

## 成人健康調査

### 原爆被爆者におけるがん以外の疾患罹患率 1958-98年

(Radiat Res 161,622,2004)

#### 研究背景と目的

放射線影響研究所では、原爆放射線の健康影響を調べるために、約2万人の成人健康調査集団を設定して、1958年から2年に1回の健診を通じて追跡調査を行っている。

この論文は、1958-98年の追跡期間中のがん以外の疾患の罹患率と放射線との関連に関して包括的に解析したものである。1993年に報告されたもの（追跡期間1958-86年）から調査期間を12年延長し、DS86を用いて解析した。

#### 研究方法

1958年7月1日から1998年6月30日までに少なくとも2回以上健診を受けた約10,000人において、21の疾患（Table 3参照）について、放射線被ばく線量との関係を検討した。

診断は、健診時の病歴聴取、診察、検査所見に基づき、ICDコードがつけられている。

慢性肝臓疾患および肝硬変のICDコードに含まれる疾患は、アルコール性脂肪肝、急性アルコール性肝炎、アルコール性肝硬変、アルコール性肝障害、詳細不明、慢性肝炎、アルコール性の記載のない肝硬変、胆汁性肝硬変、その他の慢性非アルコール性肝疾患、アルコール性の記載のない詳細不明の慢性肝疾患（アルコール性の記載のない脂肪肝を含む）である。

甲状腺疾患のICDコードに含まれる疾患は、甲状腺腫（甲状腺腫大を含む）、甲状腺結節、甲状腺中毒症（バセドウ病、甲状腺機能亢進症を含む）、先天性甲状腺機能低下症、後天性甲状腺機能低下症、甲状腺炎（慢性甲状腺炎を含む）、甲状腺のう胞、甲状腺良性腫瘍、甲状腺悪性腫瘍（甲状腺がん）である。

心筋梗塞は、1968年以前は心筋梗塞単独のICDコードが存在しないため、1968年以降を解析した。心筋梗塞の診断は、病歴に基づき、心筋梗塞による死亡や無症状の心筋梗塞は含まれていない。

線量はDS86を用い、甲状腺疾患は甲状腺臓器線量、眼科疾患は眼の臓器線量、肝臓疾患は肝臓臓器線量、婦人科疾患は子宮臓器線量、前立腺疾患は膀胱線量、その他の疾患は、胃臓器線量を用いた。

#### 研究結果

1. 21疾患の1Svあたりの相対リスクをTable3に示す。
2. 子宮筋腫、甲状腺疾患、慢性肝疾患、白内障は線量と正の関係を示した（Fig1）。

緑内障は線量と負の関係を示した (Fig1)。

3. 腎および尿路結石は、男性では線量と正の関係が認められたが、女性では関連は認められなかった。
4. 高血圧は線量が増加に対して、直線的な関係は得られなかったが、二次式の線量反応関係が得られた。心筋梗塞も線量と直線的な関係は得られなかったが、被ばく時年齢を 40 歳未満では、二次式の線量反応関係が得られた。
5. 喫煙歴、飲酒歴を考慮に入れても、上記の結果は変わらなかった (Table 3)。

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## Noncancer Disease Incidence in Atomic Bomb Survivors, 1958–1998

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Yamada, M., Wong, F. L., Fujiwara, S., Akahoshi, M. and Suzuki, G. Noncancer Disease Incidence in the Atomic Bomb Survivors, 1958–1998. *Radiat. Res.* 161, 622–632 (2004).

We examined the relationships between the incidence of noncancer diseases and atomic bomb radiation dose using the longitudinal data for about 10,000 Adult Health Study (AHS) participants during 1958–1998. The current report updates the analysis we presented in 1993 with 12 additional years of follow-up. In addition to the statistically significant positive linear dose–response relationships detected previously for the incidence of thyroid disease ( $P < 0.0001$ ), chronic liver disease and cirrhosis ( $P = 0.001$ ), and uterine myoma ( $P < 0.00001$ ), we also found a significant positive dose response for cataract ( $P = 0.026$ ), a negative linear dose–response relationship for glaucoma ( $P = 0.025$ ), and significant quadratic dose–response relationships for hypertension ( $P = 0.028$ ) and for myocardial infarction among survivors exposed at less than 40 years of age ( $P = 0.049$ ). Significant radiation effects for calculus of the kidney and ureter were evident for men but not for women (test of heterogeneity by sex:  $P = 0.007$ ). Accounting for smoking and drinking did not alter the results. Radiation effects for cataract, glaucoma, hypertension, and calculus of the kidney and ureter in men are new findings. These results attest to the need for continued follow-up of the aging A-bomb survivors to fully elucidate the effects of radiation exposure on the occurrence of noncancer diseases. ©

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**TABLE 3**  
**Linear Dose Response for Noncancer Disease Incidence between 1958 and 1998 in Hiroshima and Nagasaki**  
**Men and Women, Stratified by City, Sex, Age ATB, Age ATE, and Calendar Time**

