A Report of the 1st Chernobyl Sasakawa Medical Symposium (June 1992)

Sasakawa Memorial Health Foundation

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Preface

The Chernobyl Sasakawa Health and Medical Cooperation Project is marking a steady progress since 1990 when Japanese specialists in different disciplines of radiation medicine were dispatched to the scene of the disaster. The four-nation projects (Belarus, Russia, Ukraine and Japan) is enriched by the shared sense of urgency and humanity towards the victims. After a year of hard work and commitment, a symposium was held in June 1992 to examine the state of the progress.

In coping with the unprecedented disaster and appalling consequences, the Chernobyl Sasakawa Health and Medical Cooperation Project was conceived of the following principles.

First and foremost, the project was to be a product of cooperation. This is in line with the guiding principle of Sasakawa Memorial Health Foundation coined by its founder, Ryoichi Sasakawa: "The world is one family; and all humankind are brothers and sisters". The Foundation provides not just aid in kind but compassion; to work with the five centers in the affected regions for the benefit of brothers and sisters in their hour of need. The project received, as we learned from the Symposium, devoted cooperation from the doctors and technicians at each center. This indeed is two-sided cooperation project.

Second, the project was to be a collaboration in science and technology. Quite understandably, many different approaches can be taken in projects of this magnitude. A scientific approach was chosen to build on the strength of the Foundation which is international cooperation in the fields of health and medical care. Scientific finding will add to the reservoir of our knowledge and contribute to a better tomorrow. After heated deliberation among scientists details of health examination of child victims were selected. Decisions made finally drew from the scientific analysis of the experiences of Hiroshima and Nagasaki.

Third, the project was to be a part of a network of international cooperation. The project was able to benefit from the support and cooperation of scientists of worldwide fame with experiences of Hiroshima and Nagasaki. Sasakawa Memorial Health Foundation and its parent organization, the Japan Shipbuilding Industry Foundation (Sasakawa Foundation) brought to the project a rich accumulation of the many years of international cooperation. A solid collaboration with the World Health Organization (WHO) and the International Atomic

Energy Agency (IAEA) has been made. The project will also continue to rely on the close collaboration between the government ministries and agencies concerned including Foreign Affairs, Health and Welfare, Science and Technology as well as universities and research insitutions.

Fourth, the project was to be a product of private sector volunteerism. While there is much to be said for inter-government cooperation, flexibility of private activities and the spirit of volunteerism are vital to the success of cooperation in humane health and medical care. It was this spirit of volunteerism that brought together many experts and organizations in this project for unprecedented speed. It is the shared sense among us that we are all aboard the one and the only spaceship Earth.

Fifth, the project is future oriented. The disaster was indeed extraordinary. It is, however, not enough to analyze the past. The fundamental concept of the cooperation in this project is to search what can be done today to build a better future. It was with this in mind that priority was given to children, for it is in them that we see the hope for the future.

In the first year of our project we were able to screen 13,000 children. This is in itself a miraculous feat. We are aware that challenges that await us in future are greater. It is with renewed sense of dedication that we publish the progress report of the first year as a milestone in the course of our advancement.

Kenzo Kiikuni
Managing Director,
Sasakawa Memorial Health Foundation
Professor,
Institute of Community Medicine,
University of Tsukuba

Editorial Note

In this symposium, each center presented the results of examinations conducted during the past year (from May 1991 to April 1992), focusing mainly of 1) the thyroid, 2) blood, and 3) radiation dose. In consideration for the value of the original manuscripts, we neither deleted nor revised any parts except erroneous or hard to understand. A few charts and figures were also added, but in principle the final documents follow the presentations of each center and keep the tone of the reports. The reader is advised to refer to other authorities and may not quote from this book in any form without the permission of Sasakawa Memorial Health Foundation. the editors will continue to strive to achieve the utmost accuracy of all data and to raise these reports to the highest possible standards of scientific analysis.

Editors
Shuichi Yamashita
Kingo Fujimura
Masaharu Hoshi
Yoshisada Shibata

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1. Opening Ceremony

Greetings

Yohei Sasakawa

President
Sasakawa Foundation

I wish to express my warmest and deepest gratitude to Mr. Kenik, Deputy Prime Minister of Belarus, Mr. Kazakov, Minister of Health of Belarus and Mr. Grinev, Governor of Mogilev Region, and all the participants to this Symposium who have been making great efforts in the humanitarian activities to assist the victims of the Chernobyl disaster.

As you are well aware, 46 years ago, Japan became a victim of atomic bombing. I therefore think that perhaps we Japanese can fully share in great depth the pains and sorrows you all suffer. Although Japan's experience was the most unfortunate, the results of the untiring efforts of Japanese and the special knowledge acquired over the past 46 years can now make contribution in mitigating the aftermath of Chernobyl disaster. In this Symposium, we are able to have participation of the world's leading academic authority on radiation medicine from Japan, headed by Dr. Shigematsu, as well as from three States. I sincerely hope that active and fruitful discussions may result from this meeting.

One year has passed since we started our cooperation project. We are indeed truly grateful that medical screening of children has been making steady progress thanks to your devoted work. For that, we would like to express our appreciation. I think it is important to note that in this project, the specialists from Belarus, Russia, Ukraine and Japan have all been actively working together toward the same goal. Today, at this Symosium, we look forward to listening to the reports and studying the results of the joint activities over the past one year.

The joint cooperation project, having just reached the one year mark has yet four years to go. From the experiences of the past year, I hope that we all gain insights to make the four years ahead more productive and fruitful in mitigating the anxiety of the people by conducting medical examinations of the children. To that end, I would like to offer our utmost support to all of you working at the actual site of this project to enable you to display your fullest abilities in your activities.

Lastly, I wish to express my sincere appreciation to the members of the Organizing Committee who have extended to us their warm hospitality and exerted their greatest efforts to make this Symposium a sucess. Thank you very much.

Greetings

Ivan A. Kenik

Deputy Prime Minister of Belarus

To all distinguished delegates I would like to deliver my welcoming address here in the city of Mogilev on behalf of the Republic of Belarus.

In Belarus, we now face the urgent problem of finding appropriate means to handle the aftermath of the Chernobyl nuclear disaster. Accordingly, we all are eager to hear the collective results of your investigations and research which are and will continue to be of the greatest importance for us. As you know, the plan of emergency measures, which was decided by the supreme Soviet of former USSR, will expire this year (1992). The government of Belarus is therefore now in the process of forming new policies to cover the period 1993-2000. Under this circumstance, the results of your Symposium are of particular importance to our government. For based upon such results, our government will determine, for example, the number of people to be evacuated to other regions. None of the Academies of Science of Russia, Ukraine, and Belarus has yet come up with a concrete answer regarding this issue. Moreover, our government must learn how to reduce the level of radiation from 0.5 rem to 0.1 rem over the next seven years before the year 2000. But, this issue is not only important for our government; it is also important for the people living in the affected region, which amounts to one-fifth of the total area of Belarus.

I sincerely pray for the sccess of the Symposium, and hope that you will come to the truth after having listened to and given your fullest attention to the participants' reports and ideas. Thank you very much.

An Outline of the Chernobyl Sasakawa Health and Medical Cooperation Project

Itsuzo Shigematsu, M. D.

Chairman
Radiation Effects Research Foundation
(Epidemiology)

On the occasion of the commencement of this Symposium, I would like to outline for you the Chernobyl Sasakawa Health and Medical Cooperation Project under the following three headings: (1) Development of the Project; (2) Dispatch of investigation team and establishment of project plans; and (3) Commencement of screening and progress over the past one year.

1. Development of the Project

When Mr. Yohei Sasakawa, President of Sasakawa Fondation, visited the former Soviet Union in February of 1990 at the invitation of its government, he was asked to consider, for the purpose of finding measures to cope with the Chernobyl accident, the possible cooperation of Sasakawa Memorial Health Foundation which is well known for its significant contributions to the advancement of health and medical care on a global scale. This was the starting point.

Immediately on his return to Japan, Mr. Sasakawa discussed this request with Japanese experts in the related fields and formed a Cooperation Committee which began to discuss the means of cooperation.

Mr. Sasakawa felt that since Japan is the only country in the world to have actually suffered from atomic bombing, Japan's experiences would constructively contribute to humanitarian efforts in supporting and helping the victims of the Chernobyl disaster.

2. Dispatch of investigation team and establishment of project plans

In August 1990, an on-site investigation team was formed drawing mainly on Cooperation Committee members and it visited Ukraine and Belarus to conduct on-site investigations at the invitation of the Government of the former Soviet Union. Most of the invited members are participating in this Symposium. When the investigation team visited these areas, generous cooperation was extended by all related people in the three States of Russia, Ukraine and Belarus. I would once again like to express to them our sincere gratitude.

The following five points became clear as a result of the on-site investigations.

(1) There is great anxiety among the residents in the regions concerned.

(2) One of the main causes of this anxiety is the suspicion that they are not receiving correct information.

(3) A speedy assessment of the actual situation is vital.

(4) In order to achieve this aim, a direct screening of the residents is the optimal means.

(5) And, top priority should be on children who are the most susceptible to radiation.

Based upon these results, the Japanese Cooperation Committee began to develop urgently Project Plans for medical cooperation and a series of meetings were held with the Ministry of Health of the Soviet Union. In addition, the Committee made an effort to coordinate this project within other projects being conducted by the Government of Japan, WHO, IAEA and other international organizations.

Taking full advantage of the flexibility of a non-govenmental organization, Sasakawa project developed a plan that placed top priority on the driect and speedy delivery of services to the residents of the affected areas, and made utmost effort to carry out its activities at the first possible opportunity. In this way, the present plan for medical examination in the five regions of the three States was established with emphasis on the following three points and priority on children: (1) hematological disturbances, (2) thyroid disorders and (3) radiation dosimetry. Mobile units were specially designed and manufactured in order to carry out this plan.

Moreover, to ensure the smooth operation of the project, an advisory committee was formed in both Japan and the Soviet Union, with Academician Yevgeni Velikhov appointed as the Committee Chairman for the Soviet Union side and Mr. Sasakawa appointed as the Committee Chairman for the Japanese side.

Since then, following the independence of the three republics, Memoranda of Understanding were signed in Moscow between Sasakawa Memorial Health Foundation and the three States.

3. Commencement of screening activities and progress over the past one year

The five mobile units for medical examination which I mentioned earlier were donated at the ceremony held in the Red Square in Moscow on April 26, 1991, the fifth anniversary of the Chernobyl disaster. Following the ceremony, a training was launched at the beginning of May in Obninsk, in collaboration with Japan and the Soviet Union regarding the usage of equipment installed in the medical examination vehicles. Not only were the medical examiners from the five centers involved in the training, but researchers from the Obninsk Research Institute also participated. In mid-May, screening activities commenced at each of the five centers with the participation of Japanese specialists who stayed at the centers for one week to two months. The technical transfer required for the correct operation of Japanese equipment also went more smoothly than expected. The presence of the Japanese specialists helped to deepen mutual understanding and ties of friendship.

Following this initial phase, Japanese specialists visited each center about once every two to three months to offer technical assistance, discuss specific issues on screening and hold workshops with the participation of the staff from all five centers gathering in one place.

I believe that the results gained over the past one year were satisfactory, and I would like to thank all the staff of the five centers for their utmost thoughtfulness and cooperation offered to the Japanese specialists.

I also appreciate the work of the interpreters who did an excellent job in bridging the linguistic gap.

In Setember 1992, two staff members from each of the five centers were invited to Japan to take part in training and observations in Nagasaki, Hiroshima and Chiba. The results gained from the medical examinations in the first year will be reported at this Symposium by the representatives of each center. Approximately screening of 13,000 children were completed. Although this may not be a large figure compared with the total population of the children involved, I believe that it is better than our original forecast, considering the obstacles facing the support activities at the bases, such as those related to transporation and supply of equipment, chemical reagents, and screening activities in the winter, which were all done on a trial and error basis. It was originally planned that in the initial phase ten mobile units would be donated. However, based on bilateral discussion, it was decided that the remaining five vehicles would be replaced by the supply of medical equiment and a bus as separate items. The medical equipment would be insalled in the center and the bus would be used to transport children. Since the restrictions imposed by the requirement to mount the medical equipment on a mobile unit have been removed, it has become possible to improve substantially the quality of the whole body counter and ultrasonic equipment. Following the Symposium, training programs for this equipment will be held.

Finally, I would like to add one more comment. In the autumn of last year, the Moscow Office of Sasakawa Memorial Health Foundation was established, and I am delighted to say that mutual communication has been strengthened as a result.

Lastly, I must point out that strong interest in this Symposium has been shown from various sectors. I sincerely hope that the scientific records of this Symposium will be compiled and published by the joint cooperation of the staff members of the five centers and the Japanese specialists.

2. Reports from the Five Centers

Mogilev Regional Medical Diagnostic Center

Reporter : Natalya D. Yuryeva

I. Introduction

The Chernobyl Nuclear Power Plant accident markedly worsend the environmental conditions in the three republics affected, i.e., Belarus, Russia and Ukraine. It also produced much anxiety among the population and caused serious health hazards, especially for children who are particularly vulnerable to physical and mental injury.

During the 6 years since the accident, various examinations and studies have been performed to assess the health of the children exposed to low doses of radiation. However, the long-term effects of such radiation remain to be clarified.

At the Mogilev Regional Medical Diagnostic Center, a project team has been organized and started work on May 15, 1991 as part of the Chernobyl Sasakawa Health and Medical Cooperation Project.

Medical examinations are being carried out using a mobile clinic and other medical instruments generously supplied by Sasakawa Memorial Health Foundation.

II. Examination schedule

(1) Interviews to obtain medical history data and recording of the data on case cards.
(2) Determination of the whole body ^{137}Cs content using a whole body counter.
(3) Ultrasonography of the thyroid.
(4) Routine hematological examinations and determination of serum thyroid hormone levels.
(5) Preparation of blood smears for routine hematological examination.
(6) Assays of urinary iodine and creatinine are scheduled to start in June 1992.

III. Subjects

Examinations started on May 15, 1991 and we investigated a total of 3,822 subjects (1,848 boys and 1,974 girls aged 4-16 years) living in more than 100 villages in 8 districts. In Table 1, the subjects are classified by district of residence and sex. The Center is planning to obtain data from 5,000 subjects per year in the future. Table 2 shows the radiation levels in the districts where 3,472 subjects lived as of April 13, 1992.

All data are processed at the Mogilev Regional Medical Diagnostic Center and entered into a database. The results of examinations are planned to be reported in writing to each of the subject's parents. If any abnormal findings are detected, the subject will undergo a follow-up examination at the Mogilev Regional Medical Diagnostic Center, and treatment will be ordered if necessary.

Table 1. Classification of subjects by district and sex.

District	Total	Boys	Girls
Slavgorodskii	409	195	214
Klimovichskii	97	51	46
Chausskii	182	90	92
Krichevskii	315	152	163
Byihovskii	412	191	221
Mogilev[a]	2,023	980	1,043
Koschukovichskii	345	165	180
Krasnopolskii	39	24	15
Total	3,822	1,848	1,974

a. Includes Mogilev City.

Table 2. Classification of subjects[a] by radiation level in district of residence.

Radiation level (Ci/km^2) in district of residence	Number of subjects (%)
0 – 1	2,139 (61.6)
1 – 5	424 (12.2)
5 – 15	651 (18.8)
≧15	258 (7.4)
Total	3,472

a. Children examined by 13 April 1992.

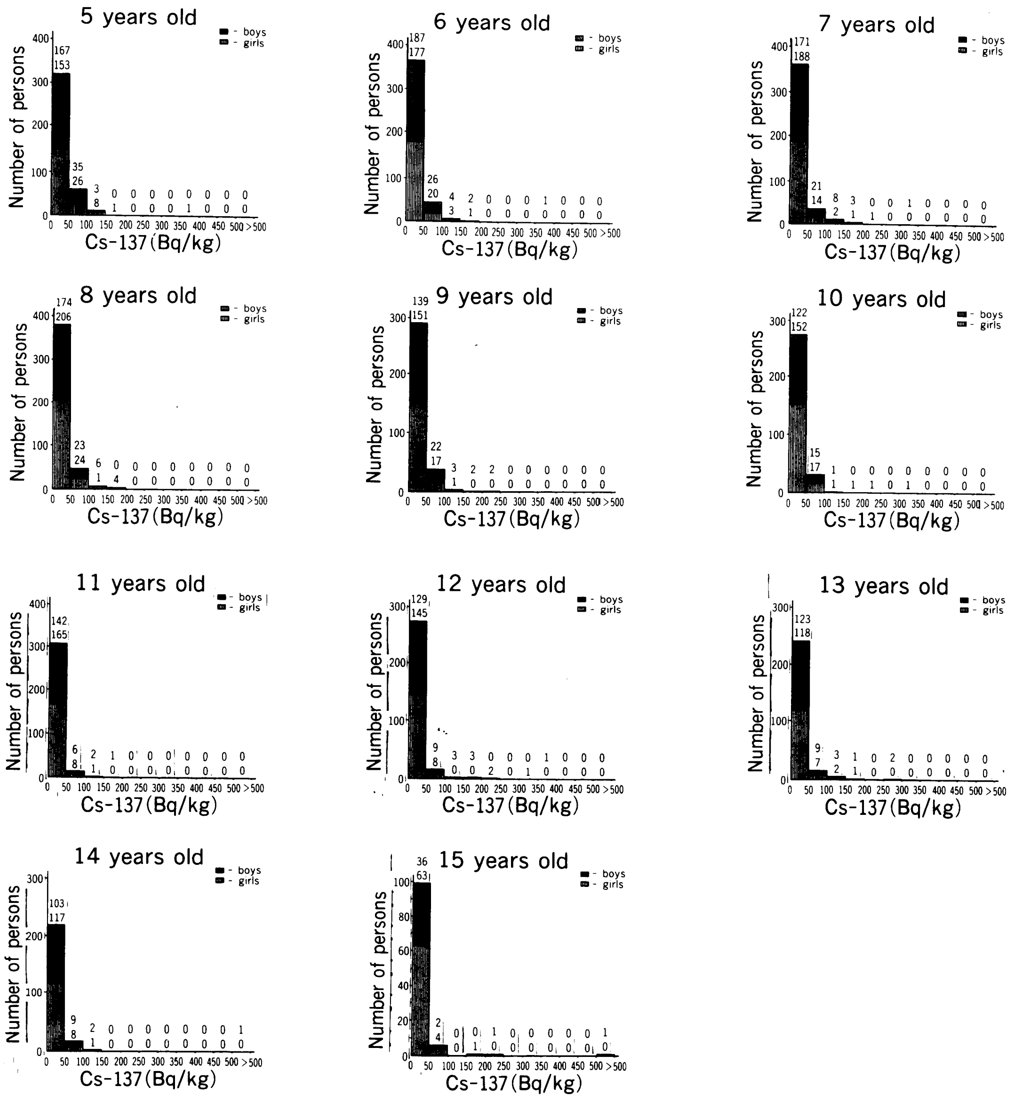


Figure 1. Distribution of whole body Cs-137 count per body weight (Bq/kg) by sex and age.

IV. Results.

1. Whole body ^{137}Cs content

The whole body ^{137}Cs content was determined in 3,457 subjects using a whole body counter. A total of 52 subjects had radiation levels of 3,700 Bq (0.1 μCi) or more. These 52 subjects are 27 from Slavgorodskii, 9 from Byihovskii, 4 from Klimovichiskii, 1 from Chausskii, 4 from Mogilev City, 1 from Mogilev, and 6 from Koschukovichskii.

All 52 children underwent a complete medical checkup and were given enteral adsorbents and vitamin preparations at the Research Institute of Radiation Medicine. These treatments produced a decrease in the whole body ^{137}Cs content in all subjects. The highest ^{137}Cs content (36,968 Bq) was observed in a 5-year-old boy.

Figure 1 shows the distribution of whole body ^{137}Cs content per kg body weight (Bq kg^{-1}) in relation to sex and age. In each age group, most of the subjects had values ranging from 0 to 50 Bq kg^{-1}. In all age groups other than the 10-year-old group, the mean value of the boys was slightly higher than that of the girls. The lowest mean value of the boys was 29 Bq kg^{-1} which was recorded at 10 and 11 years of age. The lowest mean value of the girls was 27 Bq kg^{-1} detected at 11, 13, and 14 years of age. The highest mean value of the boys was 46 Bq kg^{-1} at 15 years of age, and that of the girls was 39 Bq kg^{-1} at 5 years of age.

2. Height and body weight

2.1 Height

Figure 2 shows height in relation to sex and age. The points and the vertical lines respectively depict the mean and the standard deviation for each age group. There was a positive correlation between height and age in both sexes. In the groups aged 4 to 11, the mean heights of the boys and girls were comparable, but at 12 and 13 years of age the girls were taller than the boys. From 14 years onwards, the reverse was true and the boys were taller than the girls.

