Thyroid-stimulating Hormone Levels in Children from Chernobyl

Michael R. Quastel, John R. Goldsmith, Ludmilla Mirkin, Svetlana Poljak, Yehiel Barki, Jackov Levy, and Rafael Gorodischer

Soroka Medical Center and Faculty of Health Sciences, Ben-Gurion University of the Negev, Beer Sheva, Israel

This study assesses parameters of thyroid function in persons who resided in Ukraine, Belarus, and southern Russia and exposed at 0 to 16 years of age to radioiodine contamination from the Chernobyl accident. Six to eight years after the accident a group of 300 young people who had immigrated to Israel were interviewed, underwent physical and ultrasound thyroid examination, and had their serum tested for thyroid-stimulating hormones (TSH), thyroid hormones, thyroglobulin, and antithyroid antibodies. Comparative groups came from areas with high (> 1 Ci/km^2) or low (< 1 Ci/km^2) ^{137}Cs ground contamination. Girls from high contamination areas, when compared to girls from areas with low ground contamination, showed significant upward shifts in levels of serum TSH ($p = 0.023$) although remaining within normal limits. Boys showed no significant differences. There was no evidence for differences in thyroid size or nodularity between the two groups of girls. A working hypothesis is proposed by which the shift in TSH levels in girls from high radiocontamination areas was associated with subclinical radiation damage from environmental radioiodine at the time of the accident. — *Environ Health Perspect* 105(Suppl 6):1497–1498 (1997)

Key words: Chernobyl, radiation, thyroid, radioiodine, children, thyroid-stimulating hormone, TSH

Introduction

Children exposed to Chernobyl radioiodine in 1986 are a population of special concern because of high past consumption of radioiodine-containing dairy products, iodine deficiencies and endemic goiter in Belarus and Ukraine (*1–3*), the presumed higher sensitivity of children to ionizing radiation, and recent reports of elevated rates of childhood thyroid cancer, mainly in Belarus but also in Ukraine and the southern part of the Russian republic (*4–6*).

This paper is based on a presentation at the International Conference on Radiation and Health held 3–7 November 1996 in Beer Sheva, Israel. Abstracts of these papers were previously published in *Public Health Reviews* 24(3–4):205–431 (1996). Manuscript received at *EHP* 5 September 1997; accepted 2 October 1997.

The authors thank the Israel Ministry of Health for support and A. Snopik and S. Peremuter for technical assistance.

Address correspondence to Dr. M.R. Quastel, Institute of Nuclear Medicine, Soroka Medical Center, P.O. Box 151, Beer Sheva, 84101 Israel. Telephone: 972 7 6400754. Fax: 972 7 6400765. E-mail: maay100@bgumail.bgu.ac.il

Abbreviations used: Ci, curie; FSU, former Soviet Union; IAEA, International Atomic Energy Agency; kBq, kilobequerel; TSH, thyroid-stimulating hormone; μIU, microinternational units.

Many immigrants came to Israel from such areas in a recent wave of immigration from the countries of the former Soviet Union (FSU). Of the approximately 700,000 people who came to Israel from the FSU between 1990 and 1996, our estimate is that at least 20% came from regions of Belarus, Russia, and Ukraine that were contaminated with various amounts of radionuclides (*7*) as a result of the Chernobyl accident.

This preliminary study assesses thyroid function in immigrants who were children (0 to 16 years of age) at the time of the Chernobyl accident and reports on preliminary results of assessments of thyroid-stimulating hormone (TSH) serum levels in these young people.

Methods

Three hundred immigrant children from Belarus, Russia, and Ukraine were examined through face-to-face interviews, physical examinations (including the thyroid), blood sampling, and ultrasound examinations from 1992 to 1994. Total serum triiodothyronine, tetraiodothyronine, TSH, thyroglobulin, antithyroid, and antimicrosomal antibodies were measured. TSH levels were assessed using a chemoluminescent third-generation assay (*8*). The 129 boys and 171 girls, who were 0 to 16 years of age at time of the reactor accident, ranged in age from 5 to 24 at the time of examination. The children and young adults were brought in by their parents or were referred themselves and appeared in the clinic on a voluntary basis.