Disease	No. cases	Without smoking and drinking in stratification	
		P	Estimated RR at 1 Sv
Hypertension	5035	0.14	1.04 (0.99, 1.09) <sup>a</sup>
<i>Hypertension<sup>f</sup></i>	5035	0.028	1.03 (1.00, 1.06)
Hypertensive heart disease	1886	0.86	1.01 (0.92, 1.10)
Ischemic heart disease	1546	0.47	1.04 (0.94, 1.14)
Myocardial infarction <sup>d</sup>	117	0.38	1.11 (0.90, 1.46)
<i>Myocardial Infarction<sup>e,60</sup></i>	78	0.05	1.25 (1.00, 1.69)
Occlusion, stenosis	440	0.61	1.05 (0.88, 1.27)
Aortic aneurysm	184	0.74	1.05 (0.88, 1.44)
Stroke I	531	0.52	1.05 (0.90, 1.25)
Stroke II	729	0.43	1.06 (0.92, 1.23)
Thyroid disease	964	0.0000	1.33 (1.19, 1.49)
Cataract	3484	0.026	1.06 (1.01, 1.11)
Gastric ulcer	930	0.98	1.00 (0.89, 1.13)
Duodenal ulcer	371	0.54	0.95 (0.81, 1.14)
Chronic liver disease and cirrhosis	1774	0.0010	1.15 (1.06, 1.25)
Cholelithiasis	959	0.93	1.00 (0.89, 1.12)
Calculus of kidney and ureter	323	0.07	1.19 (0.98, 1.46)
Uterine myoma (females)	922	0.0000	1.46 (1.27, 1.67)
Cervical polyp (females)	281	0.29	1.14 (0.90, 1.48)
Hyperplasia of prostate (males)	461	0.26	0.91 (0.79, 1.07)
Dementia	316	0.22	1.17 (0.91, 1.52)
Parkinson's disease	97	0.98	1.00 (0.72 <sup>c</sup> , 1.55)
Glaucoma	211	0.025	0.82 (0.80 <sup>c</sup> , 0.97)

<sup>a</sup> Average PY: total =  $2.2 \times 10^5$  PY; male =  $8.1 \times 10^4$  PY; female =  $1.5 \times 10^5$  PY (actual numbers depend on the disease).

<sup>b</sup> 95% confidence interval.

<sup>c</sup> Minimum feasible value.

<sup>d</sup> Incidence after June 30, 1964, since no ICD codes for MI were available before 1964.

<sup>e</sup> Based on Wald's confidence interval; no feasible likelihood-based upper bound could be estimated.

<sup>f</sup> Based on the quadratic dose-response model.

<sup>60</sup> Based on the quadratic dose-response model, for incidence during 1968-1998 and age ATB under 40 years.

**TABLE 3**  
**Extended**

Without smoking and drinking in stratification		With drinking and smoking in stratification	
Average excess disease $\times 10^4$ PY Sv <sup>a</sup>	Attributable risk (%)	P	Estimated RR at 1 Sv
10.59 (-3.41, 24.63)	2.2 (-0.7, 5.0)	0.08	1.05 (0.99, 1.10)
7.26 (0.76, 14.06)	1.8 (0.2, 3.6)	0.01	1.03 (1.01, 1.06)
0.61 (-5.92, 7.48)	0.42 (-4.2, 5.2)	0.87	0.99 (0.91, 1.09)
2.13 (-3.47, 8.10)	1.5 (-3.2, 6.5)	0.33	1.05 (0.95, 1.16)
0.57 (-0.59, 1.64)	8.5 (-8.8, 24.5)	0.48	1.12 (0.84, 1.60)
1.03 (0.01, 13.84)	15.6 (0.03, 30.8)	0.14	1.17 (0.97, 1.56)
0.76 (-2.00, 3.82)	2.5 (-6.6, 12.6)	0.52	1.06 (0.89, 1.30)
0.34 (-1.41, 2.49)	2.5 (-11.0, 18.9)	0.90	1.02 (0.78, 1.41)
1.05 (-2.02, 4.50)	2.8 (-5.4, 12.1)	0.41	1.08 (0.90, 1.31)
1.57 (-2.21, 5.84)	3.0 (-4.2, 11.2)	0.40	1.07 (0.92, 1.24)
11.99 (7.43, 16.32)	18.5 (11.5, 25.2)	<0.0001	1.38 (1.22, 1.57)
7.98 (0.95, 15.16)	3.8 (0.4, 7.2)	0.004	1.11 (1.03, 1.19)
-0.038 (-4.44, 4.76)	-0.06 (-6.5, 7.0)	0.89	1.00 (0.88, 1.12)
-0.89 (-3.38, 2.09)	-3.4 (-12.7, 7.8)	0.69	0.96 (0.82, 1.16)
10.90 (4.25, 17.79)	8.1 (3.2, 13.2)	0.0087	1.12 (1.03, 1.22)
-0.19 (-4.43, 4.31)	-0.3 (-6.6, 6.4)	0.94	1.00 (0.89, 1.12)
2.41 (-0.21, 5.39)	9.8 (-0.9, 21.9)	0.13	1.16 (0.96, 1.43)
25.02 (15.68, 34.66)	18.9 (11.8, 26.2)	<0.0001	1.39 (1.22, 1.60)
2.48 (-1.97, 7.41)	6.8 (-5.4, 20.4)	0.31	1.13 (0.90, 1.45)
-4.76 (-11.95, 3.58)	-5.8 (-14.6, 4.4)	0.21	0.90 (0.78, 1.06)
1.64 (-0.91, 4.63)	7.1 (-4.0, 20.1)	0.18	1.20 (0.92, 1.59)
0.020 (-1.06 <sup>c</sup> , 1.68)	0.3 (-14.2 <sup>c</sup> , 22.6)	0.95	0.99 (0.73, 1.58)
-1.47 (-1.74 <sup>c</sup> , -0.19)	-15.4 (-17.8 <sup>c</sup> , -2.0)	0.012	0.73 (0.72 <sup>c</sup> , 0.89 <sup>c</sup> )

