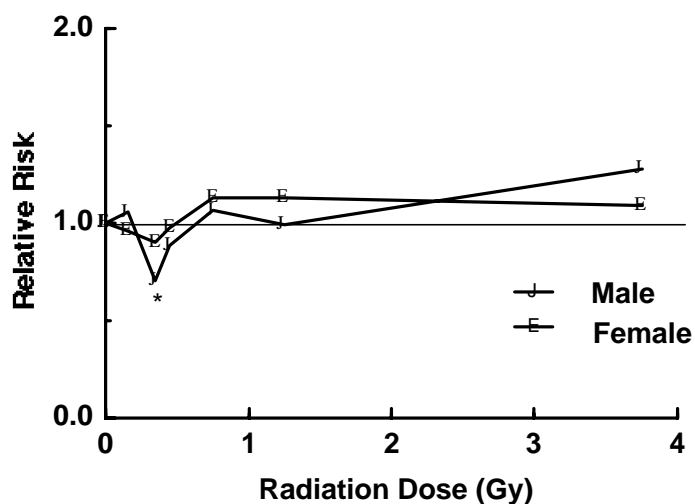


Figure 1. Relative risk by radiation dose and sex (Non-cancerous disease).

* : $p < 0.05$

(2) Table 3 shows the change in relative risks of mortality from all causes with increase in the radiation dose. It will be seen in the table that in male the risks of mortality for dose ranges, 0.06-0.09 and 0.10-0.19Gy, are significantly lower than the control value for no adjusted city. But result of adjusted for city shows no difference. Table 4 and Figure 2 shows the relative risk of mortality from non-cancerous disease. The relative risk is significantly lower than controls for a dose range 0.06-0.49Gy adjusted for sex, age, and period (Figure 2A). But result of adjusted for city is no difference in the relative risk (Figure 2B).

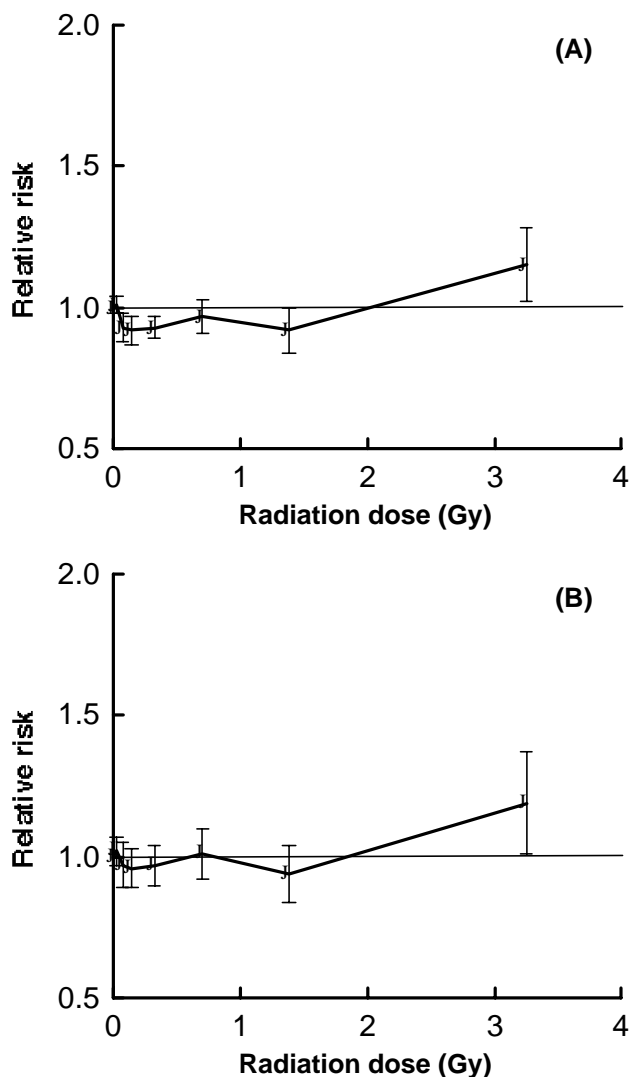


Figure 2. Relative risk by radiation dose (Non-cancerous disease).
 (A) Adjusted for sex, age and period
 (B) Adjusted for city, sex, age and period

DISCUSSION

From the analysis of LSS's population, RERF, lower relative risk of mortality from non-cancerous disease than control was observed for a dose range, 0.06-0.49Gy, when city was not adjusted. But when city was adjusted, lower relative risk was not observed. Although the number of subjects analyzed in Nagasaki University was smaller than that of LSS's population, we have obtained the lower relative risk of mortality from non-cancerous disease for male at a range of low doses.

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