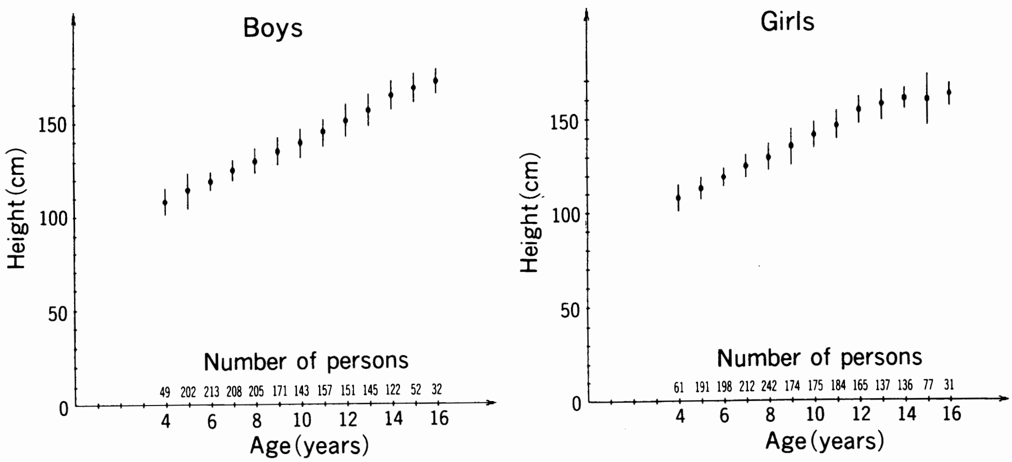


Figure 2. Height (cm) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group.

2.2. Body weight

Figure 3 shows the body weight in relation to sex and age. (Symbols have the same meaning as in Figure 2.) There was a positive correlation between body weight and age in both sexes. In the pre-pubertal period, the mean body weight values were higher in the girls than in the boys, but from 14 years of age onwards, the mean values were higher in the boys.

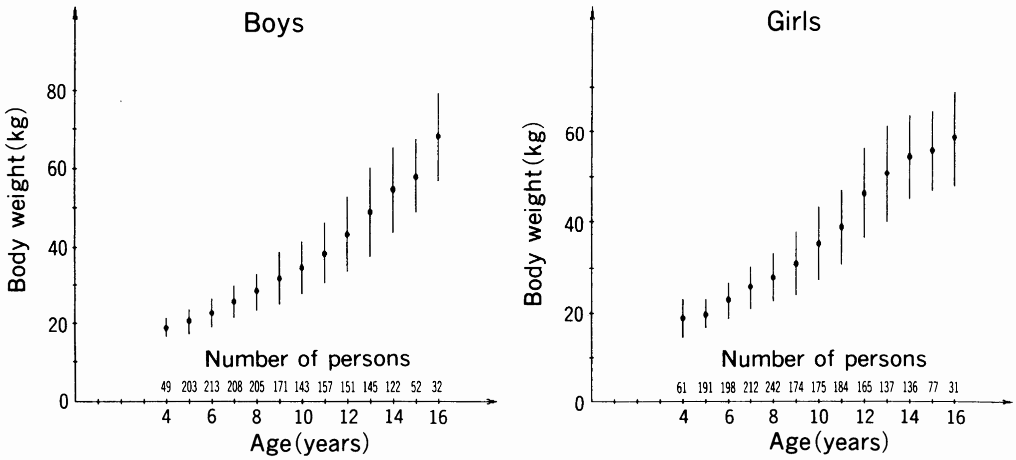


Figure 3. Body weight (kg) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group.

3. Examination of the thyroid

3.1. Ultrasonography

The Chernobyl accident released a large amount of various radionuclides including radioactive iodine into the environment. As the thyroid gland is the organ most severely affected by radioactive iodine, thyroid weight and function are expected to show a close correlation with the amount of radioactive iodine absorbed.

The thyroid is thought to be more vulnerable to the effects of irradiation in children than in adults. Figure 4 shows the relationship between the arc-type ultrasonographically determined thyroid volume and age for both sexes. A positive correlation was detected between age and thyroid volume in both sexes. The points and the vertical lines represent the mean volume and the standard deviation respectively. The lowest curve in each panel for the two sexes depicts the upper limit of the normal range for each age group determined by the conventional method. The values observed in all age groups were generally higher than the normal range of thyroid volume.

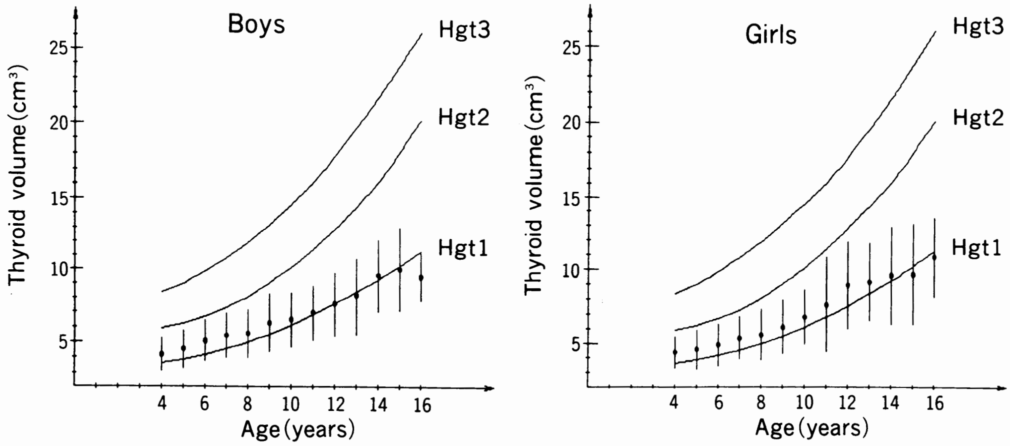


Figure 4. Thyroid volume (cm^3) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The lowest curve in each panel depicts the normal limit.

Table 3. Classification[a] of subjects by thyroid volume.

Thyroid volume	Number of subjects (%)
Normal	1,508 (43.84)
Goiter	
1st degree	1,700 (49.42)
2nd degree	226 (6.60)
3rd degree	2 (0.06)
Total	3,436

a. Based on the criteria established by the Research Institute of Medical Radiology, Academy of Medical Science of Russia.

Table 3 shows the classification of subjects by thyroid volume based on the standard criteria by the conventional method. One of the 2 children with the 3rd degree goiter lived in Mogilev City (an uncontaminated region) and the other lived in Slavgorodskii.

3.2. Determination of serum thyroid hormone levels

Figure 5 shows the serum free T_4 levels in relation to sex and age. (Points and vertical lines represent the mean and the standard deviation respectively.) The mean serum free T_4 level was within the normal range in all age groups in both sexes. The mean value showed a tendency to decrease as age increased. High serum free T_4 levels were observed in 79 subjects (2.3%). Tables 4 and 5 show the frequency of increased serum free T_4 level in relation to age and to the radiation level in the district of residence respectively. The greatest deviations from normal were detected in children who were 6–8 years old at the time of examination, i.e., 1–3 years old at the time of the accident. All these children underwent re-examinations and follow-up. At follow-up, 25% of the children who had showed increased serum free T_4 levels at the initial examination still exhibited this abnormality.

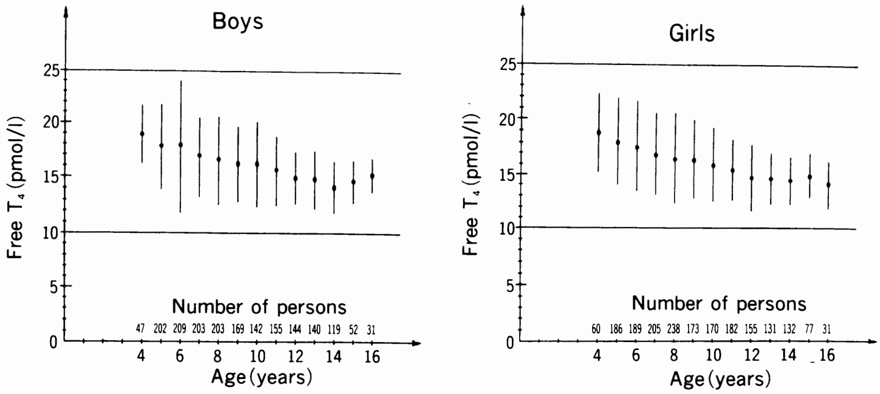


Figure 5. Serum free T_4 level (pmol/l) by sex and age. The dot and vertical line depict mean and mean $\pm$ standard deviation for each group. The two horizontal lines in each panel depict the normal limits (10pmol/l, 25pmol/l).

Table 4. Frequency of subjects with increased level of free T_4 by age.

Age (years)	Percentage of subjects
4 — 5	3.12
6 — 8	3.83
9 — 12	1.47
13 — 16	0.18

Table 5. Frequency of subjects with increased level of free T_4 by radiation level in district of residence.

Radiation level (Ci/km^2) in district of residence	Percentage of subjects
0 — 1	0.57
1 — 5	5.84
5 — 15	4.66
≧15	5.22

Decreased serum free T_4 levels were observed in 21 subjects (0.62%), most of whom lived in districts where the radiation level was 15 Ci/km^2 or more (Tables 6 and 7).

Table 6. Frequency of subjects with decreased level of free T_4 by age.

Age (years)	Percentage of subjects
4 — 5	0.84
6 — 8	0.58
9 — 12	0.52
13 — 16	0.72

Table 7. Frequency of subjects with decreased level of free T_4 by radiation level in district of residence.

Radiation level (Ci/km^2) in district of residence	Percentage of subjects
0 — 1	0.62
1 — 5	0.24
5 —15	0.47
≧15	1.60

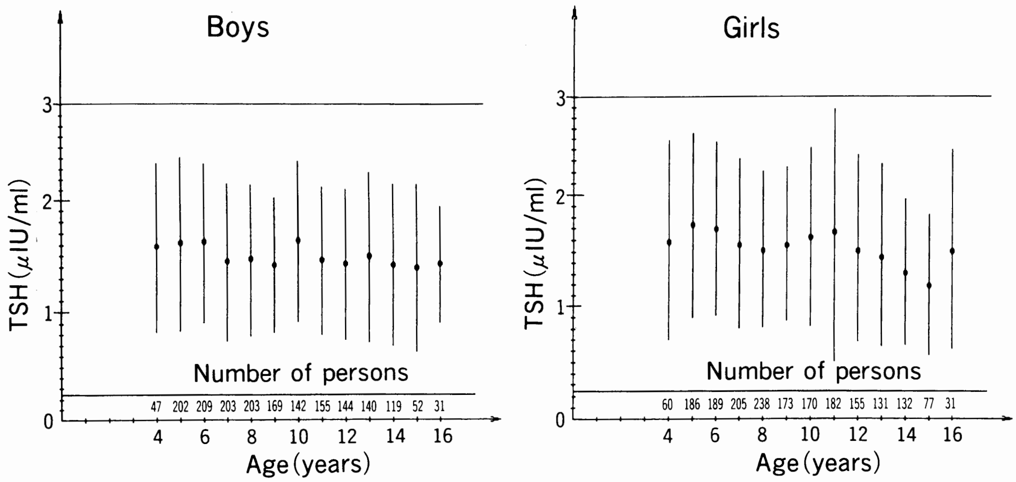


Figure 6. Serum TSH level (μIU/ml) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (0.24μIU/ml, 2.90μIU/ml).

Figure 6 shows the serum TSH levels in relation to sex and age. (Symbols are the same as those in Figure 5.) The mean serum TSH level was within the normal range in all age groups in both sexes. Increased serum TSH levels were observed in 136 subjects (3.99%). Tables 8 and 9 show the frequency of increased TSH level in relation to age and the radiation level in the district of residence respectively.

A marked deviation from the normal range was observed in the TSH levels at higher ages. This was an unexpected finding because the radiation dose generally decreases as age increases, and it shows that the increase in the serum TSH levels may not be directly related to exposure of the thyroid to radiation. Although the cause is unknown at present, the greatest deviation from the normal range was observed in children 13-16 years old at the time of examination or 8-11 years old at the time of the accident. Subsequently, we determined whether or not these increased TSH levels were truly abnormal, considering the measurement error and other relevant data such as free T_4 level, anti-thyroid antibody titer and ultrasonographic findings. The correlation between the serum free T_4 level and the TSH level by age is shown in Figure. 7. Five subjects had low free T_4 levels and high TSH levels, indicating a diagnosis of "primay hypothyroidism". (These subjects were aged 5, 11, 12, 13 and 14.) Another 6 subjects had high serum free T_4 and TSH levels, while 125 subjects had normal serum free T_4 levels and high TSH levels. It is yet to be determined whether or not the latter 125

Table 8. Frequency of subjects with increased level of TSH by age.

Age (years)	Number of subjects (%)
4 — 5	26 (5.55)
6 — 8	46 (3.83)
9 — 12	39 (3.38)
13 — 16	25 (4.53)

Table 9. Frequency of subjects with increased level of TSH by radiation level in district of residence.

Radiation level (Ci/km^2) in district of residence	Percentage of subjects
0 — 1	3.52
1 — 5	5.83
5 —15	4.35
≧15	4.02

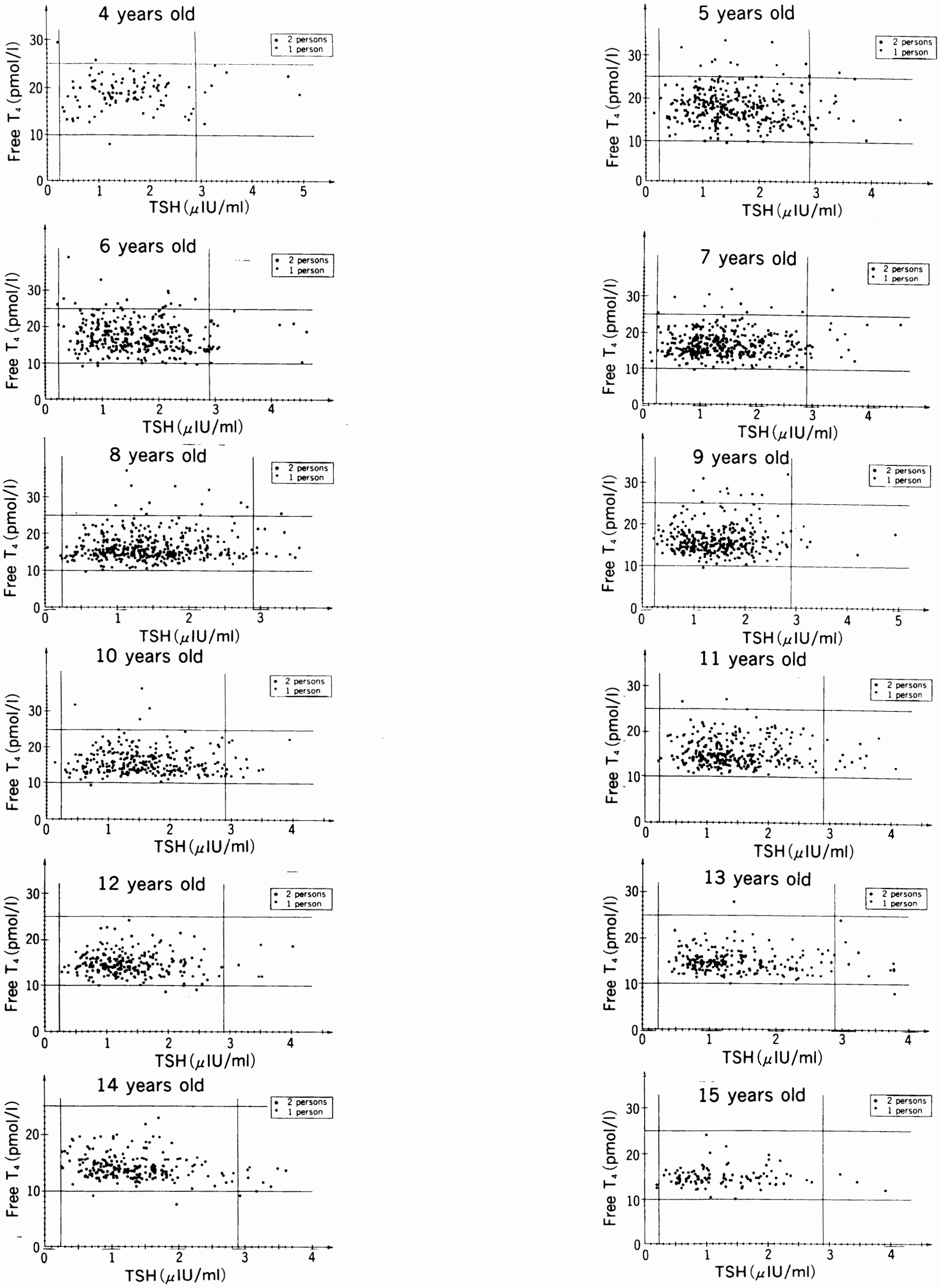


Figure 7. Scatter plots of the measurments of free T_4 and TSH by age. The two horizontal and vertical lines in each panel depict the normal limits of free T_4 (10 pmol/l, 25pmol/l) and TSH (0.24μIU/ml, 2.90μIU/ml), respectively.

subjects had latent hypothyroidism. Children with abnormal hormone levels will be subjected to re-examinations and follow-up.

Serum anti-thyroglobulin and serum anti-microsomal antibodies were examined in 2,008 subjects. Sera from all boys were negative for anti-thyroglobulin antibody, while 6 girls (0.3%) (their age being 6, 7, 9, 9, 11 and 13) showed positive antibody titers. The antibody titers (x100) in the 6 girls were 10 (2 girls aged 6 and 11), 20 (one girl aged 7), and 40 (2 girls aged 9 and one girl aged 12). Two girls (one aged 9 and one aged 11) had autoimmune thyroiditis. Table 10 shows the frequency of subjects positive for anti-thyroglobulin antibody in relation to the radiation level in the district of residence.

Serum anti-microsomal antibody was positively detected in 14 subjects (2 boys and 12 girls). The boys were both 8 years old and had titers (×100) of 10 and 20. The titers (x100) in the girls were 10 (5 girls aged 5, 8, 9, 10 and 11), 20 (2 girls aged 5 and 6), 40 (4 girls aged 5, 9, 12 and 13), and 80 (one girl aged 11). One of the two girls aged 9 had autoimmune thyroiditis, as did both of the girls aged 11. Table 11 shows the frequency of subjects positive for anti-microsomal antibody

Table 10. Frequency of subjects with antithyroglobulin antibody by radiation level in district of residence.

Radiation level (Ci/km^2) in district of residence	Number of subjects (%)
0 − 1	3 (0.39)
1 − 5	1 (0.26)
5 −15	2 (0.31)

Table 11. Frequency of subjects with antimicrosome antibody by radiation level in district of residence.

Radiation level (Ci/km^2) in district of residence	Number of subjects (%)
0 − 1	3 (0.39)
1 − 5	1 (0.26)
5 −15	9 (1.40)
≧15	1 (0.49)

in relation to the radiation level in the district of residence. Most of the subjects with positive anti-microsomal antibody lived in districts where the radiation level was at least 5 Ci/km^2.

3.3. Summary of thyroid-related data

Of the 3,440 subjects examined, 420 showed some abnormality on the thyroid-related data and underwent re-examinations. Forty-three subjects (1.25%) out of the 420 were considered to have definite abnormalities on the basis of a comprehensive assessment of all the data. These abnormalities are listed in Table 12.

A total of 22 subjects were found to have thyroid cysts. Table 13 shows the frequency of subjects with thyroid cysts in relation to the radiation level in the district of residence.

No other thyroid abnormalities were found so far. The children with thyroid abnormalities are now undergoing follow-up examinations by the endocrinologists at the Department of Pediatrics, Mogilev Regional Medical Diagnostic Center.

4. Hematological examination

4.1. Subjects and parameters assessed

Table 12. Frequency of subjects with thyroid abnormalities among 3,440 examinees.

Thyroid abnormality	Subjects with abnormality (%)
Autoimmune thyroiditis	19 (0.55)
Thyroid cyst	22 (0.64)
Diffuse goiter (3rd degree)	2 (0.05)

Table 13. Frequency of subjects with thyroid cyst by radiation level in district of residence.

Radiation level (Ci/km^2) in district of residence	Percentage of subjects
0 − 1	0.18
1 − 5	0.00
5 − 15	0.46
≧15	0.00

Peripheral blood samples were obtained from 3,427 subjects and the white blood cell (WBC), red blood cell (RBC), platelet count (Plts), hemoglobin (Hb), hematocrit (Ht), mean corpuscular volume (MCV) and mean corpuscular hemoglobin concentration (MCHC) were determined using Sysmex K-1000. Blood smears were prepared and examined to determine the differential WBC count, white blood cell and red blood cell morphology, and to reconfirm the platelet count visually.

4.2. Results

4.2.1. Hb values

Figure 8 shows the Hb values in relation to sex and age. (Points and vertical lines depict the mean and the standard deviation.) Although the mean Hb values in boys aged 4 to 6 were slightly below the normal range, the values in the boys at other ages and those in the girls at all ages were within the respective normal ranges. With increasing age, the Hb values showed a slight increase in boys but stayed within normal range. Anemia (Hb<110 g/L) was noted in 3 subjects (0.09%) aged 4, 6, and 7, but all cases were mild and the lowest value was 107 g/L.

4.2.2. MCV

Figure 9 shows the MCV values in relation to sex and age. (Symbols are the same as those in Figure 8.) There were no significant age-dependent changes in either sex. (The normal range was 70 - 95 fl.)