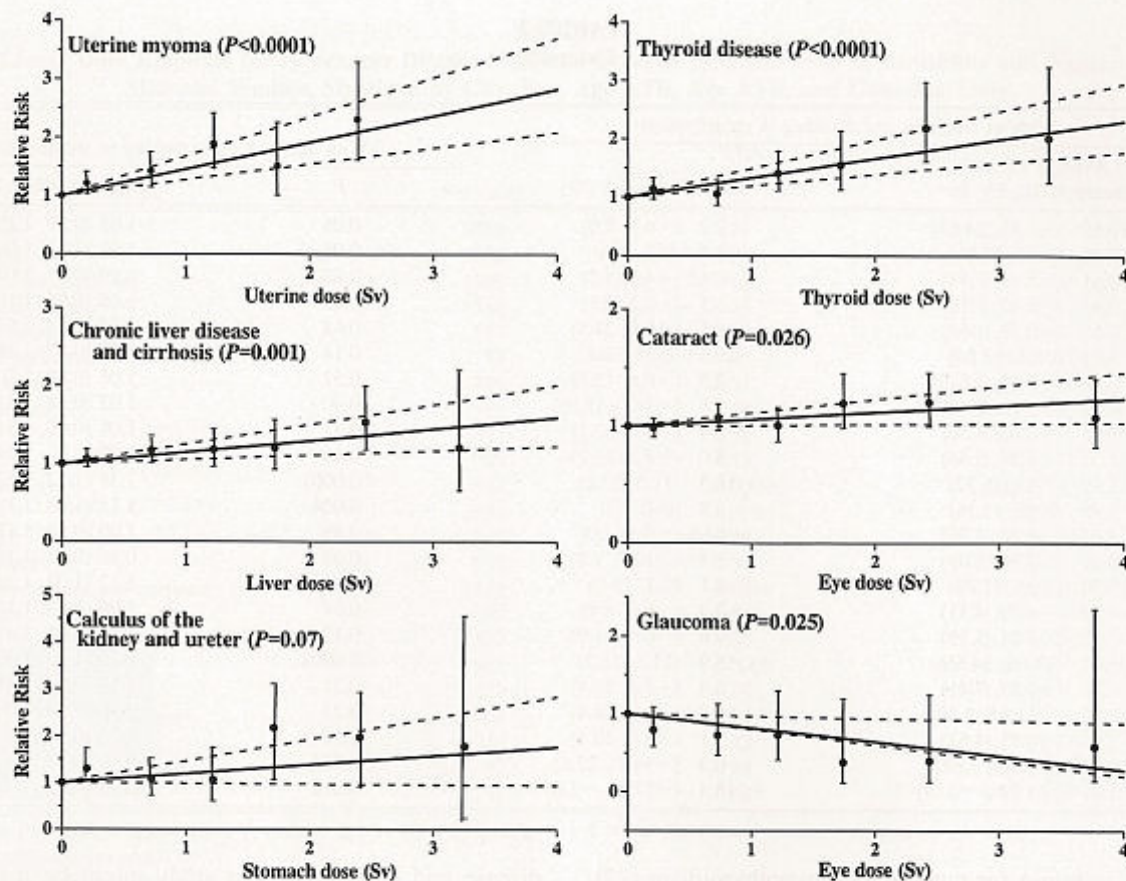


FIG. 1. Estimated linear dose response (solid line) for the incidence of six noncancer diseases with significant or suggestive radiation effects, 1958–1998. The 95% confidence bounds are shown as dotted lines. The estimated relative risks (●) and 95% confidence intervals are shown for each dose category.

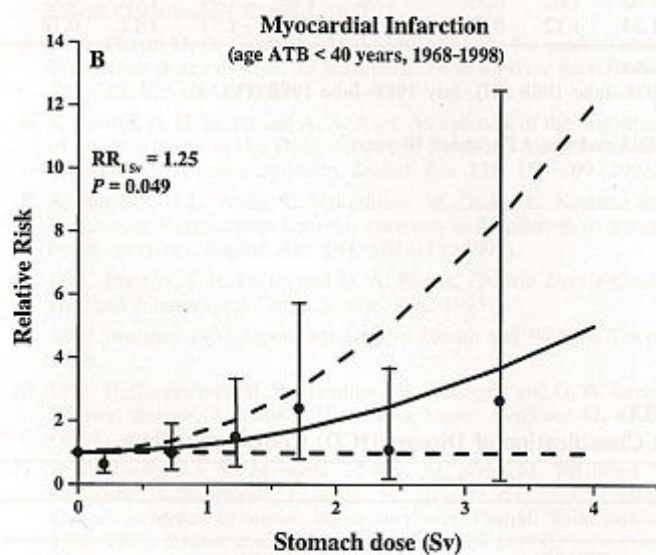
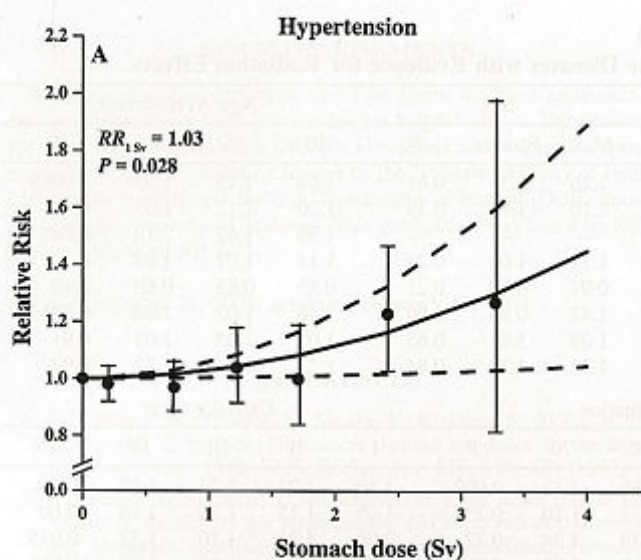


FIG. 2. Panel A: Estimated quadratic dose response for the incidence of essential hypertension, 1958–1998. Panel B: Estimated quadratic dose response, 1958–1998. Panel B: Estimated quadratic dose response for the incidence of myocardial infarction incident during 1968–1998 among AHS participants who were under 40 years ATB. The estimated relative risks (●) and the 95% confidence intervals are shown for each dose category.