A natural comparative experiment was suggested by identifying subjects coming from more contaminated and less contaminated areas as defined by the 1991 International Atomic Energy Agency (IAEA) ground radiocontamination maps (*9*). The group was therefore divided into those who originally resided in regions of higher and lower ^{137}Cs exposures because the dispersal and deposition of ^{131}I would be expected to have a similar distribution. High- and low-exposure areas are defined here as those areas with ^{137}Cs concentrations greater or less than 37 kBq/m^2 (1 Ci/km^2), respectively, as expressed on the IAEA ^{137}Cs ground contamination maps.

The 94 girls from low-contamination regions included 35 from Kiev, 18 from Minsk, 9 from Vinnitsa, 5 each from Bobruysk and Zitomir, 3 from Chernigov, 2 each from Harkov, Vitebsk, and Zaporozhye, and 1 each from Belaja Zeskov, Berdichev, Brest, Cherkassy, Chernovtsy, Dneprodzerzhinsk, Dnepropetrovsk, Globino, Lvov, Molodechno, Orsha, Pinsk, and Znamenka. All were from Belarus or Ukraine. Of the 77 girls from high-contamination areas, 56 came from Gomel, 8 from Mozyr, 4 each from Mogilev and Klintsy, 3 from Korosten, and 2 from Narovla. With the exception of the four subjects from Klintsy in Russia, all were from Belarus.

Results and Discussion

The assumption that the thyroid radiation dose due to radioactive iodine can be directly correlated with ^{137}Cs deposition is useful as an indication of those regions that probably were contaminated with radioiodine, but it is recognized to be an oversimplification. Short-lived radioiodines (including ^{132}I, ^{133}I, and ^{135}I), which have been estimated to be more destructive per rad than ^{131}I (*10*), may have caused radiation exposure related to the distance from Chernobyl, dependent on the degree of their physical decay by the time the radioactive cloud passed some distance from its origin. Hence, there is reason to expect that children living nearer the site of the accident and those living downwind had relatively higher exposures to radioiodines, which may have led to increases in the incidence of childhood thyroid cancer reported in these regions. Development of thyroid hypofunction therefore may also be anticipated. Indeed, Larsen et al. (*10*) showed that a high prevalence of thyroid hypofunction was a delayed complication of exposure to early fallout from a hydrogen bomb explosion.

Our results (Figure 1) indicate that the distribution of TSH levels in girls was higher in children from high-exposure areas, although almost all values lay within the normal range (0.4 to 4.0 µIU/ml). The shift in TSH levels was statistically significant at $p < 0.02$ by the χ^2 test. Although boys showed a similar trend the increase among boys was not statistically significant. Combining boys and girls into a single group for statistical evaluation did not improve the results of the analysis. The apparently greater sensitivity of girls may reflect known gender differences for clinical problems of the thyroid (*11*). Possible explanations for the TSH effect include either radiation damage to the thyroid with a resulting homeostatic increase of TSH or greater iodine deficiency in the more exposed areas.

To test for the second possibility we examined the incidence of enlarged thyroids by direct palpation and ultrasound. There was no difference in the prevalence of enlarged thyroids between children coming from low and high radiocontamination areas. Therefore, iodine deficiency does not appear to be an explanation for the elevated TSH levels among children in areas more highly exposed to nuclear fallout.