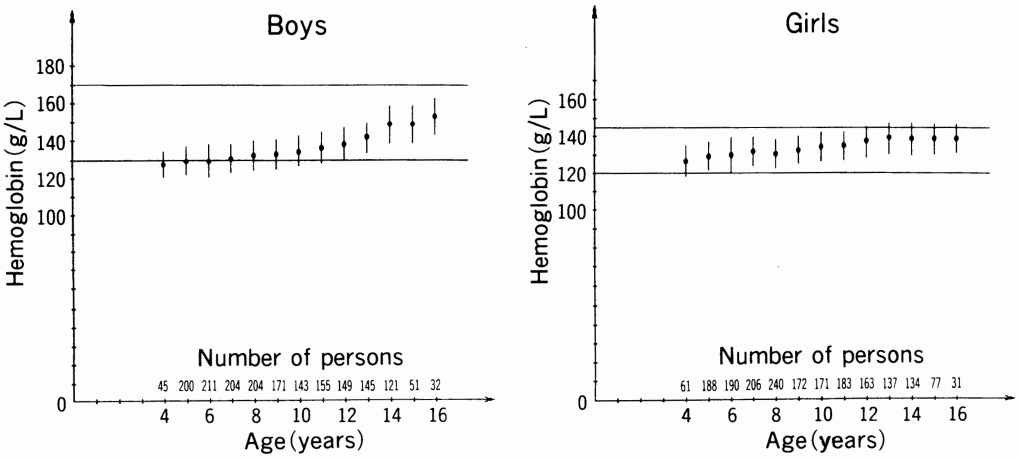


Figure 8. Hemoglobin level (g/L) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (boys: 130g/L, 170g/L; girls: 120g/L, 145g/L).

4.2.3. White blood cell count

Figure 10 shows the WBC values in relation to sex and age. (Symbols are the same as those in Figure 8.) All values observed were within the normal range, but there was a slight decrease with increasing age in both sexes. At 7-8 years of age or older, no further decrease was observed in the mean WBC values. Leukopenia (WBC < 3.5 x 10^9/L) was noted in 10 subjects (0.29%; 5 boys and 5 girls), with the lowest value being 2.9 x 10^9/L. In these subjects, blood smears revealed no abnormal cells and minimal abnormalities of the differential WBC count such as a slight decrease in lymphocytes or neutrophils. Leukocytosis (WBC > 12 x 10^9/L) was noted in 72 subjects (2.10%). No abnormalities were observed in the WBC morphology or differential WBC count in any of the subjects.

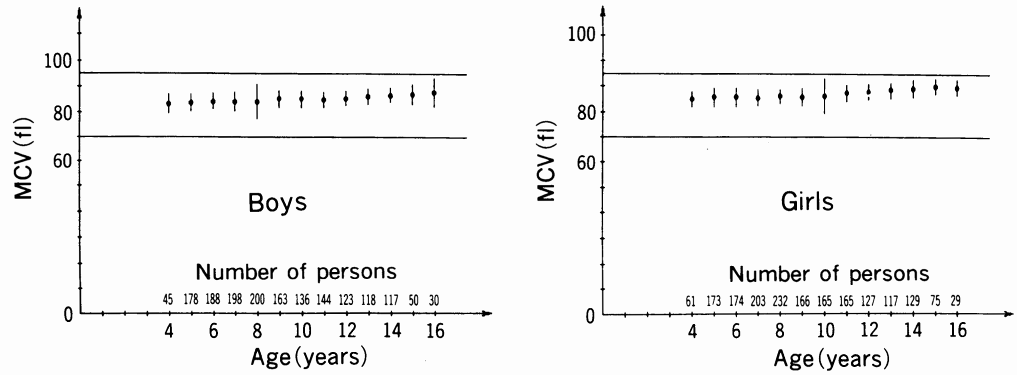


Figure 9. Mean corpuscular volume of red blood cells (fl) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (70fl, 95fl).

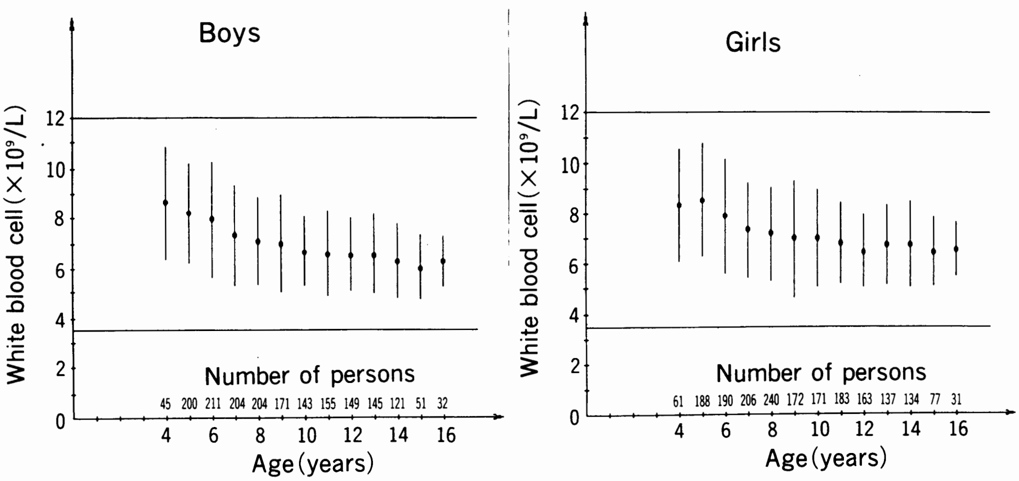


Figure 10. White blood cell count (×10^9/L) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (3.5×10^9/L, 12×10^9/L).

4.2.4. Platelet count

Figure 11 shows the platelet count in relation to sex and age. (Symbols are the same as those in Figure 8.) In both sexes, the mean platelet count was within the normal range in all age groups but showed a slight decrease with increasing age. Thrombocytopenia (platelet count $< 150 \times 10^9/L$) was noted in 16 subjects (0.47%), 3 of whom (0.09%) had platelet counts $< 100 \times 10^9/L$. These subjects all had normal values on re-examination. Thrombocytosis (platelet count $> 400 \times 10^9/L$) was noted in 218 subjects (6.36%), with the highest value being $664 \times 10^9/L$.

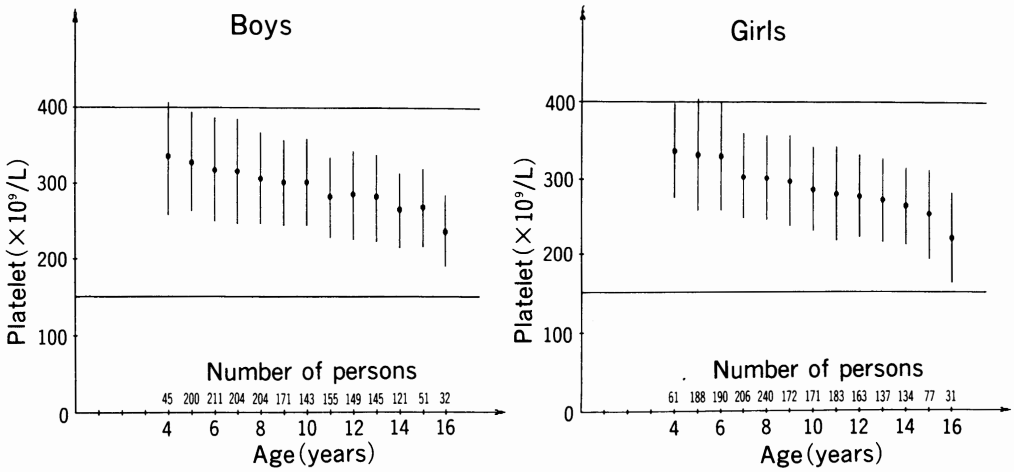


Figure 11. Platelet count ($\times 10^9/L$) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits ($150 \times 10^9/L$, $400 \times 10^9/L$).

4.2.5. White blood cell analysis

A shift to the left was observed for neutrophils in 7.94% of the subjects, while a low neutrophil count was seen in 5.5% of the subjects.

A pseudo Pelger-Huët nuclear anomaly was observed in 2 (0.06%) subjects.

Eosinophilia (an absolute eosinophil count $> 500 \times 10^6/L$) was noted in 658 (19.2%) subjects. Two thirds of these subjects had a history of parasitic and allergic diseases. Monocytosis was noted in 3.5% of the subjects.

Lymphocytopenia (an absolute lymphocyte count $< 2.5 \times 10^9/L$) was detected in 8.9% of the 4- to 7-year-olds and in 1.1% of the 8- to 16-year-olds. One subject (0.03%) showed a leukemoid reaction but had a normal blood picture at follow-up.

Table 14 summarizes the results of the hematological examinations.

Table 14. Classification of subjects with hematological abnormalities.

Hematological abnormality	Number of subjects (%)
Leukemoid reaction, lymphocytic type	1 (0.03)
Pelger anomaly of the neutrophilis	2 (0.06)
Anemia, slight degree (Hb < 110g/L)	3 (0.09)
Leukopenia (WBC < 3.5×10^9/L)	10 (0.29)
Leukocytosis (WBC > 12×10^9/L)	72 (2.10)
Thrombocytosis (PLT > 400×10^9/L)	218 (6.36)
Thrombocytopenia (PLT < 150×10^9/L)	16 (0.47)
(PLT < 100×10^9/L)	3 (0.09)
Eosinophilia (Eo > 0.3×10^9/L)	1,379 (40.24)
(Eo > 0.5×10^9/L)	658 (19.20)

Table 15. Frequency of subjects with hematological abnormalities by Cs-137 level[a].

Blood analysis			Whole body Cs-137 count per body weight (Bq/kg)					Total
			0—50	50—100	100—150	150—200	≧200	
Item (unit)	abnormality criteria	Range of measurements	Number of children examined					
			3,109	252	42	15	9	3,427
WBC ($\times10^9$/L)	<3.5	2.9— 3.4	10(0.3)					10(0.3)
	>12	12.1—28.1	57(1.8)	12(4.8)	2(4.8)	1(6.7)		72(2.1)
RBC ($\times10^{12}$/L)	<3.5							
Hb (g/L)	<110	107	3(0.1)					3(0.1)
MCV (fl)	<70	67.6—68.8	3(0.1)	1(0.4)				4(0.1)
	>95	95.1—100	19(0.6)	3(1.2)		1(6.7)		23(0.7)
MCH (pg)	<24	21.9—23.6	5(0.2)	1(0.4)				6(0.2)
	>32	32.1—42.1	36(1.2)	4(1.6)		1(6.7)		41(1.2)
MCHC (g/L)	<300	299	1(0.03)					1(0.03)
	>380	381 —472	11(0.4)	1(0.4)				12(0.4)
PLT ($\times10^9$/L)	<150	78 —148	15(0.5)	1(0.4)				16(0.5)
	>400	401 —664	191(6.1)	21(8.3)	4(9.5)	1(6.7)	1(11.1)	218(6.36)
St ($\times10^9$/L)	>0.3		239(7.7)	24(9.5)	3(7.1)	3(20.0)	3(33.3)	272(7.94)
Sg ($\times10^9$/L)	<2.0		135(4.3)	50(19.8)	3(7.1)	1(6.7)		189(5.5)
	>7.0		67(2.2)	11(4.4)	2(4.8)	1(6.7)	1(11.1)	82(2.4)
Ly ($\times10^9$/L)	<2.5[b] <1.5[c]		312(10.0)	35(13.9)	9(21.4)	5(33.3)	2(22.2)	363(10.6)
	>6.0[b] >4.5[c]		36(1.2)	10(4.0)				46(1.3)
Mo ($\times10^9$/L)	>0.6		109(3.5)	9(3.6)	3(7.1)			121(3.5)
Eo ($\times10^9$/L)	>0.5		565(18.2)	78(31.0)	9(21.4)	3(20.0)	3(33.3)	658(19.2)
Ba ($\times10^9$/L)	>0.125		40(1.3)	8(3.2)	1(2.4)	1(6.7)	1(11.1)	51(1.5)

a. Parenthetic entries refer to the percentage of the subjects while empty spaces denote the absence of subjects with abnormalities.

b. Criteria for subjects aged 4 to 7 years old.

c. Criteria for subjects aged 8 to 16 years old.

4.3. Relationship between radiation dose and hematological data

Most of the subjects (90.7%) had ^{137}Cs radiation doses of not more than 50 Bq kg^{-1}, and many of the subjects with the above-mentioned hematological abnormalities were in this group. The relationship between radiation dose and the hematological data cannot be determined at present, but the 24 subjects with ^{137}Cs content of at least 150 Bq kg^{-1} showed abnormal hematological values listed in Table 15. Because these abnormalities were also observed in subjects with radiation doses of 150 Bq kg^{-1} or less, careful follow-up studies are needed to provide a clearer assessment of the relationship with radiation exposure.

V. Conclusion

The effects of the Chernobyl accident on health problems are so complicated and far-reaching that interpretation of the meaning of detected abnormalities is often difficult. Stress and nutritional changes undoubtedly played an important role in the develoment of these abnormalities. Most of the subjects found to have abnormal thyroid hormone levels in the 1991 and 1992 examinations had no clinical symptoms.

Increased thyroid hormone levels were observed in 2.3% of the subjects, and the frequency was highest among subjects who were 6 - 8 years old at the time of examination or 1 - 3 years old at the time of the accident. Decreased thyroid hormone levels were observed in 0.62% of the subjects. Increased TSH levels were observed in 3.99% of the subjects, with the frequency being highest among subjects who were 13 - 16 years old at the time of examination or 8 - 11 years old at the time of the accident. Anti-thyroglobulin antibodies were detected in 0.3% of the subjects, and anti-microsomal antibodies were detected in 0.7% (mostly girls living in districts where the radiation level was 5-15 Ci/km^2). The frequency of autoimmune thyroiditis and thyroid cyst was highest among children living in districts where the radiation level was 5 Ci/km^2 or more.

Despite the high radiation dose received by the children, no cases of hypothyroidism have been reported thus far. However, the risk of hypothyroidism is expected to increase in the future. In view of the fact that hypothyroidism, autoimmune thyroiditis and thyroid tumors are often preceded by hormonal or immunological abnormalities, careful investigations to detect such changes are indispensable.

Two points should be taken into consideration when analyzing the hematological data. Firstly, the reliability of the examination procedures needs to be considered when any abnormal value is observed. Reliability is affected by the operation and maintenance of equipment, the method of collecting blood samples, the method of processing samples to prepare smears and various other technical factors. Thoroughgoing training of laboratory technicians is necessary to ensure reliability. Subjects with abnormal values should be followed up to confirm data and should be given appropriate treatment when necessary. Secondly, abnormal hematological values cannot be interpreted as indicators of hematological diseases until clarification of the presence or absence of systemic illness, because hematological data are often affected by systemic illnesses. A complete examination and careful history taking must therefore precede the interpretation of hematological values. Children are particularly vulnerable to viral and bacterial infections that strongly affect WBC and differential WBC count. In addition, the high incidence of eosinophilia is probably a reflection of the high incidence of parasitic and allergic diseases.

To more precisely determine the causes of detected abnormalities, comparative studies are recommended in uncontaminated regions. Although the radiation level there is less than 1 Ci/km^2, Mogilev City is not suitable as an uncontaminated region because of its severe air pollution. Future examinations will be performed while taking these factors into account.

Gomel Regional Specialized Prophylactic Center

Reporter : Valery A. Samoilenko

I. Subjects

The center performed examinatins in 64 districts or villages including Gomel City. In these districts, the radiation levels ranged from 1 to 40 Ci/km^2. A total of 4,956 subjects (2,452 boys and 2,504 girls) were examined. Table 1 shows the radiocontaminated areas [^{137}Cs level (Ci/km^2)] in each district or village. Table 2 shows the sex ratio of subjects in each district.

II. Results

1. Whole body ^{137}Cs content

The ^{137}Cs contents obtained using a whole body counter ranged from 100 to 40,000 Bq. To simplify data processing, the values were classified into 3 groups using the mean value in Gomel (1,850 Bq) and the safety limit in Belarus (11,100 Bq) as the two cut-off values. (Irradiation of the whole body with 11,100 Bq results in an annual radiation dose of 0.1 rem assuming that radioactive substance remains in the body.) Figure 1 shows the whole body ^{137}Cs data. The ^{137}Cs content in the body was less than 1,850 Bq in 80% of the subjects, between 1,850 and 11,100 Bq in 19% of the subjects, and more than 11,100 Bq in 1% of the subjects. In districts and villages other than the Braginskii district, values exceeding the safety limit (11,100 Bq) were observed only in boys.

The highest values were recorded in the Braginskii district, being 21,300 Bq for boys and 20,600 Bq for girls. These levels were 3 times the mean for children living in this district and at least 13 times the mean for children from other districts or villages. About 10% of the subjects in the Braginskii district had values exceeding the safety limit as compared to only 1-2% of subjects in other districts.

Table 3 shows the mean whole body ^{137}Cs content in relation to sex and district. In the Braginskii district, the mean ^{137}Cs content was 6,800 Bq for boys and 6,000 Bq for girls, much higher than those recorded in other districts. The overall mean content was 1,800 Bq for boys and 1,400 Bq for girls.

Figure 2 shows the mean ^{137}Cs content in relation to sex and age. In the lower age groups, no differences were observed between boys and girls, but from the age of 6 years onwards sex-related differences became apparent. In the higher age groups, these differences were significant, and the ^{137}Cs content of boys was 1.5 - 2.0 times that of girls. This sex-related difference in the ^{137}Cs content widened with increasing age. It was also found that the absolute ^{137}Cs content increased

Table 1. ^{137}**Cs level** (Ci/km^2) **by district and village.**

GOMELSKII (1-5)	JLOBINSKII (1-5)	LELCHITSKII (1-5)	BRAGINSKII (5-15)
g.Gomel 1-5	g.Jlobin <1	g.Lelchitsi 1-5	g.Bragin 15-40
Bobovichi <1	Maiskoe 1-5	Zamoshe <1	Verkhnie Jari 1-5
Grabovka <1		Milashevichi 1-5	Komarin 5-15
Davidovka 1-5		Tonej <1	Krasnoe 5-15
Kostyukovka 1-5			
Krasnoe 1-5		PETRIKOVSKII (1-5)	KHOINIKSKII (5-15)
N.Guta 1-5			
Sosnovka <1			
N.Dyatlovichi <1		g.Petrikov <1	g.Khoiniki 5-15
St.Dyatlovichi 1-5		Konkovichi <1	
St.Uza 1-5		Kopatkevichi <1	
Tereshkovichi <1		Koptsevichi <1	
Teryukha <1		Mulyarovka <1	
Tsagelnya <1		Mishanka 1-5	
Sharpilovka <1		Novoselki <1	
		Ptich <1	
BUDA-KOSHELEVSKII (5-15)	DOBRUSHSKII (5-15)	LOEVSKII (5-15)	CHECHERSKII (5-15)
g.B-Koshelevo 5-15	g.Dobrush 5-15	g.Loev <1	g.Botvinovo 5-15
Gubichi 1-5	Jgun <1	Bivalki 1-5	Vetvitsa 5-15
Zabolote 15-40	Ivaki <1	Kolpen <1	Prichalesnya 5-15
Morozovichi 5-15	Krugovets <1	Malinovka <1	Shilovichi 5-15
Sharibovka 5-15	Lenina <1	N.Borshevka 1-5	
	Igovka 5-15	Peredelka <1	
	Nosovichi <1	R.Buritskaya 5-15	
	Pererost 1-5	Starodubka <1	
	Terekhovka <1	Rucheevka 1-5	
		Uborsk 1-5	
		Chaplin <1	

with age. Thus, the mean content was 740 Bq at 4 years of age as compared to 3, 000 Bq at 14 years of age. In Gomel City, the ^{137}Cs content per kg body weight showed no significant correlation with sex or age, and over 90% of the subjects had values of 100 Bq kg^{-1} or less (Figure 3).

Table 2. Classification of subjects by district and sex.

District	Boys	Girls	Total
Braginskii	397	378	775
Buda-Koshelevskii	198	194	392
Gomel and Gomelskii	956	1,019	1,975
Dobrushskii	260	287	547
Jlobinskii	85	79	164
Loevskii	235	219	454
Lelchitskii	38	44	82
Petrikovskii	98	107	205
Khoinikskii	164	146	310
Checherskii	21	31	52
Total	2,452	2,504	4,956

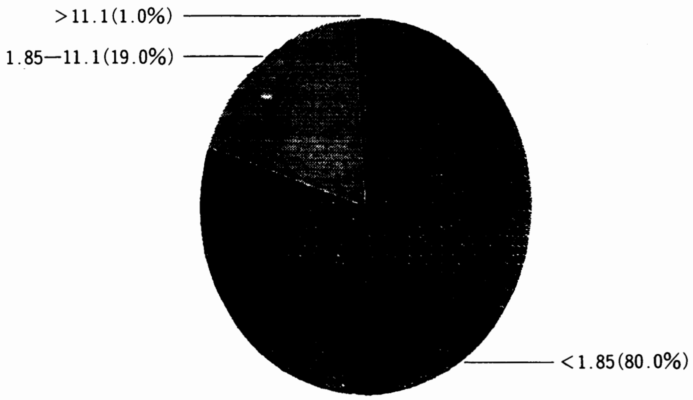


Figure 1. Proportion of whole body ^{137}Cs conunt (kBq) in the subjects.