## 広島、長崎の原爆被爆者における甲状腺結節と自己免疫性甲状腺疾患の放射線量反応関係 被ばく 55-58 年後の調査

*JAMA* 295(9):1011-22, 2006

### 研究目的、方法

1984-87 年にかけて成人健康調査長崎の受診者に対し甲状腺調査が行われ、1978 名について甲状腺疾患有病率と線量との関係が報告されている (Nagataki S et al. *JAMA* 272:364,1994)。この研究は、Nagataki らの調査から 16 年後の調査 (2000-2003) で、対象者を広島、長崎成人健康調査 4091 人に拡大して行われた。

甲状腺調査の内容は、甲状腺ホルモン、自己抗体、甲状腺超音波検査で、必要に応じて細胞診、組織診検査を行い、手術を受けた症例においては病理診断が得られた。

線量は DS02 甲状腺臓器線量を用いた。

### 研究結果

1. 全充実性結節、悪性腫瘍、良性結節、のう胞の有病率と線量との正の関係が認められた。
2. 甲状腺自己抗体陽性、甲状腺自己抗体陽性甲状腺機能低下症、バセドウ病の有病率は、線量との関係を認めなかった。(Figure 2)

# Radiation Dose-Response Relationships for Thyroid Nodules and Autoimmune Thyroid Diseases in Hiroshima and Nagasaki Atomic Bomb Survivors 55-58 Years After Radiation Exposure

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**T**HYROID DISEASE HAS BECOME an important target with which to study the effects of radiation. Many studies have reported that the risk for malignant and benign thyroid nodules increased with external irradiation<sup>1-8</sup> and internal radiation exposure<sup>9-13</sup> in people exposed at young ages, although few studies have followed exposed populations for long periods, such as more

For editorial comment see p 1060.

**Context** Effects of irradiation on thyroid diseases such as thyroid nodules and autoimmune thyroid diseases have not been evaluated among people exposed to radiation more than 50 years in the past.

**Objective** To evaluate the prevalence of thyroid diseases and their radiation-dose responses in atomic bomb survivors.

**Design, Setting, and Participants** Survey study comprising 4091 cohort members (mean age, 70 [SD, 9] years; 1352 men and 2739 women) who participated in the thyroid study at the Radiation Effects Research Foundation. Thyroid examinations were conducted between March 2000 and February 2003.

**Main Outcome Measures** Prevalence of thyroid diseases, including thyroid nodules (malignant and benign) and autoimmune thyroid diseases, and the dose-response relationship of atomic bomb radiation in each thyroid disease.

**Results** Thyroid diseases were identified in 1833 (44.8%) of the total participants (436 men [32.2% of men] and 1397 women [51.0% of women]) ( $P < .001$ ). In 3185 participants, excluding persons exposed in utero, not in the city at the time of the atomic bombings, or with unknown radiation dose, the prevalence of all solid nodules, malignant tumors, benign nodules, and cysts was 14.6%, 2.2%, 4.9%, and 7.7%, respectively. The prevalence of positive thyroid antibodies, antithyroid antibody-positive hypothyroidism, and Graves disease was 28.2%, 3.2%, and 1.2%, respectively. A significant linear dose-response relationship was observed for the prevalence of all solid nodules, malignant tumors, benign nodules, and cysts ( $P < .001$ ). We estimate that about 28% of all solid nodules, 37% of malignant tumors, 31% of benign nodules, and 25% of cysts are associated with radiation exposure at a mean and median thyroid radiation dose of 0.449 Sv and 0.087 Sv, respectively. No significant dose-response relationship was observed for positive antithyroid antibodies ( $P = .20$ ), antithyroid antibody-positive hypothyroidism ( $P = .92$ ), or Graves disease ( $P = .10$ ).

**Conclusions** A significant linear radiation dose response for thyroid nodules, including malignant tumors and benign nodules, exists in atomic bomb survivors. However, there is no significant dose response for autoimmune thyroid diseases.

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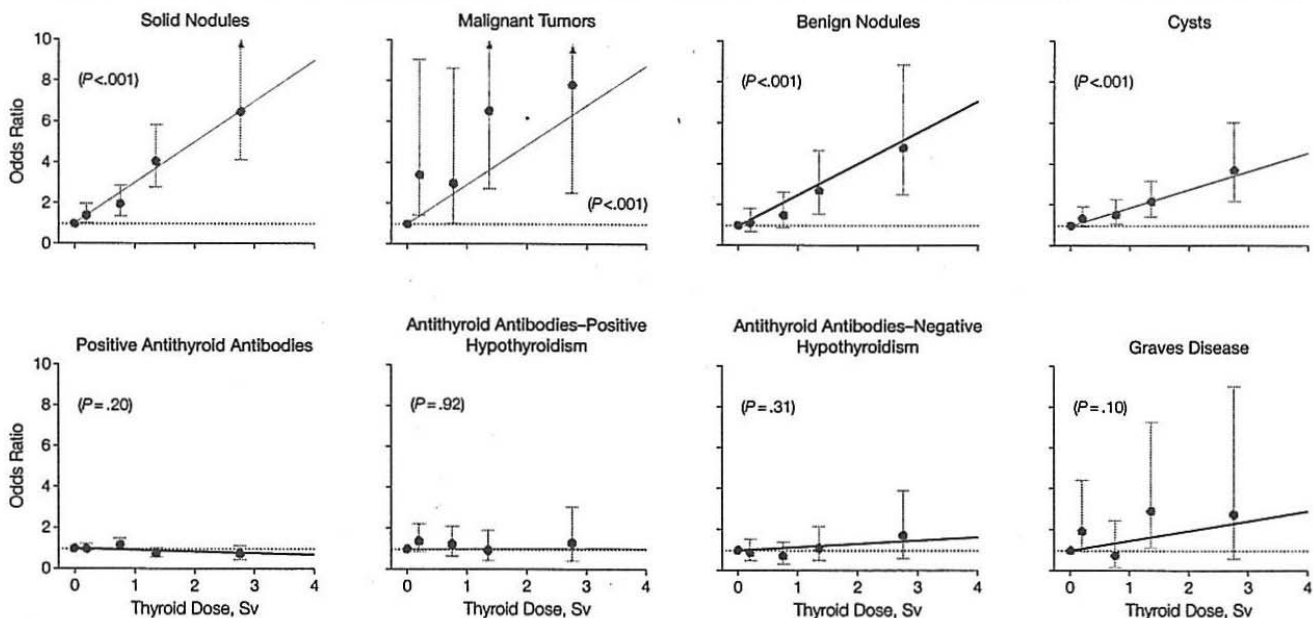
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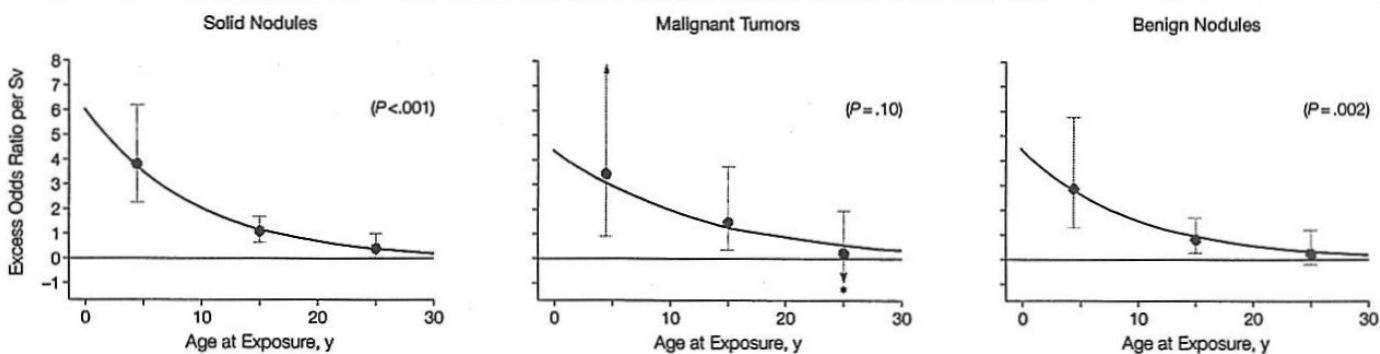
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**Figure 2. Dose Response for Thyroid Diseases**