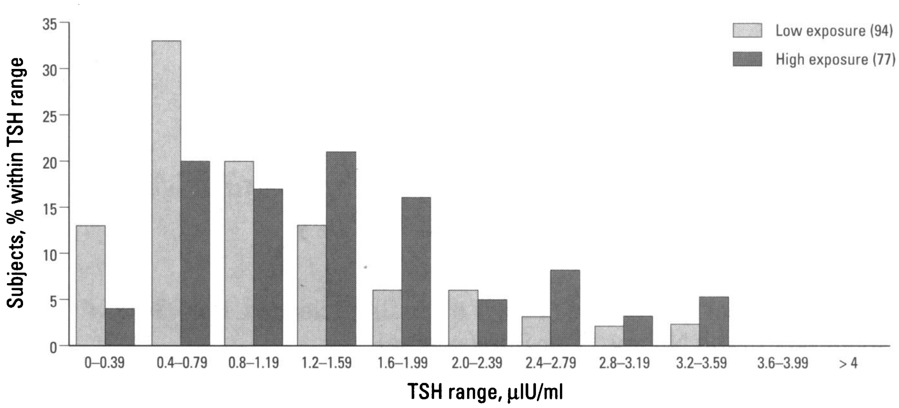

Figure 1. TSH levels in 171 girls (all ages) from low- and high-exposure areas. Mean TSH values are defined as low exposure (ground contamination <37 GBq/km² [1 Ci/km²]) and high exposure (ground contamination >37 GBq/km² [1 Ci/km²]). The shift in TSH levels was statistically significant at $p < 0.02$ by the χ^2 test.

Our working hypothesis, therefore, is that some children who came from the higher contamination areas had subclinical radiation damage that led to compensatory homeostatic increases in TSH. Hence, elevated TSH in a population group could be a marker for prior exposure of the thyroid to environmental radioiodine. Other evidence for past radiation exposure (based on elevated clastogenic factors) has been reported in children who came from areas radiocontaminated by the Chernobyl accident (*12*).

It must be pointed out, however, that the effects observed do not provide any quantitative indication of radiation doses received by individuals within the group.

We are unaware of any previous studies of such an effect on TSH levels in children who lived in regions contaminated by the Chernobyl accident. Therefore we present these preliminary results anticipating that large-scale studies in FSU countries may be able to test the hypothesis with larger numbers of subjects from radiocontaminated areas.

REFERENCES

1. Bolshova EV, Tronko ND, VanMiddlesworth L. Iodine deficiency in Ukraine. Acta Endocrionol 129:594 (1993).
2. Mityukova TA, Astakhova LN, Asenchyk LD, Orlov MM, VanMiddlesworth L. Urinary iodine excretion in Belarus children. Eur J Endocrinol 133:216–217 (1995).
3. Sugenoya A, Asanuma K, Hama Y, Masuda H, Skidanenko GS, Anatoliebna AT, Koike K, Komiyama A, Iida F. Thyroid abnormalities among children in the contaminated area related to the Chernobyl accident. Thyroid 5:29–33 (1995).
4. Kazakov VS, Demidchik EP, Astakova LN. Thyroid cancer after Chernobyl [Letter]. Nature 359:21 (1992).
5. Baverstock K, Egloff B, Pinchera A, Ruchti C, Williams ED. Thyroid cancer after Chernobyl [Letter]. Nature 359:21–22 (1992).
6. Williams ED. Thyroid cancer and the Chernobyl accident. J Clin Endocrin Metab 81:6–8 (1996).
7. Israel. Central Bureau of Statistics. Immigration to Israel. Publ No 1037. Jerusalem:Ministry of Immigrant Absorption, Government of Israel, 1995.
8. Wilkinson E, Rae PW, Thomson KJ, Toft AD, Spencer CA, Beckett GJ. Chemiluminescent third-generation assay (Amerlite TSH-30) of thyroid-stimulating hormone in serum or plasma assessed. Clin Chem 39:2167–2173 (1993).
9. IAEA. The International Chernobyl Project: Surface Contamination Maps. Report by an International Advisory Committee. Vienna:International Atomic Energy Agency, 1991.
10. Larsen PR, Conard RA, Knudsen KD, Robbins J, Wolff J, Rall JE, Nicoloff JT, Dobyns BM. Thyroid hypofunction after exposure to fallout from a hydrogen bomb explosion. JAMA 247:1571–1575 (1982).
11. Ingbar SH, Braverman LE, eds. Werner's The Thyroid. 5th ed. Philadelphia:JB Lippincott, 1986;71, 983.
12. Emerit I, Quastel M, Goldsmith J, Merkin L, Levy A, Cernjavski L, Alaoui-Youssefi A, Pogossian A, Riklis E. Clastogenic factors in the plasma of children exposed at Chernobyl. Mutat Res 373:47–54 (1997).