Table 3. ^{137}**Cs content** (μ**Ci**) **in the subjects by district and sex.**

District	Boys	Girls
Braginskii	0.184	0.162
Gomelskii	0.036	0.032
Loevskii	0.046	0.011
Lelchitskii and Petrikovskii	0.054	0.048
Checherskii	0.059	0.033
Total	0.049	0.038

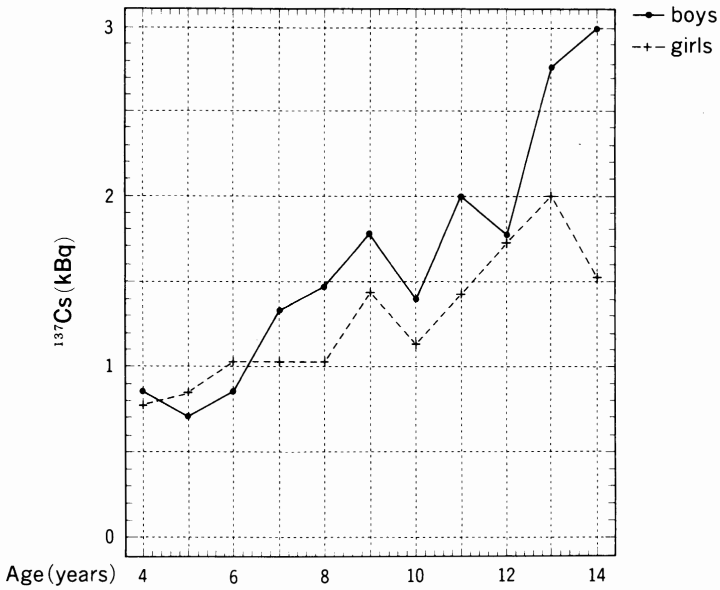


Figure 2. Mean level of ^{137}**Cs (kBq) in the subjects by sex and age.**

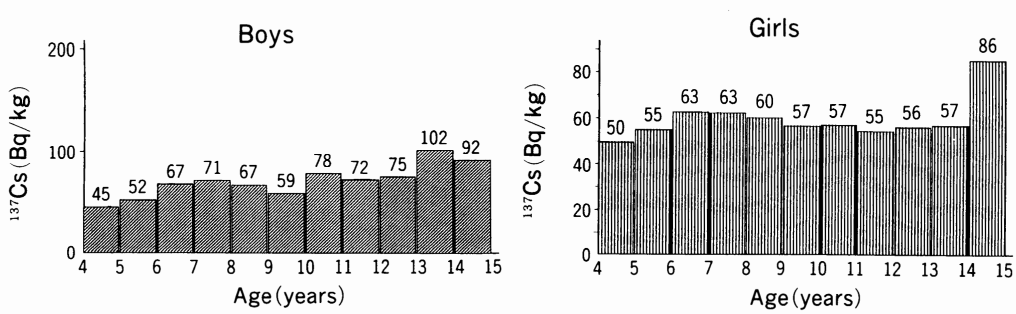


Figure 3. Mean level of ^{137}**Cs per body weight (Bq/kg) by sex and age.**

2. Examination of the thyroid

2.1. Ultrasonography

The relationship between ultrasonographically determined thyroid volume and age is shown in Figure 4. (Points and vertical lines depict the mean and the standard deviation for each age group.) As shown in this figure, the thyroid volume for both sexes in the age range of 5 to 16 years could be classified as "normal to lst degree goiter" according to the criteria established by the Research Institute of Medical Radiology (Obninsk) using the conventional ultrasonographic machines. Thyroid volume showed no significant differences related to sex or district of residence. However, the relative thyroid volume ($cm^3\ kg^{-1}$) was bigger in the Loevskii district than in the other districts (0.290 $cm^3\ kg^{-1}$ vs. 0.235 $cm^3\ kg^{-1}$).

2.2. Assay of serum thyroid hormone levels

Modest increases of serum free T_4 and TSH levels were recorded in 80% of the subjects whose ultrasonographic findings were suggestive of chronic thyroiditis. The frequency of subjects with structural abnormalities of the thyroid detected by ultrasonography averaged 15% in this region, and ranged from 3.3% to 22% in each district. In view of the data obtained thus far, it cannot be definitely concluded that the incidence of abnormalities correlated with either the radiation level in each district or the whole body ^{137}Cs content of the subjects. The mean serum free T_4 and TSH levels in Gomel City (shown in Figures 5 and 6, respectively) were within the respective normal ranges for both sexes and each age group. (Points and vertical line depict the mean and the standard deviation for each age group.)

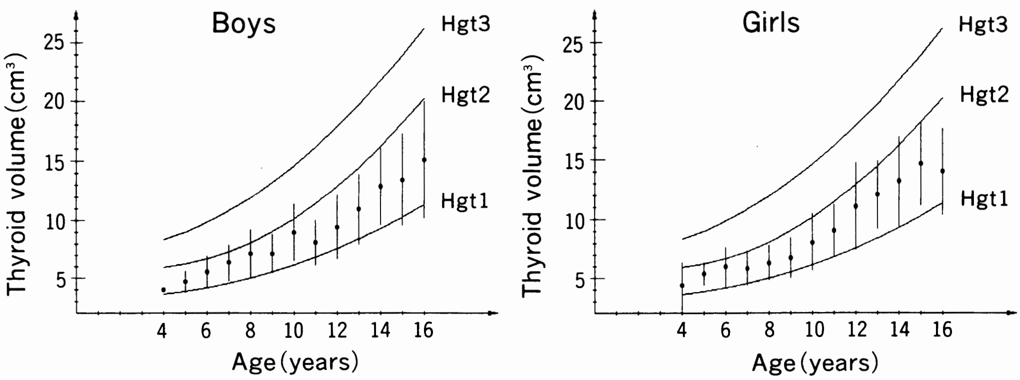


Figure 4. Thyroid volume (cm³) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The lowest curve in each panel depicts the normal limit.

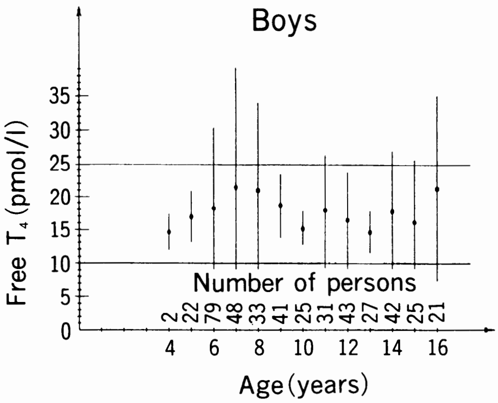


Figure 5. Serum free T_4 level (pmol/l) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (10pmol/1, 25pmol/1).

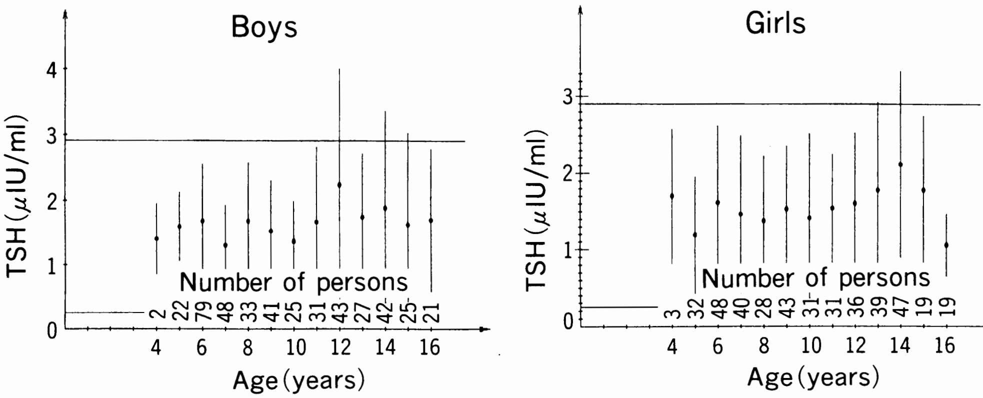


Figure 6. Serum TSH level (μIU/ml) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits 0.24μIU/ml, 2.90μIU/ml) .

3. Hematological examinations

Figures 7-10 show the data obtained for the following parameters in Gomel City in relation to sex and age: hemoglobin, mean corpuscular volume (MCV), white blood cell count (WBC), and platelet count. In this region, a total of 3,798 subjects underwent hematological examinations. The subjects with abnormal hematological values are listed in Table 4.

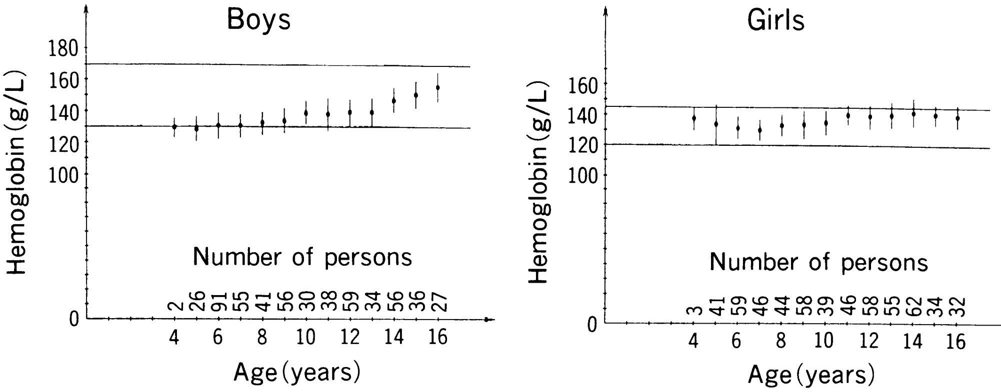


Figure 7. Hemoglobin level (g/L) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (boys : 130g/L, 170g/L ; girls : 120g/L, 145g/L).

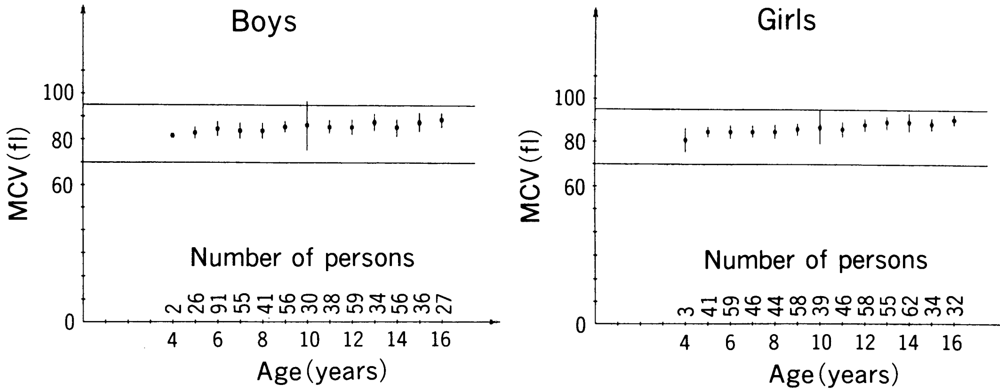


Figure 8. Mean corpuscular volume of red blood cells (fl) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (70fl, 95fl)

Table 4. Frequency of blood abnormalities in the 3,798 children examined.

Abnormality	Number of subjects (%)
Anemia, slight degree (Hb < 110 g/L)	12 (0.32)
Leukopenia (WBC < 3.5×10^9/L)	11 (0.29)
Leukocytosis (WBC > 12×10^9/L)	101 (2.66)
Thrombocytosis (PLT > 400×10^9/L)	210 (5.54)
Thrombocytopenia (PLT < 150×10^9/L)	37 (0.97)

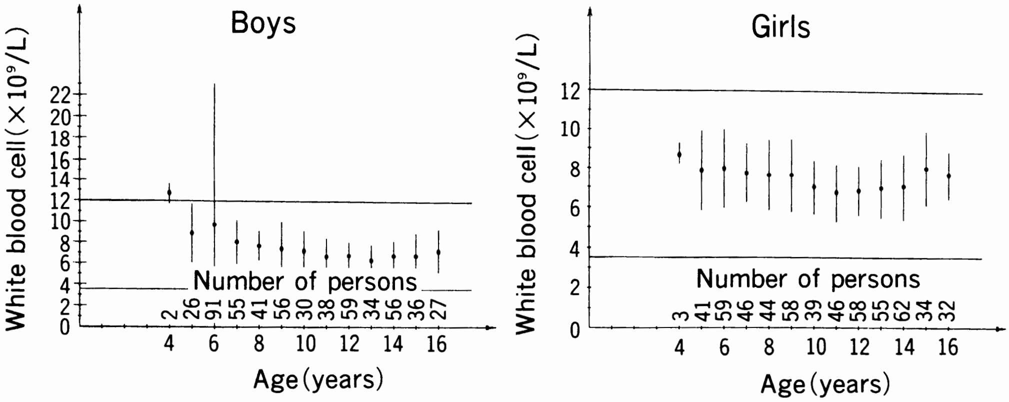


Figure 9. **White blood cell count** $(\times 10^9/L)$ **by sex and age. The dot and vertical line depict mean and mean ± standard deviation for each group. The two horizontal lines in each panel depict the normal limits** $(3.5\times 10^9/L,\ 12\times 10^9/L)$.

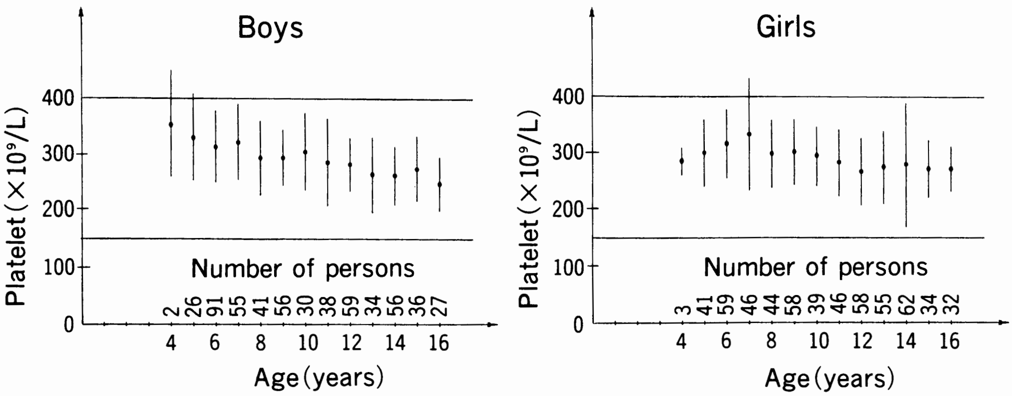


Figure 10. **Platelet count** $(\times 10^9/L)$ **by sex and age. The dot and vertical line depict mean and mean ± standard deviation for each group. The two horizontal lines in each panel depict the normal limits** $(150\times 10^9/L,\ 400\times 10^9/L)$.

Klincy Diagnostic Center

Reporter : Irina V. Karevskaya

I. Introduction

The Chernobyl Sasakawa Health and Medical Cooperation Project also extends to Klincy City in the Russian Federation. Klincy City is situated in a region where the radiation levels are between 5 and 15 Ci/km^2. The staff members of the Klincy Diagnostic Center were trained by Japanese specialists and started examination of the local children on May 21, 1991. In 1991, examinations were performed from May 21 to July 30 when the summer vacation began. During the coldest season, examinations were discontinued because the use of medical instruments became impossible. The screening activities were resumed on March 30,

Table 1. Classification of subjects by age.

Age (years)	Number of subjects
4	120
5	265
6	260
7	126
8	33
9	20
10	30
11	25
12	23
13	26
14	200
15	403
16	29
Total	1,560

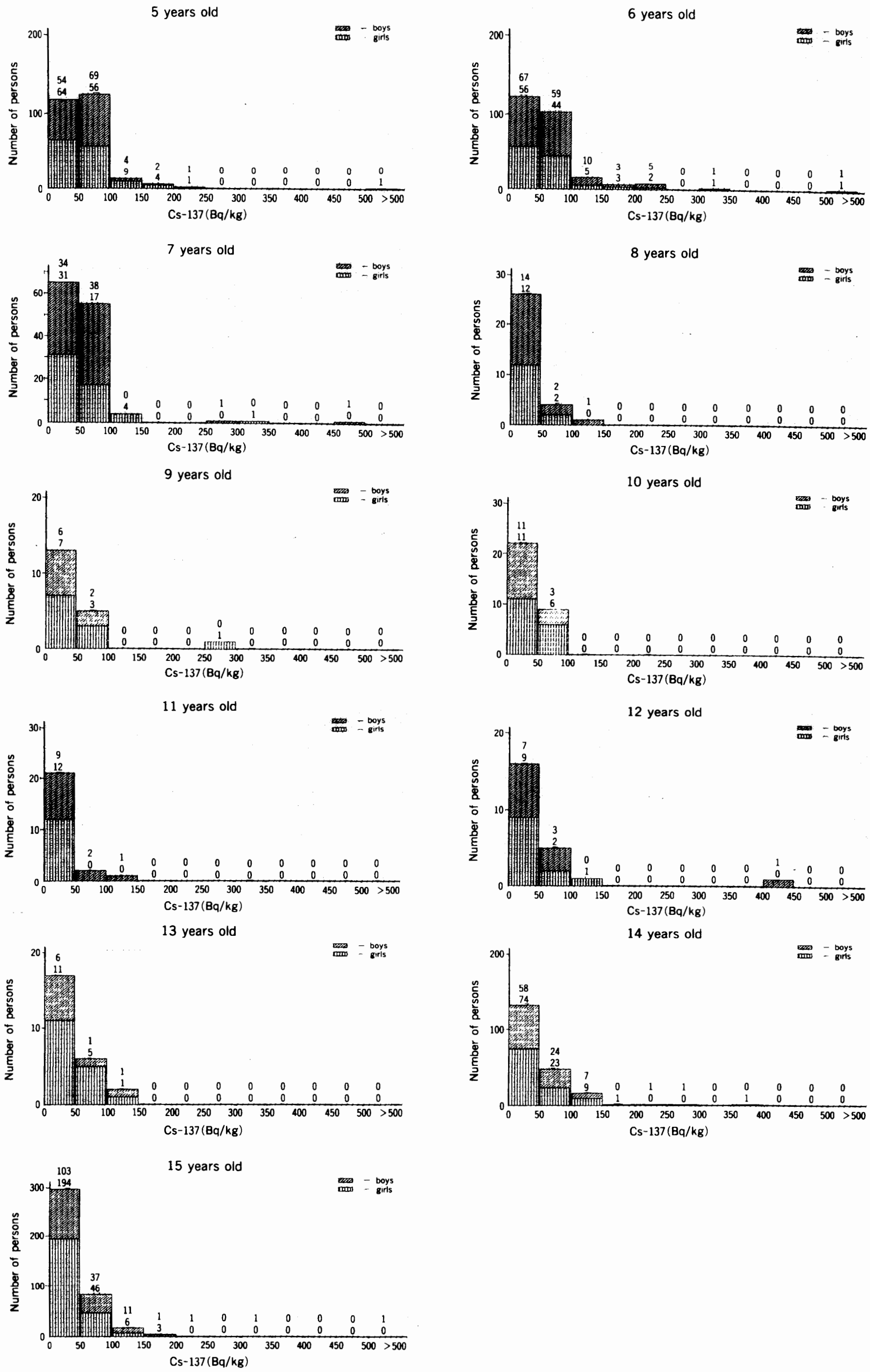


Figure 1. Distribution of whole body Cs-137 count per body weight (Bq/kg) by sex and age.

1992. At present, a garage equipped with a complete heating system has been provided so that the instruments can be used even during the cold season.

This garage contains parking space for the mobile clinic and rooms for writing up case cards, performing tests, and collecting blood samples.

The project involves the medical examination of children living in the contaminated regions using medical equipment supplied by Sasakawa Memorial Health Foundation. Examinations are being performed according to a uniform protocol established by agreement among the five centers.

II. Subjects

As of May 21, 1992, a total of 1,560 subjects aged 4 to 16 living in regions with radiation levels between 5 and 15 Ci/km^2 have been examined. Table 1 shows the number of subjects at each age.

III. Results

1. Whole body ^{137}Cs content

The whole body ^{137}Cs content was determined in 1,558 subjects using a whole body counter. Figure 1 shows the whole body ^{137}Cs content per kg body weight (Bq kg^{-1}) in relation to sex and age, and Figure 2 shows the mean values of ^{137}Cs content per kg body weight by age and sex.

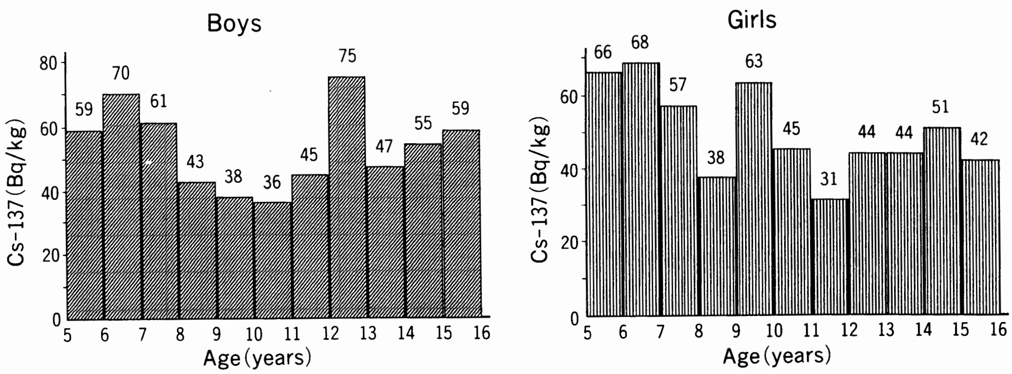


Figure 2. Mean level of Cs-137 per body weight (Bq/kg) by sex and age.