The straight line displays the odds ratio from the best-fitting linear excess odds ratio model at age 10 years at exposure. The points are dose category-specific odds ratios with 95% confidence intervals, plotted at the mean radiation dose of the study population within each dose category. The dose categories shown on the plots represent  $<0.005$  Sv, 0.005-0.499 Sv, 0.500-0.999 Sv, 1.000-1.999 Sv, and  $\geq 2.000$  Sv. *P* values are calculated by likelihood ratio test.

**Figure 3. Trend for Age at Exposure in Radiation Dose Response for Thyroid Diseases**



The curves display the trend for age at exposure in excess odds ratio per Sv based on the best-fitting model. The points are excess odds ratios per Sv in each age at exposure category with 95% confidence intervals, plotted at the mean age for each age category. The age at exposure shown on the plot represents 0 through 9, 10 through 19, and  $\geq 20$  years. *P* values are calculated by likelihood ratio test.

\*Indicates detectable limit.

## 広島原爆被爆者における副甲状腺機能亢進症

(Radiat Res 130,372-8,1992)

### 研究背景と目的

良性疾患の放射線治療後 40 年以上経過して副甲状腺機能亢進症が発生することが報告されている。この調査の目的は、原爆放射線被ばく線量と副甲状腺機能亢進症有病率との関係を検討することである。

### 研究方法

1986-88 年に広島成人健康調査を受診した 3,948 人について、血清カルシウム検査で高カルシウム値を示す人をスクリーニングした。副甲状腺機能亢進症の診断は、血清カルシウム、副甲状腺ホルモン、甲状腺超音波検査、必要に応じてタリウム・テクネシウムサブトラクションスキャンを行い診断した。手術を受けた場合は、病理診断を得た。

線量は、DS 86 の甲状腺臓器線量を用いた。

### 結果

1. 19 人（男性 3 人、女性 16 人）の副甲状腺機能亢進症が診断された（Table 1）。9 例が手術を受け、副甲状腺腺腫 7 例、過形成 2 例であった。
2. 副甲状腺機能亢進症の 1 Gy あたりの相対リスクは 4.1（95%信頼区間 1.7-14）であった。（Fig 1）
3. 副甲状腺機能亢進症の 1 Gy あたりの相対リスクは、被ばく時年齢が若いほど大きかった。（Fig 1）



# Hyperparathyroidism among Atomic Bomb Survivors in Hiroshima

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FUJIWARA, S., SPOSTO, R., EZAKI, H., AKIBA, S., NERIISHI, K., KODAMA, K., HOSODA, Y., AND SHIMAOKA, K. Hyperparathyroidism among Atomic Bomb Survivors in Hiroshima. *Radiat. Res.* 130, 372-378 (1992).

To determine the effect of exposure to atomic bomb radiation on the occurrence of hyperparathyroidism, the prevalence was determined among a population of 3,948 atomic bomb survivors and their controls in Hiroshima. The diagnosis of hyperparathyroidism was based upon histopathological findings or the presence of consistent hypercalcemia and elevated levels of serum parathyroid hormone. Primary hyperparathyroidism was diagnosed in 19 persons (3 males, 16 females). Females had approximately a threefold higher overall prevalence of hyperparathyroidism than males ( $P < 0.05$ ). The prevalence rates of hyperparathyroidism increased with radiation dose ( $\chi^2 = 12$ ,  $P < 0.001$ ) after adjusting for sex and age at the time of the bombing. The estimated relative risk was 4.1 at 1 Gy (95% confidence limits 1.7 to 14). There was some evidence that the effect of radiation was greater for individuals who were younger at the time of the bombing. In conclusion, exposure to atomic bomb radiation affected the occurrence of hyperparathyroidism, suggesting that doses of radiation lower than those used in radiotherapy may also induce this disorder. © 1992 Academic Press, Inc.

