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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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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THYROID 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[1-8] and internal radiation exposure[9-13] 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.

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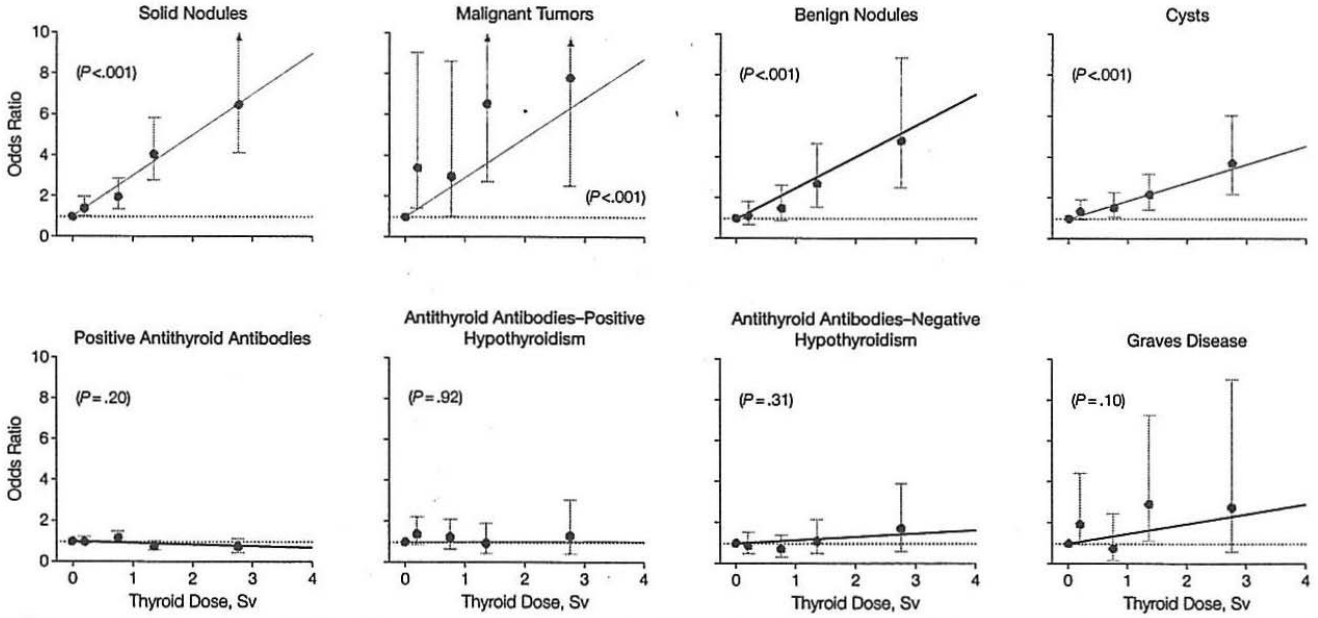
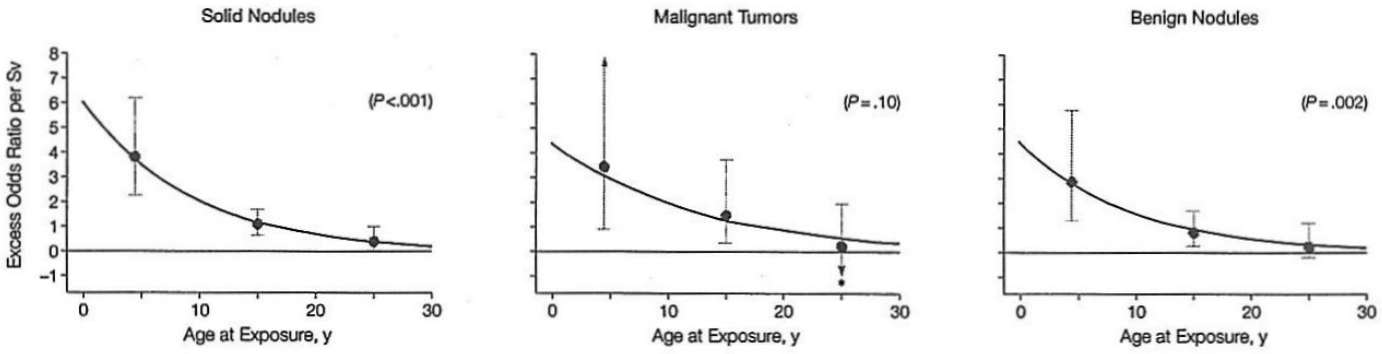
Figure 2. Dose Response for Thyroid Diseases



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 ≥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 ≥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、DS８６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（Table１）。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１Ｇｙあたりの相対リスクは 4.1（95%信頼区間　1.7-14）であった。（Fig１）

３．　副甲状腺機能亢進症の１Ｇｙ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。（Fig１）