2. Height and body weight

Figures 3 and 4 respectively show the data on height and weight by sex and age. (Points and vertical lines depict the mean and the standard deviation for each age group.)

All subjects showed normal physical development comparable to the established standards for their ages.

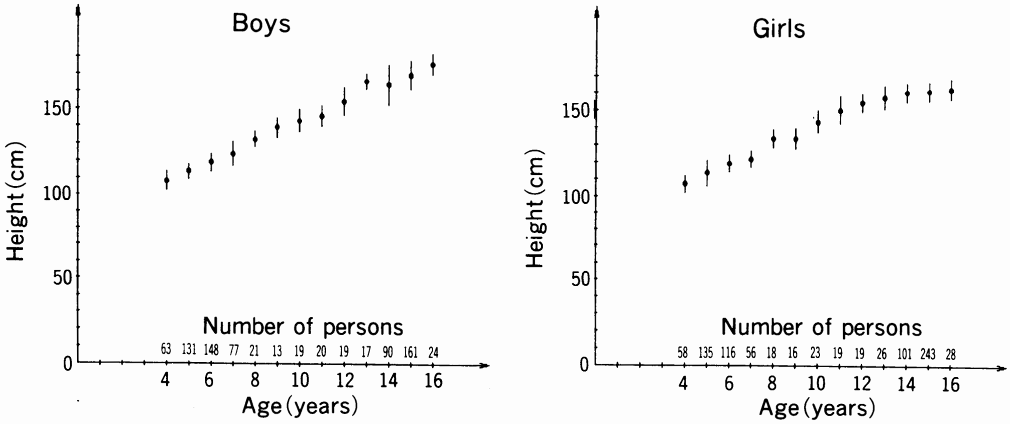


Figure 3. Height (cm) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group.

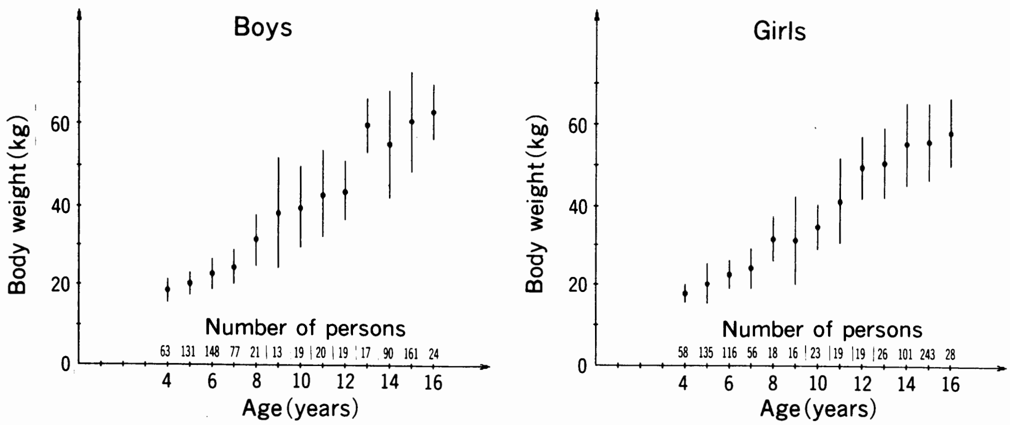


Figure 4. Body weight (kg) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group.

3. Examination of the thyroid

The protocol for examination of the thyroid consisted of ultrasonography, determination of serum free T_4 and TSH levels and determination of anti-thyroglobulin and anti-microsomal antibody titers.

3.1. Ultrasonography

Ultrasonography was performed in 1,554 subjects. Table 2 shows the number of subjects of each age. Ultrasonography revealed a direct correlation between thyroid volume and age in both sexes (Figure 5). The detected abnormalities are shown in Table 3. Some children had slightly increased goiter size.

Table 2. Classification of ultrasound examinees by age.

Age (years)	Number of subjects
4	118
5	264
6	260
7	126
8	32
9	20
10	30
11	25
12	23
13	25
14	198
15	403
16	29
Total	1,554

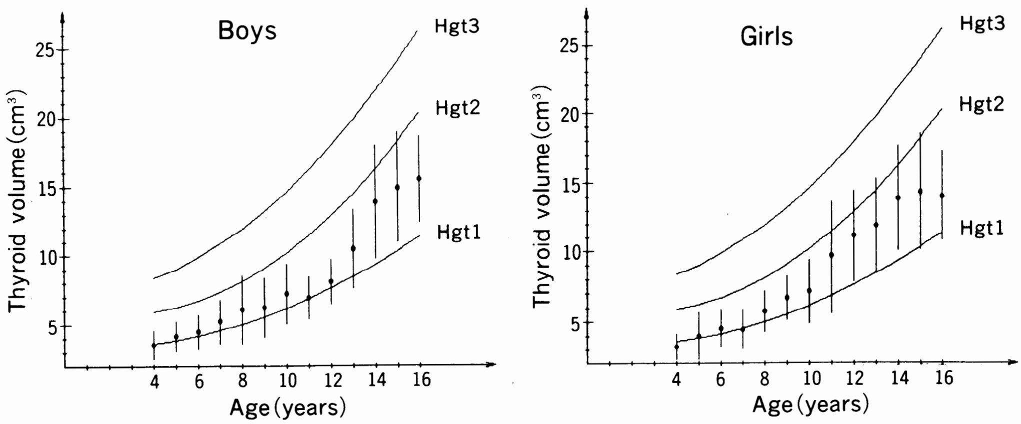


Figure 5. Thyroid volume (cm^3) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The lowest curve in each panel depicts the normal limit.

Table 3. Subjects with thyroid abnormalities.

Thyroid abnormality	Number of subjects with abnormality		
	Boys	Girls	Total (%)
Goiter (3rd degree)	10	8	18 (1.15)
Thyroid cyst	2	2	4 (0.25)
Thyroid nodule	0	2	2 (0.12)
Thyroid hypoplasia			40 (2.57)

3.2. Assay of serum thyroid hormone levels

Serum free T_4 and TSH levels were determined using an Amerlite TM analytical instrument and a total of 470 subjects aged 4-14 were examined. The mean circulating free T_4 levels in boys of all ages were within normal range. In girls, the mean level at 13 years of age was above the normal range and the mean level at 8 years of age was at the upper limit of the normal range, but the mean levels for the remaining age groups were within the normal range (Figure 6). For both sexes, the mean serum TSH levels in all age groups were within the normal range (Figure 7).

Serum free T_4 levels were plotted against serum TSH levels to investigate the correlation between the two hormones (Figure 8). Both hormones showed normal levels in 388 (82.6%) subjects. In 44 (9.36%) subjects, the TSH levels were close to normal, but the free T_4 levels were markedly above the normal range. In

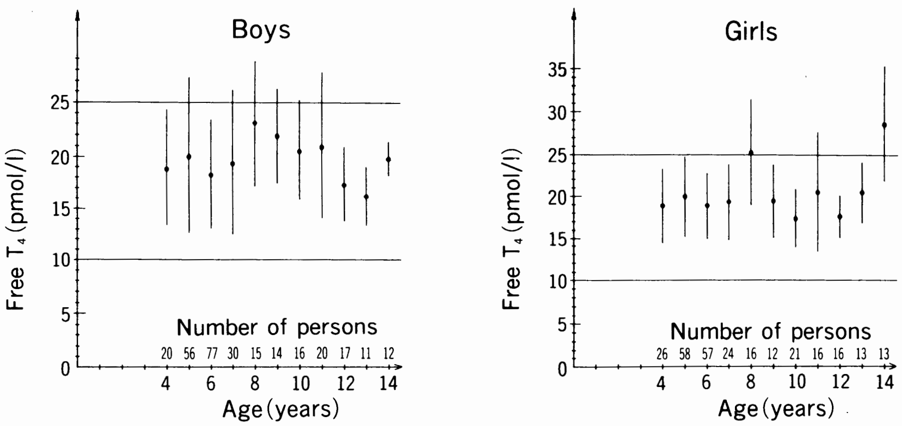


Figure 6. Serum free T_4 level (pmol/l) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (10pmol/l, 25pmol/l).

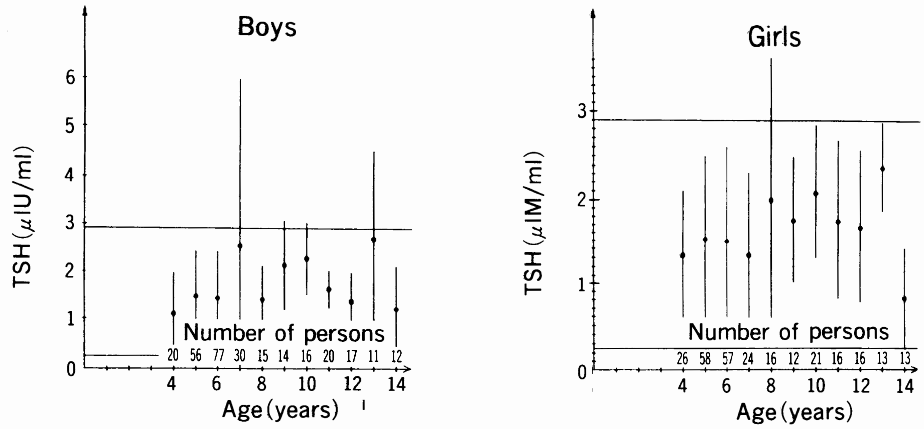


Figure 7. Serum TSH level (μIU/ml) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (0.24μIU/ml, 2.90μIU/ml).

the age group of 6-8 years, 2 (0.42%) subjects had a high free T_4 level and a low TSH level, while 1 (0.21%) subject had a low free T_4 level and a very high TSH level ($>$ 20 μIU/ml). Thirty-two (6.8%) subjects had normal free T_4 levels and high TSH levels. Free T_4 and TSH levels could be determined in only a few children because the instrument did not work properly and the necessary reagents were not available for a long period.

Anti-thyroglobulin and anti-microsomal antibody titers were determined in 637 children. Anti-thyroglobulin antibody was positive in 14 (2.20%) subjects (1 aged 4 and 12, 2 aged 5 and 10, and 4 aged 6 and 15). The titers ranged from 10 x 100 to 80 x 100. Anti-microsomal antibody was positive in 40 (6.28%) subjects, and was detected in all age groups except the 14-and 16-year-olds. The titers ranged from 10 x 100 to 320 x 100.

3.3. Summary of the thyroid-related examinations

Complete thyroid examination (ultrasonography, free T_4 and TSH levels, and antibody titers) was performed on 470 subjects. Of these, 71 showed findings which suggested the need for follow-up examinations to confirm the presence of thyroid abnormalities. The abnormalities suspected were thyroiditis in 18 subjects, Basedow's disease in 46, hypothyroidism in 1, nodular thyroid in 2, and thyroid cyst in 4. Of the 47 subjects who underwent follow-up studies, 10 (0.64% of all the subjects) (1 each in the 5-, 6-, 7- and 14-year-old age groups, 2 aged 12, and 4 aged 15) were found to have thyroid abnormalities.

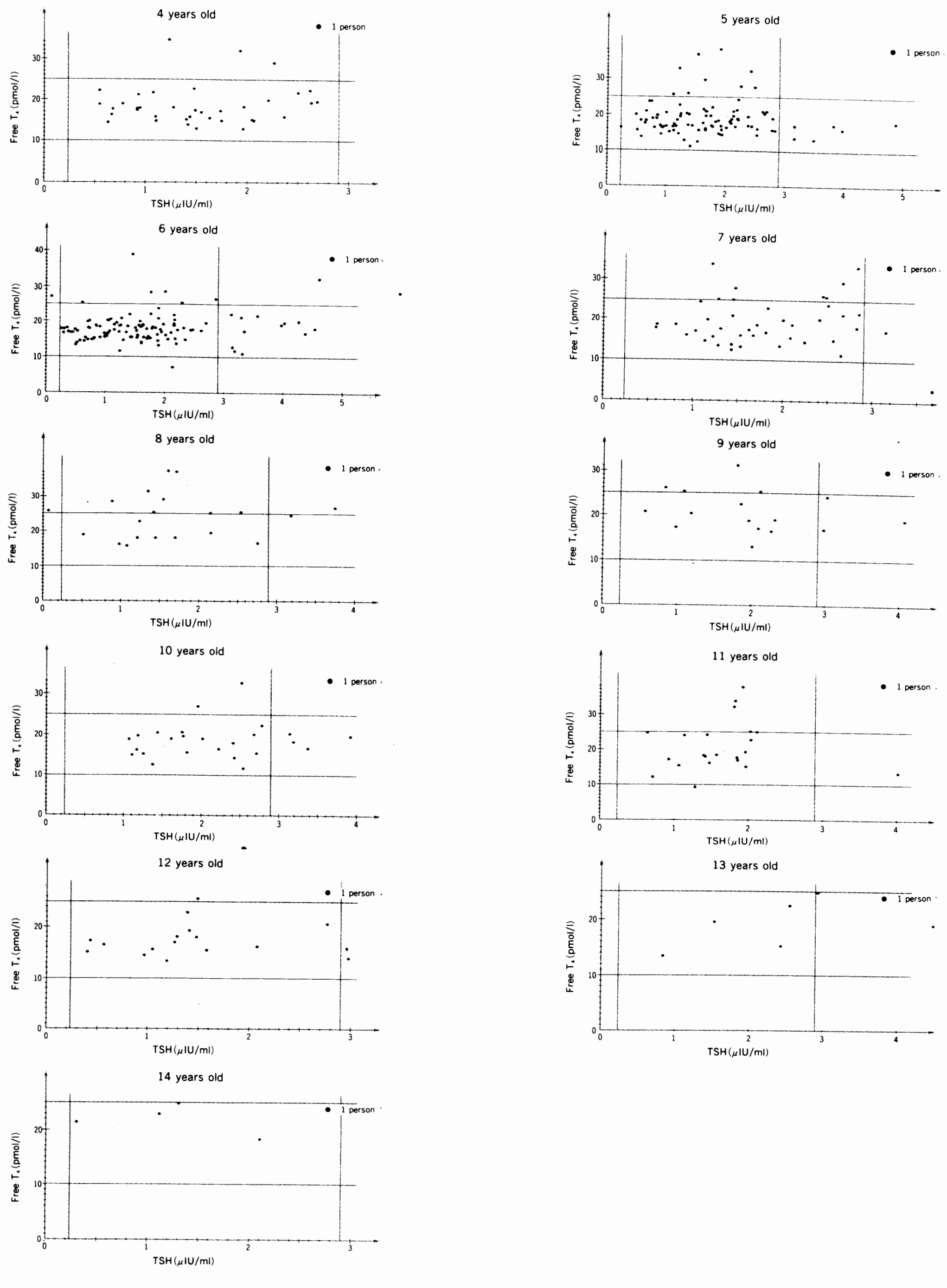


Figure 8. Scatter plots of the measurements of free T_4 and TSH by age. The two horizontal and vertical lines in each panel depict the normal limits of free T_4 (10 pmol/l, 25pmol/l) and TSH (0.24μIU/ml, 2.90μIU/ml), respectively.

4. Hematological examination

4.1. Subjects and parameters assessed

Peripheral blood samples were collected from 1,544 subjects and examined to determine the white blood cell count (WBC), red blood cell count (RBC), platelet count (Plts), hemoglobin (Hb), hematocrit (Ht), mean corpuscular volume (MCV) and mean corpuscular hemoglobin concentration (MCHC) using blood Sysmex K-1000. Blood smears were prepared and examined to assess the white blood cell morphology and differential count.

4.2. Results

The mean RBC and WBC values in all age groups were within the respective normal ranges for both sexes (Figure 9). The hemoglobin values were also normal except for the values in boys aged 4 to 8 which were at the lower limit of the normal range. Hb values increased with age (Figure 10). The mean Ht and MCV values were also within their respective normal ranges (Figure 11). Platelet counts were also normal in all age groups, although the mean values in girls aged 4-7 and in boys aged 4-10 were higher than those in the other age groups (Figure 12). The differential WBC count (neutrophils, eosinophils, basophils, lymphocytes and monocytes) was within the normal range in most subjects. Table 4 lists the subjects with abnormal hematological values according to the criteria established in the former USSR.

Blood smear analysis revealed abnormal cells or lymphocytes with nucleolus in 34 (2.46%) subjects. In 44 (2.85%) subjects, immature lympocytes were detected. Such cells are regarded as atypical lymphocytes. Four (0.26%) subjects had lymphocytes with very basophilic cytoplasma and 5 (0.32%) subjects had

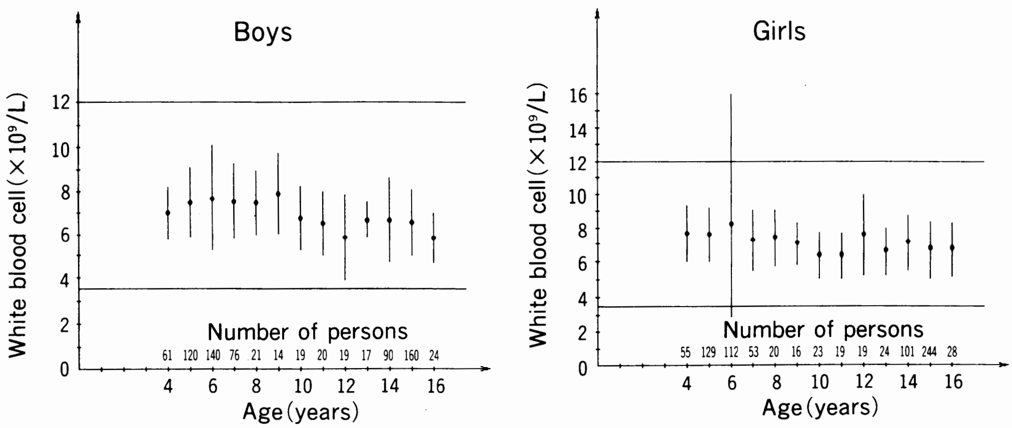


Figure 9. White blood cell count ($\times 10^9$/L) by sex and age. The dot and vertical line depict mean and mean$\pm$standard deviation for each group. The two horizontal lines in each panel depict the normal limits (3.5×10^9/L, 12×10^9/L).

monocytes with very basophilic cytoplasma. Some subjects with abnormal hematological values had underlying diseases at the time of examination (e.g., parasitic diseases in the subjects with eosinophilia). Most cases of lymphocytosis were thought to be related to the enlargement of local lymph nodes.

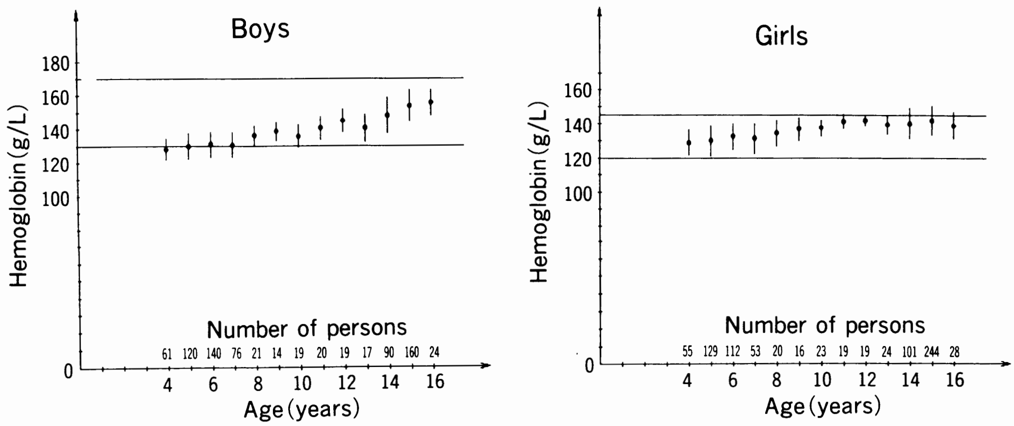


Figure 10. Hemoglobin level (g/L) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (boys: 130g/L, 170g/L; girls: 120g/L, 145g/L).

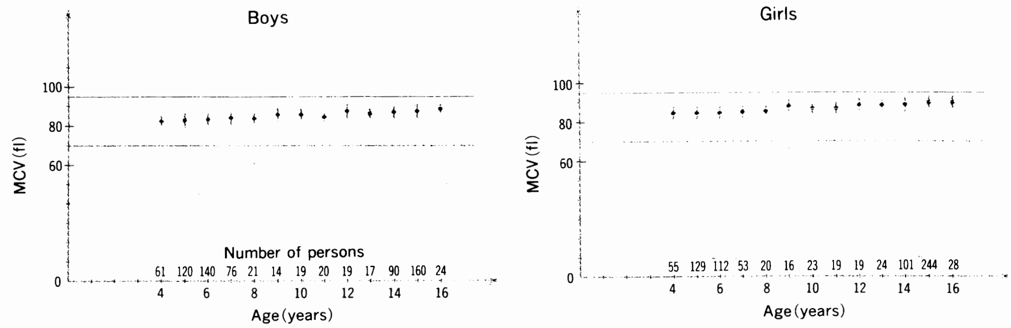


Figure 11. Mean corpuscular volume of red blood cells (fl) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (70fl, 95fl).