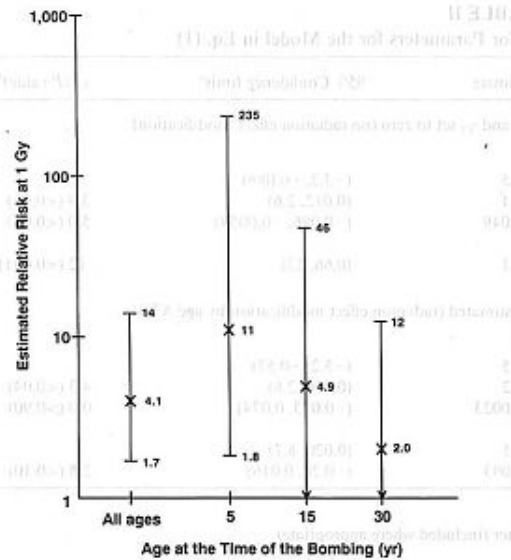


FIG. 1. Relative risk of hyperparathyroidism at 1 Gy compared to 0 Gy for all ages at the time of the bombing (ATB) combined and for three specific ages ATB. Ninety-five percent confidence bounds are also shown. Confidence bounds for the three ages are simultaneous 95% bounds.

TABLE I  
Study Subjects, Observed Prevalent Cases, and Prevalence Rate (%) of Hyperparathyroidism by Thyroid Dose, Sex, and Age at the Time of the Bombing (ATB) (3948 Individuals with DS86)

Thyroid dose (Gy)	Males (age ATB)			Females (age ATB)		
	0-9	10-19	20+	0-9	10-19	20+
<b>Total</b>						
Hyperparathyroidism	2	0	1	4	6	6
No. examined	201	553	471	321	815	1587
<b>0.000-0.009 Gy</b>						
Hyperparathyroidism	0	0	0	1	0	2
No. examined	79	223	203	133	327	618
Prevalence rate (%) <sup>a</sup>	0.084	0.081	0.078	0.27	0.26	0.25
<b>0.01-0.499 Gy</b>						
Hyperparathyroidism	0	0	1	0	3	0
No. examined	41	177	161	100	271	603
Prevalence rate (%)	0.28	0.14	0.094	0.77	0.45	0.31
<b>0.50-0.999 Gy</b>						
Hyperparathyroidism	1	0	0	1	2	1
No. examined	32	66	60	39	114	203
Prevalence rate (%)	0.68	0.29	0.14	2.3	0.99	0.48
<b>1.00+ Gy</b>						
Hyperparathyroidism	1	0	0	2	1	3
No. examined	49	87	47	49	103	163
Prevalence rate (%)	1.9	0.67	0.20	5.4	2.3	0.81

<sup>a</sup> Estimated prevalence rates derived from the model in Eq. (1) with the parameter estimates shown in Table IIB.

## 広島原爆被爆者の放射線白内障 1949-64 年

(William J Shull, 大竹正徳、船本幸代、RERF TR 11-92)

### 研究目的

1949-64 年の眼科調査で得られた白内障のデータを使って、DS86 線量を用いて、原爆被爆者における白内障の線量との関係を解析する。

### 研究方法

DS86 線量推定値が得られている広島原爆被爆者 2249 人について、1949-64 年の間に眼科調査で認められた後囊下混濁と電離放射線被曝と線量との関係を再解析した。

### 研究結果

DS86 眼臓器線量を用いた場合の放射線白内障における閾値は 1.75Sv (95%信頼区間 1.31-2.21) と推定される。

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**Technical Report Series**

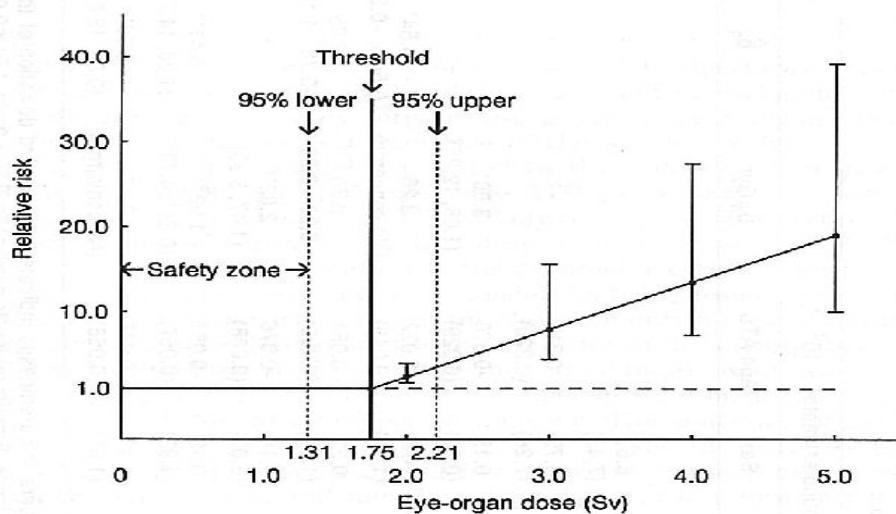

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# Radiation Cataracts among Hiroshima Atomic-bomb Survivors, 1949–64<sup>§</sup>

William J Schull,<sup>a</sup> Masanori Otake,<sup>b</sup> Sachiyo Funamoto<sup>b</sup>

## Summary

This report reexamines the quantitative relationship of exposure to ionizing radiation to the occurrence of cataracts (posterior lenticular opacities) seen in the years 1949–64 among 2249 Hiroshima atomic-bomb survivors with known Dosimetry System 1986 (DS86) doses. Among several dose-response relationships with or without two thresholds, the best fit based on binomial odds-regression models is achieved with a linear-linear dose-response relationship that assumes different thresholds for the two types of radiation. The neutron and gamma-ray regression coefficients, 199 Gy (90% CI: 28–473 Gy) and 5.14 Gy (95% CI: 1.38–14.77 Gy), based on this model, are suggestively higher for the neutron dose, and significantly higher for the gamma-ray dose than previously reported. The estimates of the two thresholds also differ significantly from zero: 0.06 Gy with 95% lower and upper bounds of 0.03 and 0.10 Gy for the neutron dose and 1.08 Gy with 95% bounds of 0.51 and 1.45 Gy for the gamma-ray dose. The safety zone for radiation-induced cataracts is estimated to be a 1.75-Sv threshold with 95% lower and upper bounds of 1.31 and 2.21 Sv using DS86 eye-organ-dose equivalents, assuming a neutron relative biological effectiveness of 18, derived from the ratio of the two thresholds, that is, 1.08 Gy for gamma rays and 0.06 Gy for the neutrons.



**Figure 2.** Relative risk of radiation cataracts and a threshold with 95% confidence limits using Dosimetry System 1986 eye-organ-dose equivalents (relative biological effectiveness = 18).

## 原爆被爆者における白内障

(Int J Radiat Biol 80:339-345,2004)

### 研究目的

被ばく後 55 年経過後に、眼科調査に基づいて診断された白内障の有病率と放射線被ばく線量との関係を検討する。

### 研究方法

被ばく時年齢 13 歳未満、あるいは 1978-80 年に成人健康調査眼科調査を受け、かつ、2000-2002 年の眼科調査を受けた広島、長崎 AHS 受診者 913 人を対象とした。

白内障は、眼科医によるスリットランプ、デジタル写真、白内障グレーディングシステムに基づき診断された。悪いほうの目の所見を使った。

線量は DS86 の眼臓器線量を用いた。

### 研究結果

1. 1 Sv あたりのオッズ比は、核色濁は 1.07 (95%信頼区間 0.90-1.27)、核混濁 1.12 (0.94-1.30)、皮質混濁 1.29 (1.12-1.49)、後囊下混濁 1.41 (1.21-1.64) であった。

(Fig 1)

2. 前回の調査 (1978-80 年) で後囊下混濁が認められた 13 例を除いても同じ結果が得られた。

## Cataract in atomic bomb survivors

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(Received 5 September 2003; accepted 2 February 2004)

### Abstract.

**Purpose:** Ophthalmologic examinations were conducted on atomic bomb (A-bomb) survivors 55 years after exposure.

**Materials and methods:** A-bomb survivors who had been exposed before 13 years of age at the time of the bombings in 1945 or who had been examined in a previous study between 1978 and 1980. The examinations, conducted between June 2000 and September 2002, included slit-lamp examination, digital photography and a cataract grading system for three parts of the lens (nucleus, cortex and posterior subcapsule) as an outcome variable. Proportional odds logistic regression analysis was conducted using the lowest grading class as a reference and included explanatory variables such as age, sex, city, dose and various cataract-related risk factors. When the grades in an individual differed, the worst grade was used.

**Results:** Results indicate that odds ratios (ORs) at 1 Sv were 1.07 (95% confidence intervals [CI] 0.90, 1.27) in nuclear colour, 1.12 (95% CI 0.94, 1.30) in nuclear cataract, 1.29 (95% CI 1.12, 1.49) in cortical cataract and 1.41 (95% CI 1.21, 1.64) in posterior subcapsular cataract. The same was true after excluding 13 people whose posterior subcapsular cataracts had been previously detected.