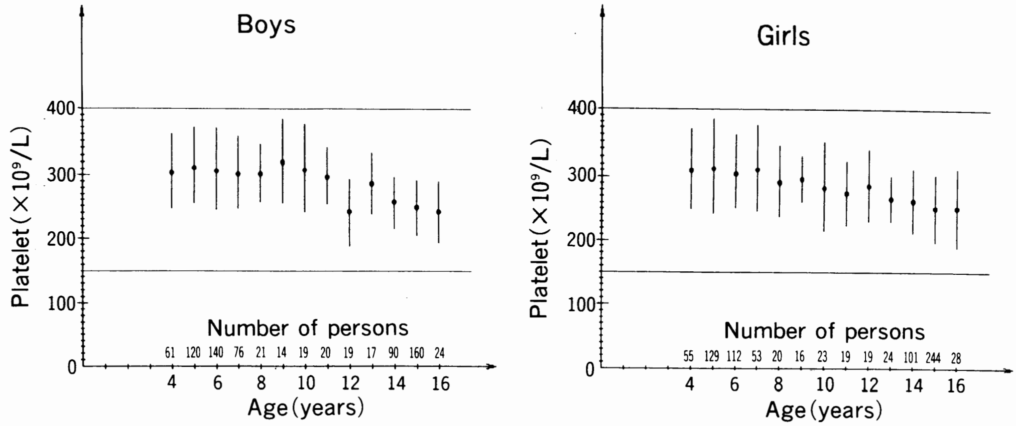


Figure 12. Platelet count ($\times 10^9$/L) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (150×10^9/L, 400×10^9/L).

Table 4. Frequency of subjects with hematological abnormalities.

Abnormality	Number of subjects (%)
Leukopenia (WBC $< 3.5\times 10^9$/L)	4 (0.25)
Leukocytosis (WBC $> 12\times 10^9$/L)	21 (1.3)
Anemia (Hb < 110g/L)	4 (0.25)
Thrombocytopenia (PLT $< 100\times 10^9$/L)	1 (0.06)
Thrombocytosis (PLT $> 400\times 10^9$/L)	62 (4.0)
Eosinophilia (Eo $> 0.5\times 10^9$/L)	359 (23.2)
Lymphocytosis (8-16 years old: Ly $> 6\times 10^9$/L)	66 (4.27)

IV. Conclusion

The number of subjects is too small to derive any conclusions about the health of children living in the contaminated regions on the basis of these preliminary data. In order to determine the true morbidity and the effects of radiation exposure, it will be necessary to continue our examinations in regions with various levels of contamination.

Kiev Regional Diagnostic Center

Reporter : Vadim S. Shvetsov

I. Introduction

The disastrous accident at the Chernobyl Nuclear Power Plant in the northern part of the Kiev region, which is adjacent to the Zhitomir and Chernigov regions in Ukraine, caused death and radiation injury in the plant personnel and firemen. A few thousand individuals who participated in clean-up and reconstruction work after the accident were also heavily exposed to radiation. Serious environmental contamination necessitated the evacuation of all the people living within 30 km of the plant.

Among the radionuclides released into the air, radioactive iodine (primarily ^{133}I), cesium (^{134}Cs and ^{137}Cs), strontium (primarily ^{90}Sr), and plutonium (^{239}Pu and ^{240}Pu) are the deciding factors in the levels of short-term and long-term contamination.

At present, two thirds of the Kiev region, which is home to 937,500 people including 201,600 children, is contaminated with radioactive substances. The residential districts can be classified by the level of radiocontamination as follows: < 5 Ci/km^2 (420 districts), 5-15 Ci/km^2 (18 districts), $\geqq 15$ Ci/km^2 (20 districts).

It is vitally important to determine how the radioactive substances released by the accident will affect the health of the residents over the long term. Children exposed to high radiation doses to the thyroid should be considered a high-risk group and subject to careful follow-up studies. It is the opinion of the International Advisory Committee (IAC; Chairman: Itsuzo Shigematsu, Hiroshima, Japan) that the thyroid radiation dose of the children of Kiev reached a level at which the incidence of thyroid cancer can be expected to increase significantly.

In 1986, radiation dose to the thyroid resulting from exposure to radioactive iodine was examined, and the doses determined in 6,500 children ranged from 0.2 to 3.2 Gy. Radiation dose was especially high in children living in the Polesskii and Ivankovskii districts in the northern part of the Kiev region.

The medical examinations performed each year were determined according to the health hazards expected to arise from the accident. The results of the physical and laboratory examinations have resulted in measures to improve the health of the population of Ukraine and in efforts to construct databases at the state-wide, regional and district levels.

The program to monitor the health of children exposed to radiation was prepared by medical specialists in Ukraine and was approved by the Ministry of Health. This program aims at the detection of hematological and immunological disorders of the thyroid.

The Chernobyl Sasakawa Health and Medical Cooperation Project planned in cooperation with Hiroshima University and Nagasaki University shares many common points with the above program in Ukraine. In the former project, advanced technology and modern medical and diagnostic equipment is being utilized.

Thanks to the cooperation of the Japanese specialists, who provided both scientific and technical assistance, the project was launched in May 1991 and has since proceeded favorably. During 1991, 1,553 children living in 5 districts in the northern part of the Kiev region were examined useing a mobile clinic.

II. Results

1. Whole body ^{137}Cs content

The environmental pollution caused by the Chernobyl accident is a major threat to the health of residents in the contaminated regions. The examinations performed annually since 1986 to determine the whole body cesium content revealed levels of not more than 0.05 rem in 75% of the adults and 98% of the children examined.

As part of the Chernobyl Sasakawa Health and Medical Coopereation Project, the whole body ^{137}Cs content was determined using a whole body counter in regions where the radiation levels were 1-5 Ci/km^2, 5-15 Ci/km^2 and 15-40 Ci/km^2. Table 1 shows the results. A very high whole body ^{137}Cs content of 14,000 Bq was found in one subject living near a forest. The whole body ^{137}Cs content was not related to age or sex. Figure 1 shows the whole body ^{137}Cs content per kg body weight (Bq kg^{-1}) in children aged 5, 6, 9 and 10, while Figure 2 shows the mean values in each age group. There were no marked differences in the mean values among the various age groups, except for 16-year-old boys.

2. Examination of the thyroid

2.1. Ultrasonography

As the thyroid gland is severely affected by radioactive iodine, ultrasonography of the thyroid and determination of serum thyroid stimulating hormone (TSH) and thyroid hormone (free T_4) levels were performed as part of this

Table 1. Classification of subjects by Cs-137 level.

Cs-137 level (Bq)	Percentage of subjects
≦ 1,000	57.6
1,000 — 2,000	32.7
2,000 — 3,000	6.3
3,000 — 4,000	2.4
≧ 4,000	1.0

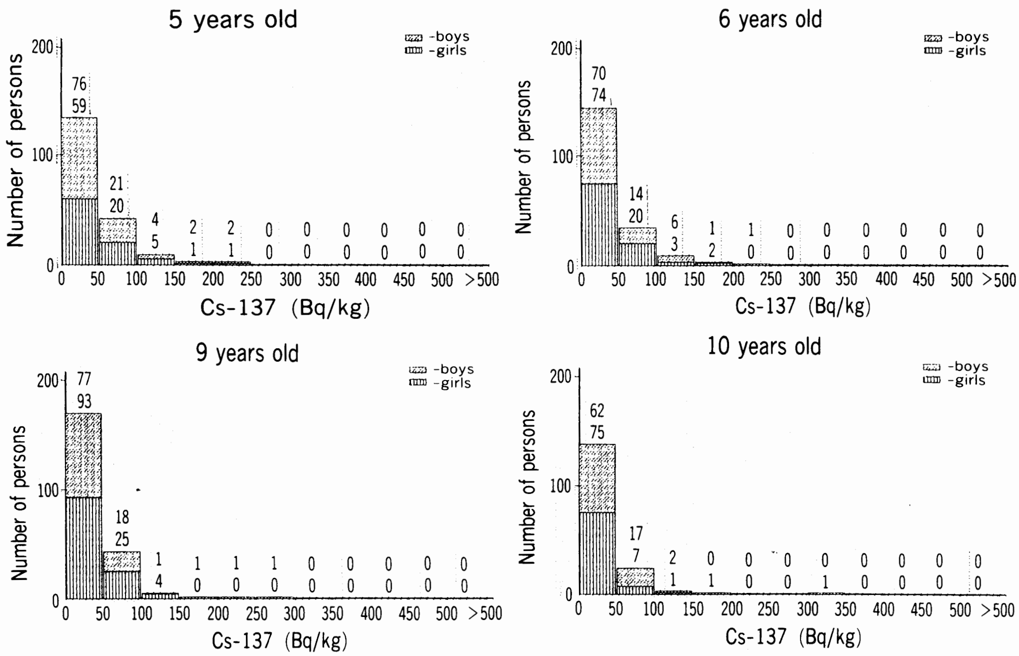


Figure 1. Distribution of whole body Cs-137 count per body weight (Bq/kg) by sex and age.

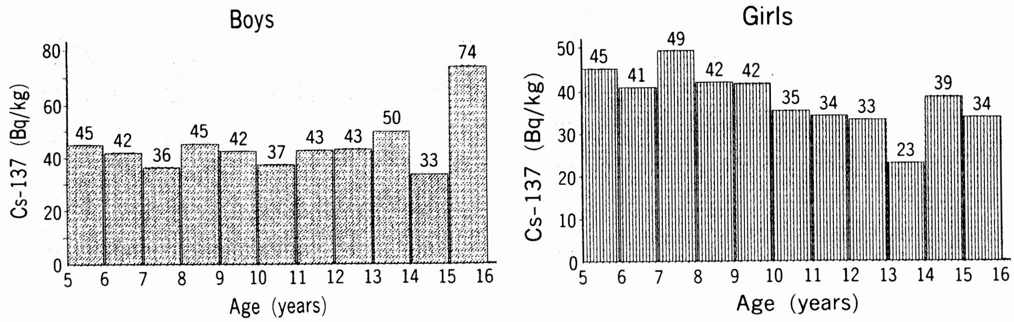


Figure 2. Mean level of whole body Cs-137 count per body weight (Bq/kg) by sex and age.

project. Most of the subjects had received high doses of radiation to the thyroid.

Analysis was conducted in 1,437 children (724 boys and 713 girls) aged 4-15 to assess the role of sex and age in the differences of thyroid volume. As shown in Figure 3, the thyroid volume for boys and girls in each age group was beyond the normal range (thyroid enlargement). There were no sex-related differences within each age group. Deviation from the normal range was greatest in subjects aged 5-7.

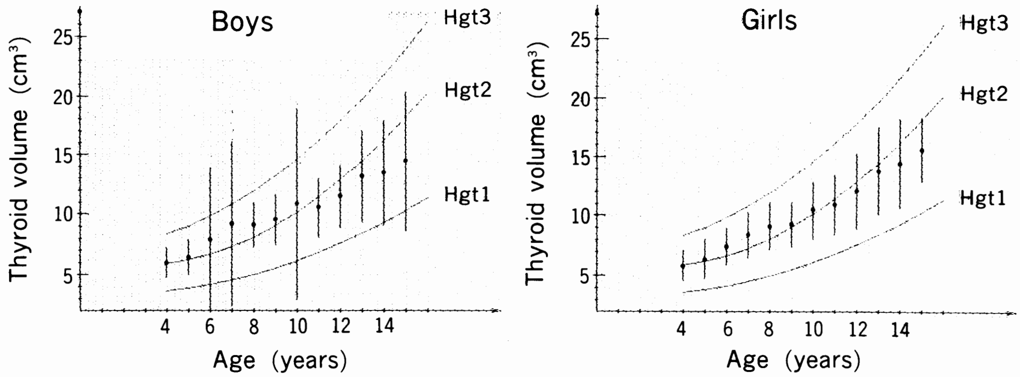


Figure 3. Thyroid volume (cm^3) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The lowest curve in each panel depicts the normal limit.

2.2. Data of serum thyroid hormone levels

The data on serum free T_4 and TSH levels are shown in Figures 4 and 5, respectively. In each age group, the mean free T_4 level was within the normal range. The serum free T_4 level was above normal in 2 subjects. In each age group, the mean TSH level was within the normal range. In 56 subjects, serum TSH levels were above normal, but they did not exceed 9.6 μIU/ml.

Forty-seven subjects were suspected to have a nodular thyroid or thyroid cysts (Table 2). They all had thyroid volumes exceeding the normal range for their ages. However, no marked hormonal abnormalities were observed in this group of subjects.

3. Hematological examination

The mean values of hemoglobin, red blood cell count (RBC), white blood cell count (WBC) and platelet count for each age group were within the respective normal ranges. However, a few children had slightly abnormal hematological values (Table 3). The frequency of subjects with abnormalities of white blood cell morphology and differential count is shown in Table 4. Morphological abnormalities of white blood cell such as abnormal segmented neutrophils and deformed monocyte were observed at a frequency of less than 1/300 but were not recorded. It is necessary to re-examine the subjects with these abnormalities by

Table 2. Classification of subjects with suspected thyroid nodule and cyst by sex and age.

Age	Number of examinees			Number of suspected examinees		
	Boys	Girls	Total	Boys	Girls	Total
4	29	23	52	0	0	0
5	105	86	191	1	1	2
6	89	97	186	4	2	6
7	120	113	233	3	2	5
8	108	104	212	3	1	4
9	74	96	170	2	4	6
10	80	82	162	4	4	8
11	58	48	106	4	1	5
12	28	19	47	2	1	3
13	19	19	38	2	2	4
14	12	15	27	2	1	3
15	2	11	13	0	1	1
Total	720	713	1,433	27	20	47

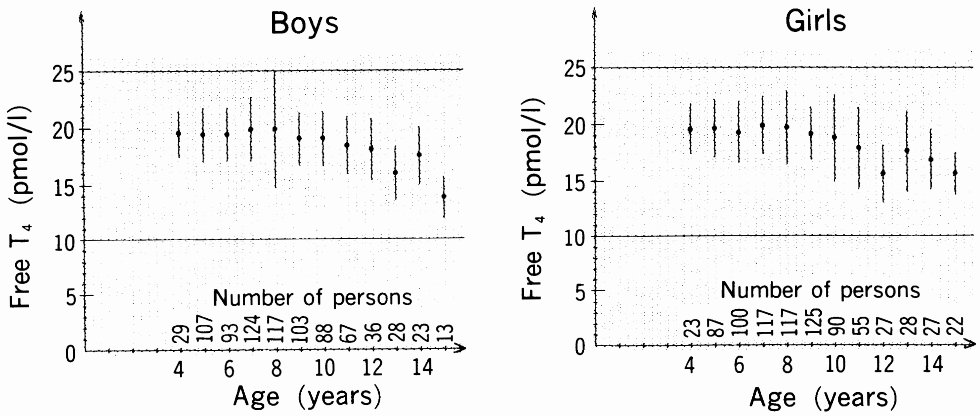


Figure 4. Serum free T_4 level (pmol/l) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (10pmol/l, 25pmol/l).

repeating the differential count or morphologic examination of white blood cells.

In our opinion, the hematological abnormalities observed were a result of various factors, including the accumulation of radioactive substances, the nutritional status and other accompanying disorders such as thyroid abnormalities. The data and clinical findings reported here suggest that immunological examinations should be performed in the future.

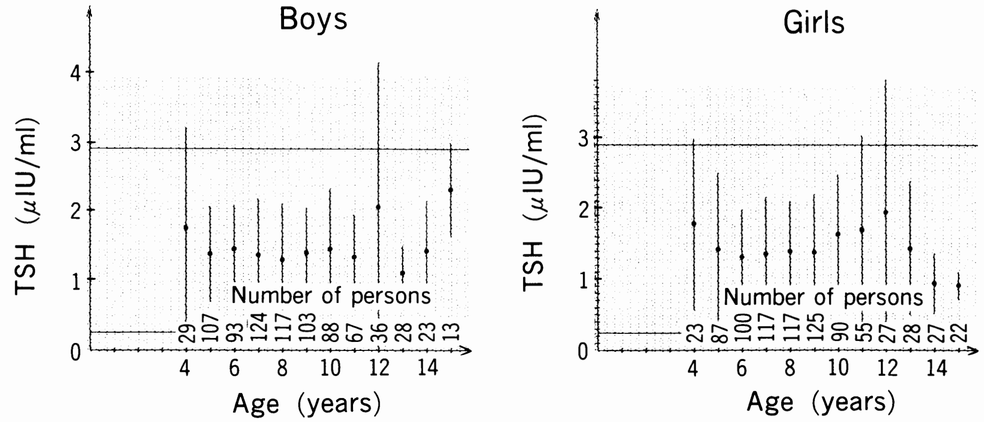


Figure 5. Serum TSH level (μIU/ml) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (0.24μIU/ml, 2.90μIU/ml).

Table 3. Frequency of hematological abnormalities.

Hematological abnormality	Percentage of subjects
Anemia	0.6
Thrombocytopenia	0.1
Thrombocytosis	10.0
Leukopenia	0.3
Leukocytosis	3.0

Table 4. Frequency of white blood cell abnormalities.

Abnormality in white blood cells	Age (years)	
	4 − 7	8 − 16
Lymphopenia	19.5%	6.0%
Eosinophilia		22.9%
Monocytosis		14.9%

Korosten Diagnostic Center

Reporter : Valery V. Danilyuk

I. Introduction

The Korosten Diagnostic Center has used a mobile clinic to examine children living in the northern part of the Zhitomir region who were exposed to radiation of the Chernobyl accident. Korosten City is about 100 kilometers from the Chernobyl Nuclear Power Plant. Total population of this region is 500,000 including 70,000 children. Part of the region is a low iodine intake area where goiter is an endemic disease. The radiation levels in this region range from 1 to 40 Ci/km^2. During the first year of the study, a total of about 2,000 children (5-16 years old) were examined.

II. Results

1. Whole body ^{137}Cs content

The whole body ^{137}Cs content was determined using a whole body counter. The ^{137}Cs content was more than 10,000 Bq in 21 subjects. (The ^{137}Cs content is shown in Figure 1 in relation to sex and age.) The mean ^{137}Cs content per kg body weight ($Bq\ kg^{-1}$) for both sexes and each age group is shown in Figure 2. The content was slightly higher in boys aged 10-15 and girls aged 13-15.

2. Examination of the thyroid

2.1. Ultrasonography

Figure 3 shows the relationship between the ultrasonographically determined thyroid volume by sex and age. There was a positive correlation between thyroid volume and age in both sexes. (Points and vertical lines represent the mean and the standard deviation.) For each sex, the lowest curve depicts the normal limit for each age as determined by the conventional method.

Ultrasonography revealed the abnormalities listed in Table 1.

2.2. Data of serum thyroid hormone levels

Figure 4 shows the serum free T_4 levels in relation to sex and age. (Points

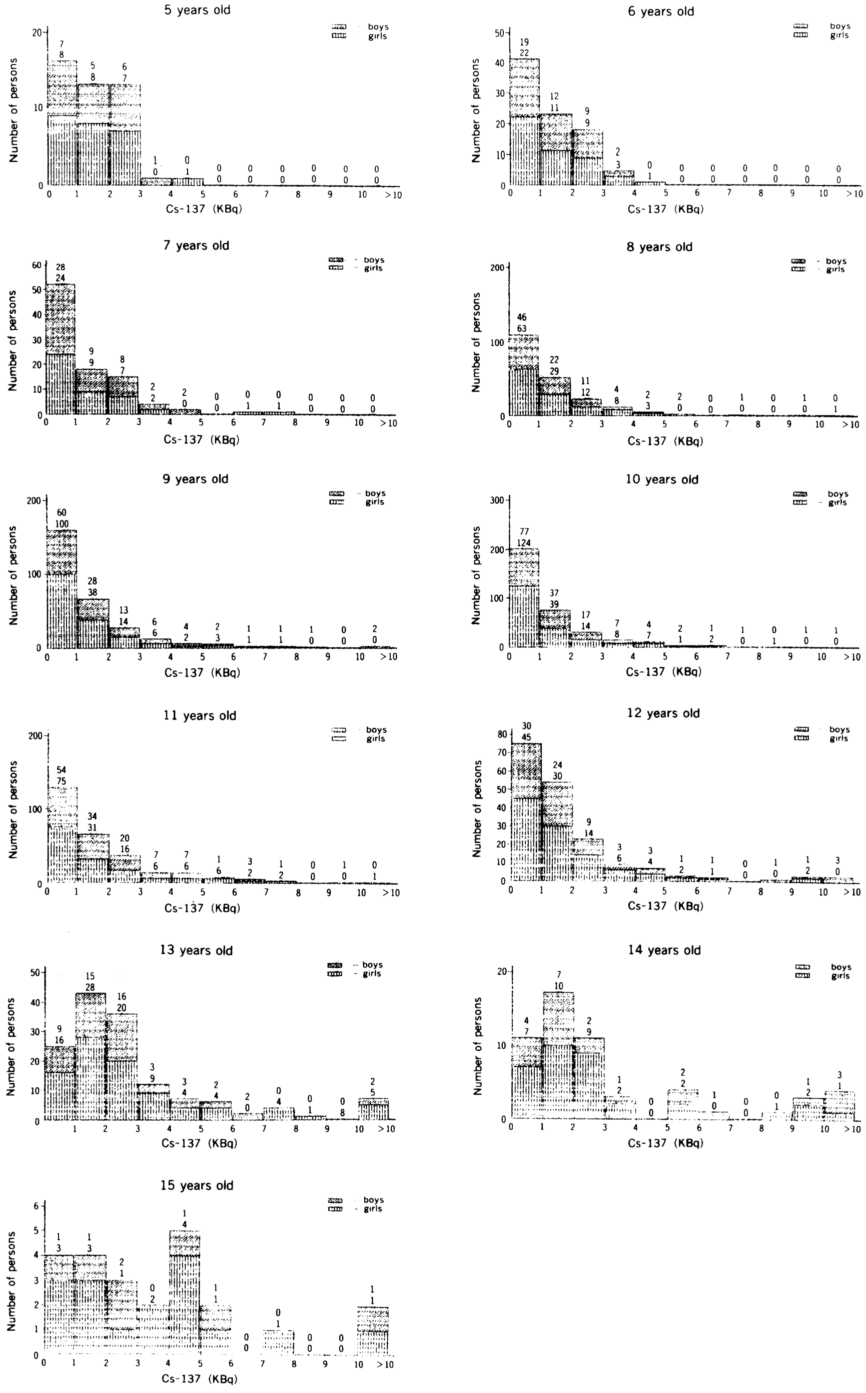
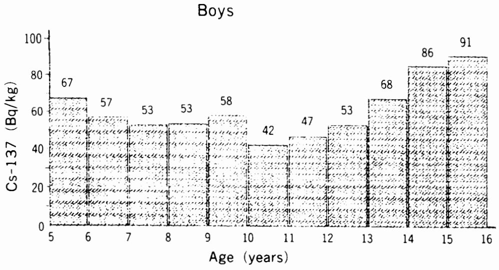


Figure 1. Distribution of whole body Cs-137 count per body weight (Bq/kg) by sex and age.



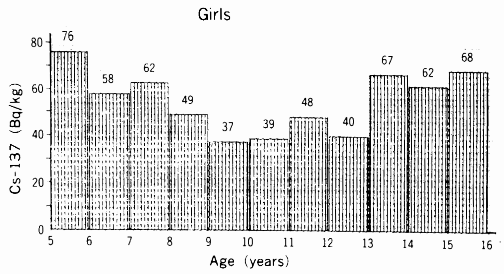
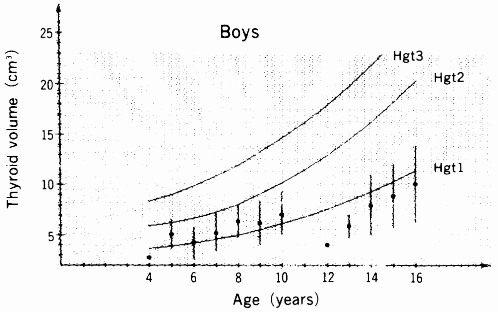


Figure 2. Mean level of whole body Cs-137 count per body weight (Bq/kg) by sex and age.



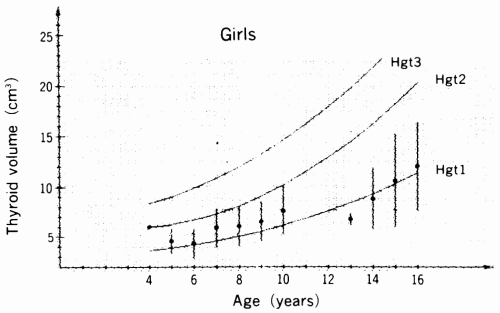


Figure 3. Thyroid volume (cm^3) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The lowest curve in each panel depicts the normal limit.

Table 1. Classification of subjects with thyroid abnormalities found by ultrasound scanning.

Thyroid abnormality	Boys	Girls	Total
Goiter[a]			
1st degree	36	69	105
2nd degree	6	30	36
3rd degree	0	1	1
Diffuse goiter	1	1	2
Nodular goiter	0	4	4
Thyroid hypoplasia	0	1	1

a. Based on the criteria established by the Research Institute of Medical Radiology, Academy of Medical Science of Russia.

and vertical lines represent the mean and the standard deviation.) For both sexes, the mean serum free T_4 level was within the normal range in all age groups.

Figure 5 shows the serum TSH levels in relation to sex and age. (Symbols are the same as those in Figure 4.) The values observed in 11- and 13-year-old boys showed marked variation and a few subjects had values beyond the normal range. These children are undergoing follow-up examinations but have shown no clinical abnormalities other than those of the thyroid. In the girls, a marked variation was observed in the data from all groups of subjects aged 5 to 15. However, these age groups all had normal serum free T_4 levels and no clinical abnormalities. Taking all these findings together, however, it seems necessary to follow-up these girls. The serum anti-thyroglobulin and anti-microsomal antibody titers could not be determined because of a delay in obtaining the necessary reagents.

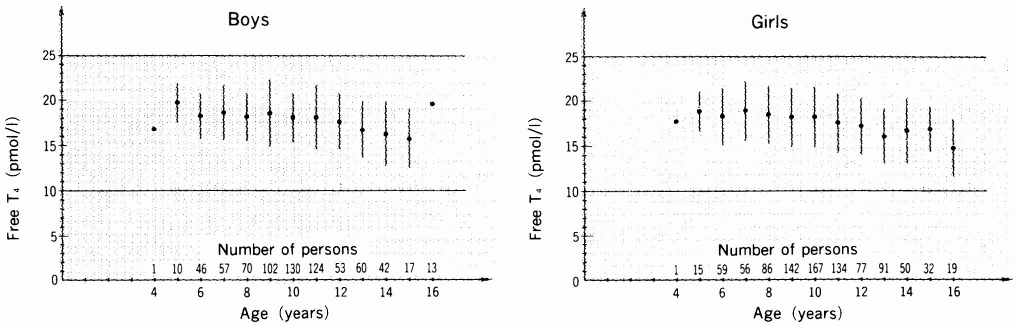


Figure 4. Serum free T_4 level (pmol/l) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (10pmol/l, 25pmol/l).

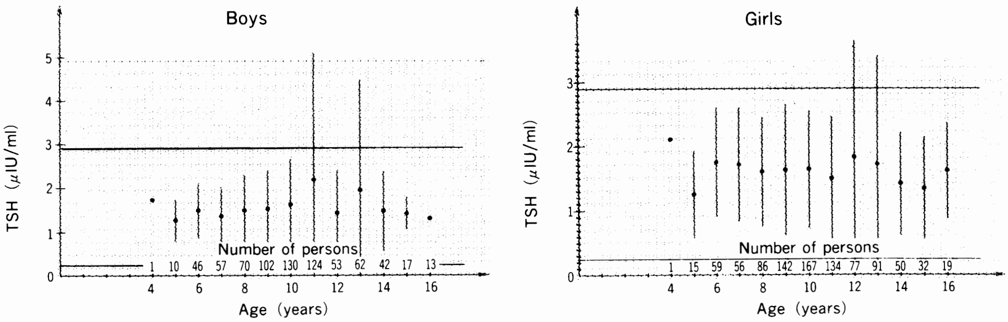


Figure 5. Serum TSH level (μIU/ml) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (0.24μIU/ml, 2.90μIU/ml).

3. Hematological examination

The hemoglobin values are shown in relation to sex and age in Figure 6. (Points and vertical lines represent the mean and the standard deviation for each age group.) The mean hemoglobin level in boys aged 4-9 was at the lower limit of the normal range, i.e., 120 g/L. In girls, the mean hemoglobin levels were within the normal range in all age groups.

The white blood cell counts are shown in Figure 7 in relation to sex and age. (Symbols are the same as those in Figure 6.) A marked variation in the values obtained was observed in boys from 5 to 15 years of age. The variation noted in 10-year-old girls was especially conspicuous, and the reason for this needs to be studied in the future.

Investigation of the platelet count showed that there were no boys with thrombocytopenia (a platelet count < 100 x 10^9/L) (Figure 8). However, a few boys aged 5, 6 and 7 had thrombocytosis.

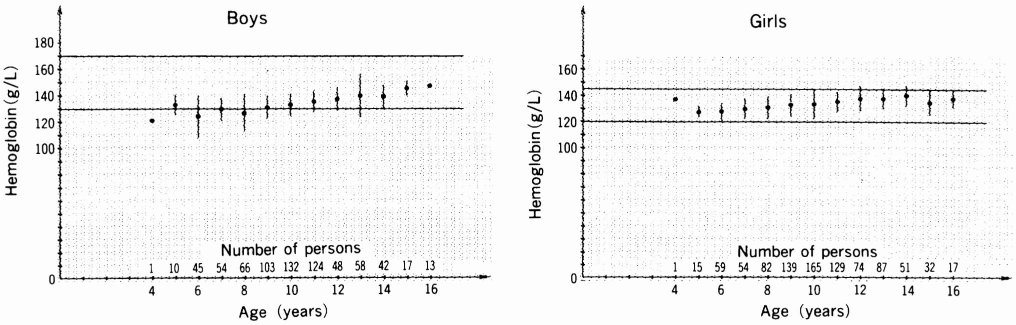


Figure 6. Hemoglobin level (g/L) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (boys: 130g/L, 170g/L; girls: 120g/L, 145g/L).

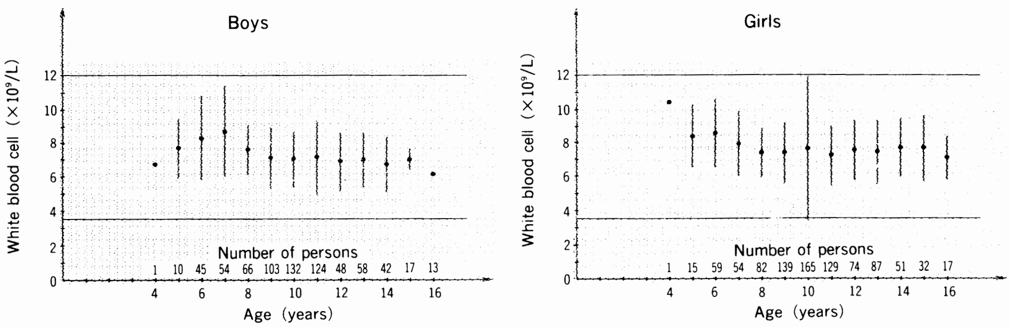


Figure 7. White blood cell count ($\times 10^9$/L) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (3.5×10^9/L, 12×10^9/L).

Hematological examination revealed the abnormalities listed in Table 2. The subjects with these abnormalities will be re-examined and follow-up studies will be performed if re-examination confirms the presence of abnormalities.

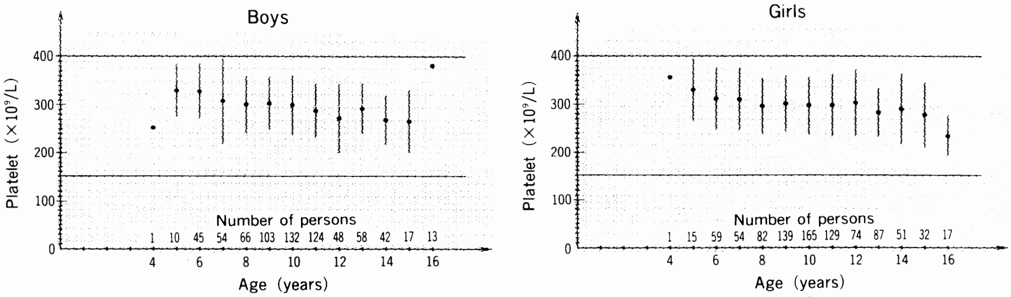


Figure 8. Platelet level ($\times 10^9$/L) by sex and age. The dot and vertical line depict mean and mean$\pm$standard deviation for each group. The two horizontal lines in each panel depict the normal limits (150×10^9/L, 400×10^9/L).

Table 2. Classification of subjects with hematological abnormalities.

Hematological abnormality	Number of subjects
Anemia (Hb < 110g/L)	9
Leukopenia (WBC < 3.5×10^9/L)	6
Leukocytosis (WBC > 12×10^9/L)	46
Thrombocytosis (PLT > 400×10^9/L)	95
Lymphocytosis	
(4-7 years old: Ly > 6.0×10^9/L)	6
(8-16 years old: Ly > 4.5×10^9/L)	51
Monocytosis (Mo > 0.6×10^9/L)	239
Eosinophilia (Eo > 0.5×10^9/L)	408
Basophilia (Ba > 0.125×10^9/L)	158

III. Conclusion

The results obtained during the first year of the project indicate that the initial health disorders of childen exposed to radiation by the accident can be detected by the Chernobyl Sasakawa Health and Medical Cooperation Project. During this cooperative study with Sasakawa Memorial Health Foundation, which is scheduled to continue for 5 years, our Center will make every effort to improve the examination techniques, to provide local residents with more precise data, to detect diseases as early as possible and to take rapid action for their treatment.

3. Comments on the Reports—Part 1

Determination of radiation levels

Shunzo Okajima
Professor Emeritus, School of Medicine, Nagasaki University
(Radiation biophysics)

I would like to comment on the presentations related to the determination of radiation levels. My speech consists of three parts. First, I will comment on the results reported from the five centers today. Second, I will report on the effects of radioactivity from atomic fallout caused by the atomic bomb dropped in Nagasaki. In Nagasaki, the whole body cesium-137 content has been determined in many residents. Third, I would like to make some suggestions regarding future studies related to this project.

According to the presentation today, the results obtained by the five centers indicate that the cesium-137 content per kilogram of body weight (Bq/kg) is similar in males and females. I will comment on this finding later by referring to the results we have obtained in Nagasaki. The results also indicate that there is no significant age-related difference in the cesium-137 content (Bq/kg) within the age range of 5 to 15 years. The most notable finding reported today appears in the histogram of the cesium-137 content. In most children, the cesium-137 content was less than 100-150 Bg/kg. It may become easier to compare the data when logarithmic scales are used for the abscissa of the histogram, and I hope that this will be done at each center. The highest value on the scale in the histogram presented from each center is 500 Bq/kg, so none of the 13,500 children tested had a cesium-137 content exceeding 500 Bq/kg. This is a notable finding. In the IAEA study, the cesium-137 content exceeded 1,000 Bq/kg or even 10, 000Bq/kg in some adults. The highest value in these studies of 500 Bq/kg corresponds to an annual radiation dose of 430 μSv, or 43 mrem in the former units. As you know, this dose is equivalent to half of the natural annual radiation dose. Furthermore, the cesium-137 content in most of the subjects was several times lower than this value. Such low radiation doses are unlikely to have any adverse effects. At these five centers, the cesium-137 content was not zero in most of the subjects. If the study had been using the same instrument before the Chernobyl accident, the cesium-137 content would have been under the detectable limit in all of the subjects. In this sense, most of the levels obtained after the accident are abnormal, but they are not so high as to have any adverse effects.

Next, I will present a summary of the results of our study in Nagasaki,

The atomic bomb dropped in Nagasaki in August 1945 exploded at about 500m above the ground. As there was a westerly wind blowing at about 3 meters per second, radioactive fallout and rain primarily fell on the Nishiyama District about 3,000m to the east of the spot where the bomb was dropped (Figuere. 1).

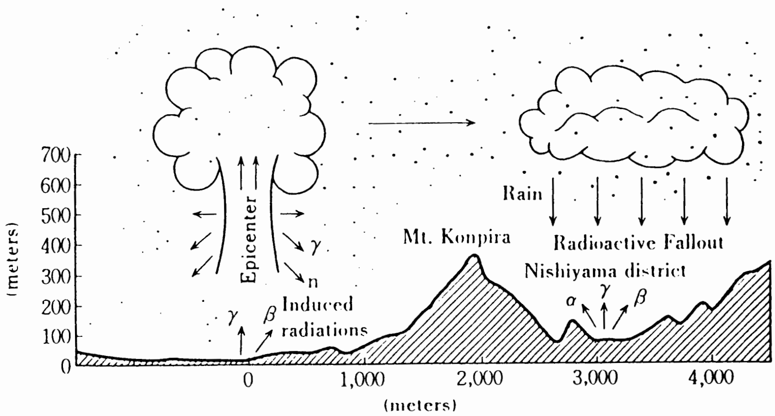


Figure 1 Fallout caused by the atomic bomb dropped in Nagasaki.

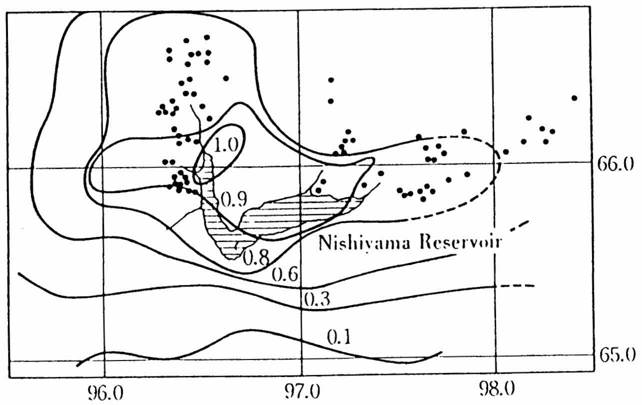


Figure 2 Isodose curves of γ-rays from radioactive fallout in Nishiyama, Nagasaki. (determined on October 3-7, 1945). Figures show the dose rate of γ -rays (mR/hr) and dots represent the locations of residents in whom the measurement of body burden was done with a whole body counter.

Figure 3 shows a cross-sectional view of the whole body counter. The chamber was constructed with 20 cm thick iron walls.

The data on the whole body cesium-137 content are shown in Fig. 4. The ages of the sujects when the bomb was dropped in 1945 are presented on the abscissa. The left panel is for males and the right panel is for females. There are sets of two columns in each graph. In each set, the black column represents data for the residents of Nishiyama District, and the white column, designated "comparison", represents control data obtained in 1969 at 24 years after the bomb was dropped. The radioactivity levels in the control group are attributed to the universal global contamination resulting from nuclear tests carried out by the USA and the USSR. Thus, the difference in the cesium content between the two groups is thought to be the net effect of the Nagasaki atomic bomb. For both males and females, the values obtained in the Nishiyama District are about twice the respective control values. A comparison between the sexes reveals a higher cesium-137 content per kilogram of body weight in males than in females. Please note that the cesium-

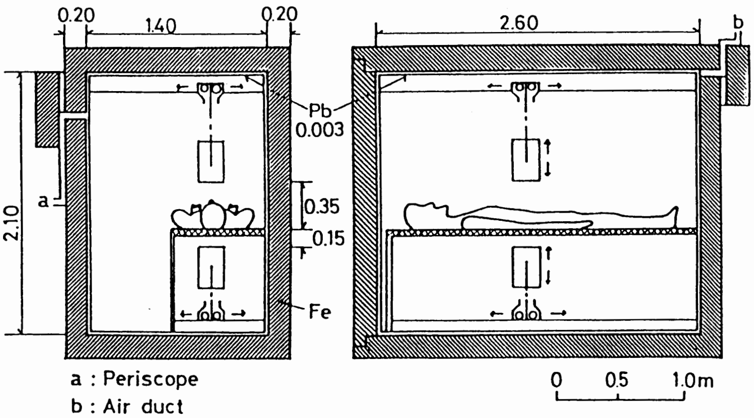


Figure 3 Cross-sectional view of whole body counter.

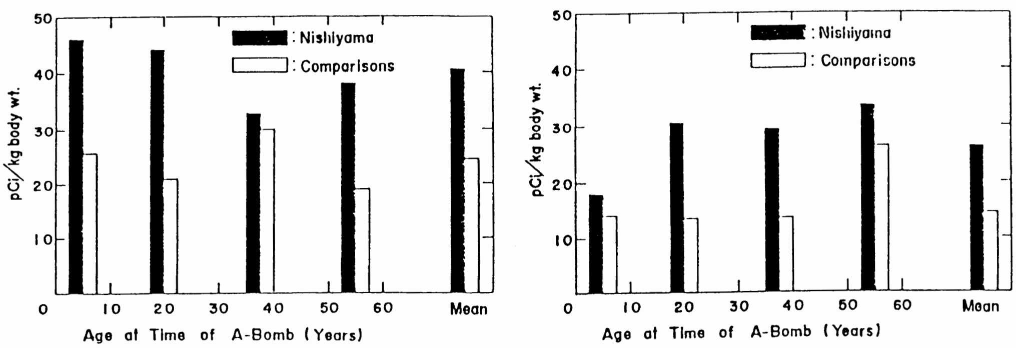


Figure 4 Cesium-137 content in relation to age (left panel is for males and right panel is for females).

137 content is presented in terms of pci/kg and not Bq/kg. When converted to Bq/kg, these values are much lower than those which were determined after the Chernobyl accident and presented today. The higher levels in males can be explained as follows. Cesium is primarily absorbed by muscle and shows little uptake by fat tissue, which comprises a higher percentage of the body weight in females than in males. In contrast, the data reported in this symposium showed no sex-related differences. I think that this is because the percentages of muscle and fat tissue are similar in boys and girls under 15 years of age.

Figure 5 shows data obtained in the Nishiyama District in 1969 and 1981. During the intervening 12 years, the cesium-137 content showed a considerable decrease. One reason for this decrease could be the social and environmental changes occurring in this district. Nishiyama is a farming district located about 1-2 km from Nagasaki City. During the 12-year period between determinations, the number of houses in this district increased and the cultivation of rice was abandoned. Along with these changes, the diet of the residents of this district also changed. This fact has to be taken into consideration when these data are compared with the results of the study in this project.