**Conclusion:** Significant radiation effects were observed in two types of cataracts in A-bomb survivors.

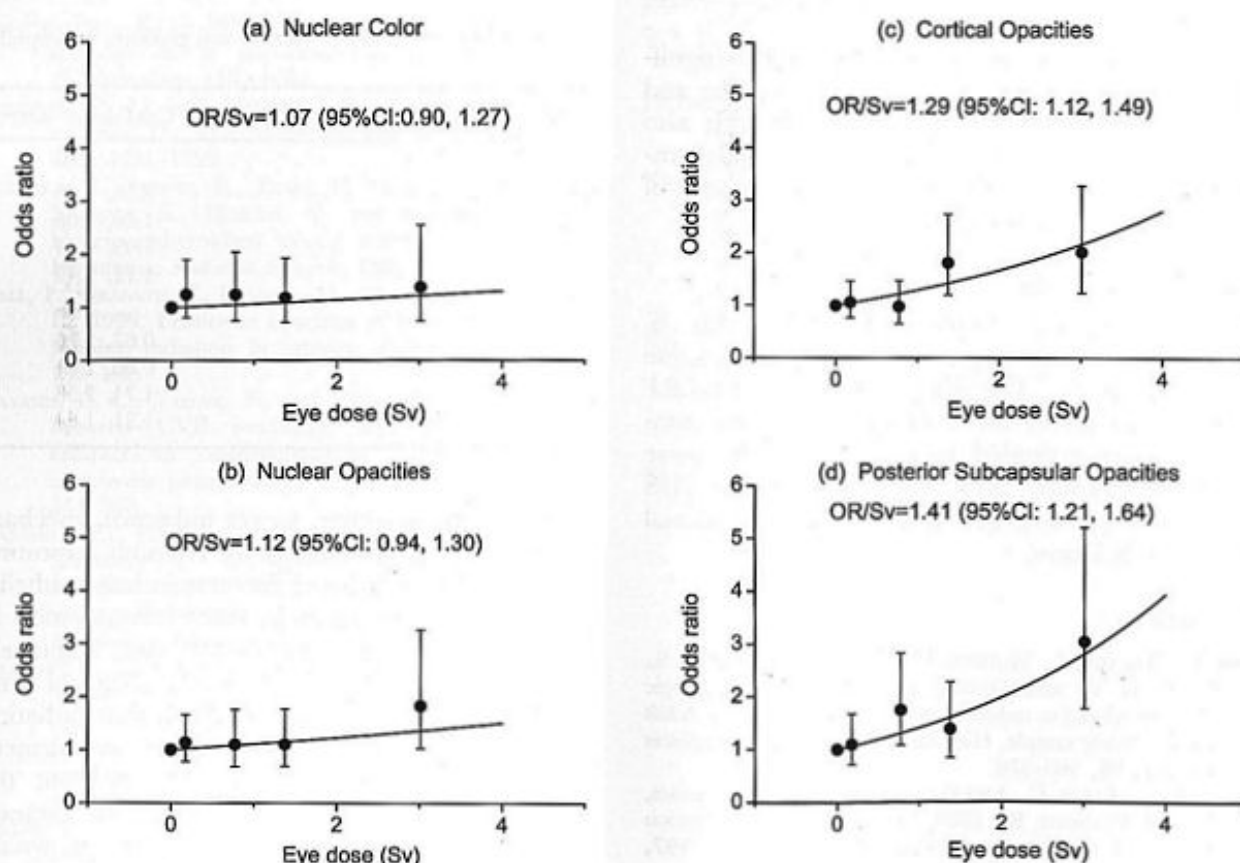


Figure 1. Odds ratios (OR) of the prevalence for nuclear colour (a), nuclear opacities (b), cortical opacities (c) and posterior subcapsular opacities (d) at 1 Sv (DS86) in 873 A-bomb survivors during 2000-02 using a proportional odds regression model with 'no opacity' as the reference of the LOCS II and adjusting for city, sex and age at the time of the bombings.



## 原爆被爆者における白内障手術後症例：放射線線量反応と閾値

(Radiat Res 168;404-408,2007)

### 研究目的

白内障手術後の症例と放射線被ばく線量との関係を検討した。

### 研究方法

対象者は2000-2002年にAHSの健診を受けた3761人である。診断は、健診時に得られた白内障手術後の病歴に基づいた。

線量はDS02の眼臓器線量を用いた。

### 研究結果

1. 白内障術後の人は479人であった。
2. 白内障術後であった人のオッズ比は、1 Gyあたり1.39 (95%信頼区間 1.24-1.55)であった。有意ではない線量閾値0.1Gy (<0-0.8)を認めた。(8ページ Fig 1)

## Postoperative Cataract Cases among Atomic Bomb Survivors: Radiation Dose Response and Threshold

Kazuo Neriishi,<sup>a,1</sup> Eiji Nakashima,<sup>b</sup> Atsushi Minamoto,<sup>c</sup> Saeko Fujiwara,<sup>a</sup> Masazumi Akahoshi,<sup>d</sup> Hiromu K. Mishima,<sup>e</sup> Takashi Kitaoka<sup>f</sup> and Roy E. Shore<sup>g</sup>

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Neriishi, K., Nakashima, E., Minamoto, A., Fujiwara, S., Akahoshi, M., Mishima, H. K., Kitaoka, K. and Shore, R. E. Postoperative Cataract Cases among Atomic Bomb Survivors: Radiation Dose Response and Threshold. *Radiat. Res.* 168 404–408 (2007).

Recent evidence argues against a high threshold dose for vision-impairing radiation-induced cataractogenesis. We conducted logistic regression analysis to estimate the dose response and used a likelihood profile procedure to determine the best-fitting threshold model among 3761 A-bomb survivors who underwent medical examinations during 2000–2002 for whom radiation dose estimates were available, including 479 postoperative cataract cases. The analyses indicated a statistically significant dose-response increase in the prevalence of postoperative cataracts [odds ratio (OR), 1.39; 95% confidence interval (CI), 1.24–1.55] at 1 Gy, with no indication of upward curvature in the dose response. The dose response was suggestive when the restricted dose range of 0 to 1 Gy was examined. A nonsignificant dose threshold of 0.1 Gy (95% CI, <0–0.8) was found. The prevalence of postoperative cataracts in A-bomb survivors increased significantly with A-bomb radiation dose. The estimate (0.1 Gy) and upper bound (0.8 Gy) of the dose threshold for operative cataract prevalence was much lower than the threshold of 2–5 Gy usually assumed by the radiation protection community and was statistically compatible with no threshold at all. © 2007 by Radiation Research Society

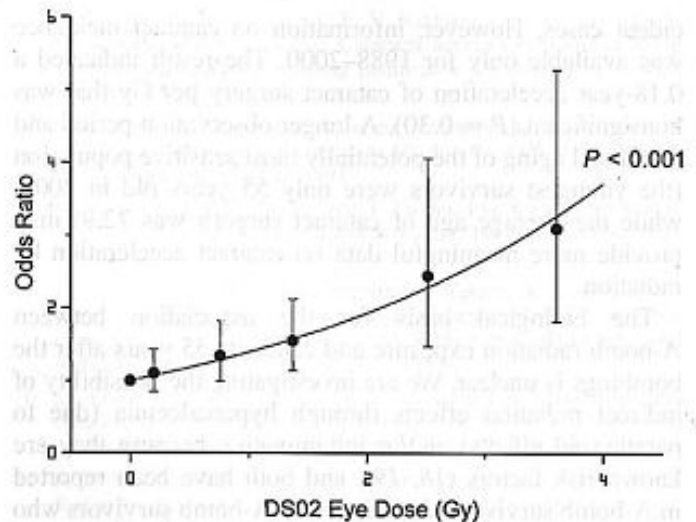


FIG. 1. The main-effect model dose-response curve in regression analysis after adjusting for city, sex, age at the time of the bombings, and diabetes mellitus in A-bomb survivors who had undergone lens removal surgery (OR at 1 Gy, 1.39; CI, 1.24–1.55). Mean doses (Gy) for dose categories are 0.199 for  $0.005 \leq d < 0.50$ , 0.759 for  $0.5 \leq d < 1.0$ , 1.373 for  $1.0 \leq d < 2.0$ , 2.517 for  $2.0 \leq d < 3.0$ , 3.610 for  $3.0 \leq d$ , respectively.