Next, I would like to make some suggestions regarding future studies with respect to this projedct. First, I would like to suggest that a follwp-up study be performed to examine further changes in the cesium-137 content with the passage of time. It may be desirable to design a 5-year or 10-year study of the same population. It would not be necessary to enroll a large group of subjects. I would expect that the whole body cesium-137 content will decrease gradually with the passage of time. As I stated in the first part of my speech, the annual radiation

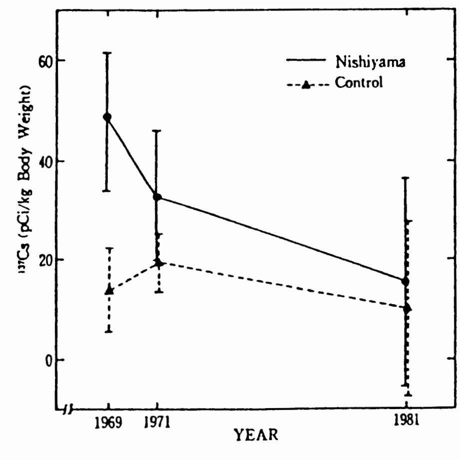


Figure 5 Changes in the whole body cesium-137 content (1969-1981).

dose is 43 mrem even in the subjects with the highest cesium-137 content. Even if such subjects were continuously exposed to internal radiation for a period of 70 years, the total radiation dose would not exceed 2 rem because the cesium-137 content should decrease over time. If the time course of the cesium-137 content can be determined in future studies, it will become possible to estimate the radiation dose which the subjects received during the previous 5 years.

I would also suggest that the relationship between the whole body cesium-137 content (Bq/kg) and the degree of soil contamination where each subject lives should be investigated. It would also be desirable to perform an overall analysis of all data obtained from the centers rather than an independent analysis at each center. I think that such investigations could provide very significant results.

Finally, I would like to suggest that for subjects with very high cesium-137 contents, answers to diet-related questions in the questionnaire should be examined to analyze the relationship between the whole body cesium-137 content and food intake. Further, I hope that future studies will determine the cesium-137-associated radioactivity in their daily diet and elucidate the relationship between the whole body cesium-137 content and the degree of contamination of soil and food.

Thank you very much for your kind attention.

Comments on the results of the hematological examination

Atsushi Kuramoto

Director of the Research Institute for Nuclear Medicine and Biology, Hiroshima University
(Hematology)

I would like to honor the great efforts of the personnel of the five centers in obtaining the results during this year that were reported today and to express our gratitude for the cooperation and advice of the specialists from the three republics who are present here.

The hematological examinations used in this Sasakawa Project are aimed at determining the hematological changes resulting from various effects of the Chernobyl accident, with radiation-related changes being distinguished from other changes. Under the guidance of the personnel of each center, I had the opportunity to come into contact with some of the residents of the contaminated regions, including children and parents, and to appreciate their fear of the potential adverse effects of the accident. Based on this invaluable experience as well as my experience in Hiroshima, I decided to perform an examination of four major subjects. The first subject was anemia. Each patient should be examined for the presence of anemia and its cause should be determined. During my tour, I heard many persons complaining of an increased incidence of anemia in the children. The second subject was the effect of radiation on the white cell (leucocyte) counts and their differential counts. I thought that it was necessary to investigate the effect on various blood cells because I heard many mothers complaining of an increased incidence of infection, increased susceptibility to various diseases, and reduced resistance among their children. Neutrophils and lymphocytes, as is well known, play a particularly important role in the self-defense to infection and certain other diseases. In order to clarify the causes of these problems in the children, I decided to investigate lymphocyte numbers and morphology as indicators of protective immunity. Third, there was the risk of an increased or increasing incidence of leukemia, which is the greatest fear related to radiation. Therefore, the differential leukocyte count needs to be assessed in order to detect leukemic cells as soon as possible. Fourth, the incidence of coagulopathy or hemostatic disorders may be increased by radiation. As reported in the morning presentations today, hemostasis could not be easily achieved in some patients who experienced severe hemorrhage because of abnormal childbirth (dystocia).

Accordingly, the screening hematological examination determined RBC, hemoglobin, and hematocrit and calculated the mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC). Abnormalities of these parameters should allow us to predict the causes of any anemia that is detected. The results reported at this symposium indicate that the incidence of anemia was lower than expected. When I participated in the IAEA study in 1990, I heard that the incidence of anemia in children was at least 10% and was up to 30% in the 3 republics. I also heard that the major causes of anemia were malnutrition and parasitic disease. In some regions, the incidence of anemia was reported to be very high immediately after the accident, but to decrease at follow-up after 1 or 2 years with significant improvement. Therefore, I think that some of the anemia observed after the accident was caused by restriction on the intake of foods such as milk. Let me ask you whether the low incidence of anemia presented at this symposium can be interpreted as being a result of nutritional improvement. As other possible causes of anemia, there might be the effects of elements such as lead, cadmium, and mercury immediately after the accident. In light of the presentations today, I do not think that lead or other toxic metals have had any notable effect, although the serum iron level should of course be continuously monitored.

Concerning the second subject, I will now comment on the data on the leukocyte profile and immunity. The incidence of eosinophilia was high, 20-30% in various regions, suggesting the need to inventigate its relationship with allergic diseases, infections such as toxoplasmosis, and lymphoid tumors. Today's presentations did not refer to abnormalities of lymphocyte numbers or morphology. In the future, more complete examinations need to be performed, including determination of serum proteins, in order to investigate whether or not these subjects have become more susceptible to infection. Studies have been started at institutions in the three republics, in which it is of course essential to investigate T lymphocytes, B lymphocytes, and T lymphocyte subsets. These examinations will also provide information necessary for detecting any disease of the thyroid (thyropathy).

Concerning the third subject, it would be interesting to determine whether the incidence of childhood leukemia is increasing. As referred to in the question asked a little while ago, children sometimes show transient abnormal myelopoiesis (TAM), a finding suggestive of leukemia. Keeping this in mind, studies are now being carried out carefully at the five centers. At the center in Mogilev, a leukemoid reaction was reported to occur in 1 subject but this soon disappeared. Thefore, there have been no reports of leukemia so far. In the future, some subjects with abnormal leukocyte findings will be referred to specialists, or specialists will be consulted on this matter.

Finally, I will comment on coagulopathy or hemostatic disorders. Today, the individual centers presented the very interenting finding that the platelet count is between 300,000 and 400,000 at the age of 5-8 years and gradually decreased to 200,000-300,000 at ages over 8 years, which is comparable to the adult range. This finding was common to all of the institutions. Further investigation will be necessary to derive a definite conclusion from this finding, but this happened to disclose that individual institutions employ the standardized determination of the platelet count. At the hematology workshop, Mr. Uesugi will talk on examination techniques, Dr. Fujimura will talk about blood cell classification on smears, Dr. Imamura will speak about lymphocyte markers, Dr. Dohi will cover therapy for hematological diseases, and Drs. Kusumi and Shibata will review the problems related to registration.

In the future, I think it is necessary to establish ways of controlling the precision of examinations and to devise a medical checkup system that will support such controls and increase the reliability of the data obtained during the second and third years of this project.

Hematological examinations

Shiro Miwa, M.D.

Director, Okinaka Memorial Institute for Medical Research, Tokyo
(Hematology and laboratory tests)

I was deeply impressed by the excellent results obtained during this year. Prof. Kuramoto has already made the major comments on the hematological data. I would like to talk instead about how the normal values for children were established, as was asked a little while ago. I will use hemoglobin values obtained in the Klincy region (shown in Figure 1) as an example. With this parameter, the normal adult values accepted in the USSR are 13.0-17.0 g for males and 12.0-14.5 g for females. We applied these values to all subjects regardless of age. There are sex-related differences in RBC and hemoglobin levels, and these parameters are higher in males than in females. These differences become apparent at the age of about 14-15 years, when the values in males began to increase while those in females remain constant. At the age of 15 years, the mean hemoglobin level for females is about 14.5g, which is about 2g lower than that for males (about 16g). This is thought to be related to an effect of androgens. Therefore, it is of some concern how to establish normal hematological values for children, as suggested by the question. One of the challenges facing participants in this project is to establish normal hematological values for children, particularly for hemoglobin and RBC, as is also the case with thyroid volume. Determination of normal RBC and hemoglobin values is important criteria for the diagnosis of anemia. To be more concrete, I would like to suggest that the answers to the questionnaires should be carefully examined to determine whether the subject has been exposed to radiation and is in good health or not at the time of examination. I would also like to suggest that the subjects be classified into 3, 4, or 5 age groups by combining, for example, children of 4, 5, 6, and 7 years of age. Then randomly sampled data from subjects who appear to be healthy according to the answers in the questinnaires should be used for establishing normal values for both sexes and each age group. The actual breakdown of the age groups will be another issue, but this method is feasible and would provide values which could be used as suitable diagnostic criteria for anemia. In addition, it is desirable to determine other factors promoting anemia and to exclude data from subjects with such factors when calculating the normal values. For example, as most cases of anemia in Japan are caused by iron deficiency, data from subjects with low serum Fe levels should be excluded from such a calculation if it were done in this country. It seems necessary to employ some such procedures.

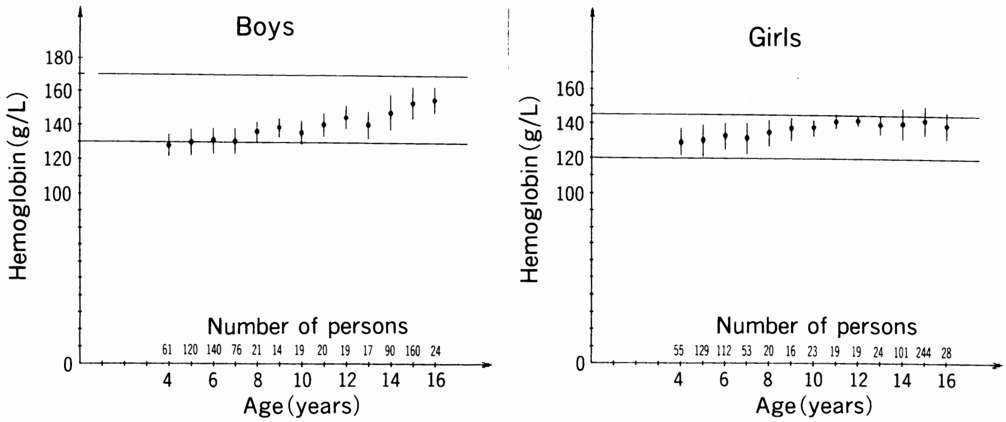


Figure 1. Hemoglobin level (g/L) by sex and age. The dot and vertical line depict mean and mean±standard deviation for each group. The two horizontal lines in each panel depict the normal limits (boys: 130g/L, 170g/L; girls: 120g/L, 145g/L).

Thyroid gland

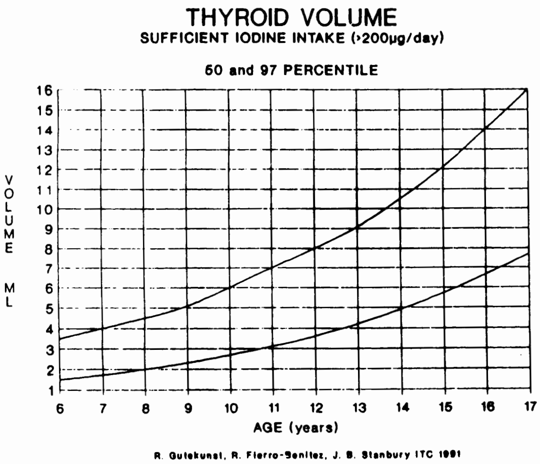
Shigenobu Nagataki

Professor, School of Medicine, Nagasaki University
(Thyroidology and endocrinology)

I was pleased to learn that the instrument we developed for atomic bomb survivors in Nagasaki was used in Mogilev when I first visited this city. I would like to heartly praise the efforts of the personnel of the five centers in accumulating so much data during the short period of 1 year, as reported in the morning session. However, I think that further discussion and investigation will be necessary before the results obtained in the Sasakawa Project can be published in other countries or presented to Prof. Tsyb and other specialists in Moscow, or to specialists in the study groups in Minsk or Kiev, as discussed just now. I believe that valuable data were obtained from about twelve thousand individuals during this year. I would like to make some suggestions for studies to be performed using these data.

First, I will talk about the final purpose of this Sasakawa Project based on our experience in Nagasaki.

In order to determine the effect of radiation on thyroid disease, it is necessary to establish an exact diagnosis in individual patients. If a solid nodule is detected in a patient, it should be determined whether the nodule is a cancerous lesion, an adenoma, or an adenomatous goiter, or else the nodule should be documented as being not yet histologically diagnosed. If hypothyroidism is found, it should be characterized as being spontaneous or iatrogenic (e.g., being caused by surgery). The presence of thyroid autoantibodies should also be examined. Furthermore, hyperthyroidism should be clearly defined and the presence of thyroid autoantibodies should be examined all patients with an enlarged thyroid. After establishing a diagnosis, individual patients should be classified into two groups, one which was free from radiation hazard and the other which was exposed to radiation. The incidence of each diagnosis should then be compared between the two groups in order to detect any differences. Therefore, to achieve the final purpose of this study, an exact diagnosis should be established in the individual children, and the incidence of each diagnosis should be compared between children living in the control regions and those exposed to radiation by the Chernobyl accident to detect any effects of radiation. Before this will be possible, there seem to be many problems that need to be solved with regard to each step of diagnosis as demonstrated in today's presentation. As one example, I would like to discuss the relationship between the age of the children in Mogilev and thyroid size. If the normal ranges employed by specialists in Moscow are applied, about 50-60% of the children in Mogilev are judged as having a large thyroid. Therefore, the first thing to be done in this study is to determine normal values for thyroid volume.



THYROID VOLUME

UPPER LIMITS OF NORMAL (ml)

WOMEN	18.0
MEN	25.0
CHILDREN	
age	
17	16.0
16	14.0
15	12.0
14	10.5
13	9.0
12	8.0
11	7.0
10	6.0
9	5.0
8	4.5
7	4.0
6	3.5

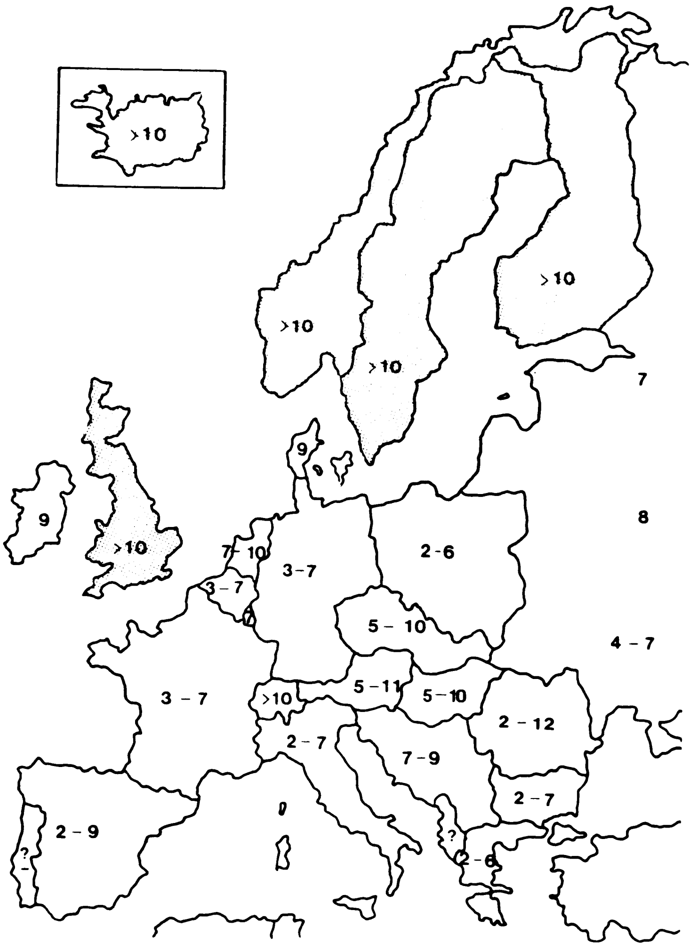
Gutekunst et al., The Hague 1991,
10th International Thyroid Congress

Figure 1.

Figure 1 shows the normal ranges currently used by specialists in Moscow, which were collaboratively established by specialists in Germany and the US to study the incidence of goiter in regions where the inhabitants have a low-iodine diet. These normal ranges were published at the meeting held in April of this year in Brussels, Belgium. The group led by Prof. Dedov of the former USSR also particpated in that meeting. The specialists from the former USSR employed these values as the normal ones at this symposium. Figure 2 shows the data on iodine intake (in terms of urinary iodine excretion) reported at that meeting. These data suggest that iodine intake may be inadequate in most regions of the former USSR. In fact, specialists in Moscow have reported that more than 60 % of the children in some regions have an enlarged thyroid gland.

Figure 3 illustrates the conventional ultrasonographic method of determining thyroid size, which is commonly used in both Germany and the USSR. With this method, the length, depth and width of the gland are measured. I think that Prof. Tsyb, Prof. Astakhova, and the doctor who asked a question a little while ago are familiar with this method.

Figure 4 shows a comparison of the rerults obtained using the instrument



Urinary iodine excretion (μg/dl)
European Journal of Internal Medicine 1992 ICC IDD : R. GUTEKUNST & F. DELANGE

Figure 2.

employed in the Sasakawa Project and the conventinal one. The values obtained using the conventional instrument are generally lower than those obtained in the Sasakawa Project, which may more closely approximate the true weight and volume of the thyroid. We would like to establish a normal ranges of thyroid volume that can be applied to the entire region of the former USSR in this project, and which could preferably also be applied to all European countries and be accepted internationally. Now, I would like to confirm that Mogilev City has been free from the effects of radiation since specialists from the Russian Federation, Belarus, and Ukraine are present here. May we regard the values of urinary iodine excretion obtained in Mogilev as normal? As stated previously, the values

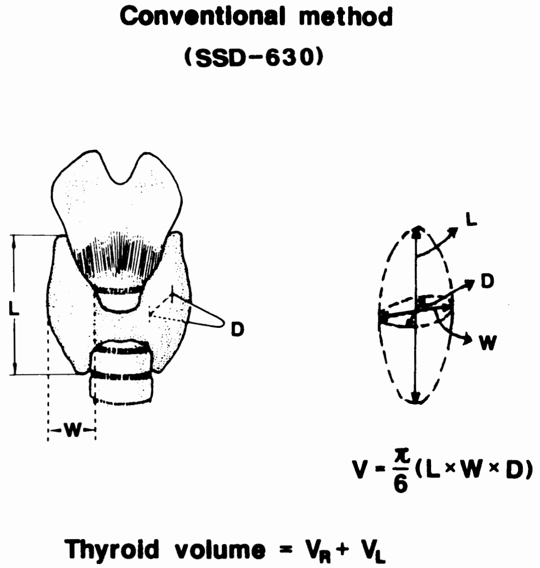


Figure 3.

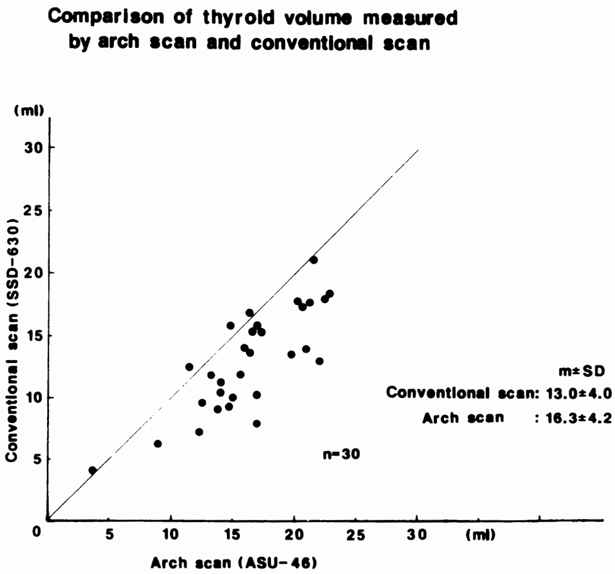


Figure 4.

obtained in this city, although from a small number of subjects, were more than 10 $\mu g/dl$. These values do not appear to suggest that Mogilev is in a region where the inhabitants suffer from iodine deficiency. We calculated normal ranges from the data obtained in children from Mogilev as a trial, although it is not clear whether the children in Mogilev can actually be used as controls. The calculated values are obviously different from those established by specialists in Germany because the thyroid weight depends on body weight in children. Now, we should calculate normal values based on the data obtained from healthy children in Mogilev and use these values to detect thyroid disease in the 3 republics of the CIS. This is only one example of the various studies that need to be performed in the future. Nodular goiter or thyroid nodules have not been reported in any subjects in Mogilev. According to the presetations, using the same ultrasonographic method, nodular goiter was not detected in any subjects in Mogilev, but was found in 6 subjects in Gomel and in Kiev the study is continuing of 47 subjects. Two and 4 cases have been reported from the other 2 centers. These nodules were only visualized by ultrasonography and their histological characterization has not been completed. We will perform histological examination on specimens obtained by aspiration biopsy from the individual patients. Then we will evaluate the imaging and histological data together and present the results in detail. Previous reports from Gomel and Minsk have made the high incidence of thyroid cancer among victims of the Chernobyl accident an international issue. Whenever the issue is referred to, however, it is pointed out that the reports only stated the number of patients and not the sample size, that is, the total number of subjects enrolled in the study. A long-term study has been planned in this Sasakawa Project, in which data may be obtained from ten thousand individuals even just in Gomel during the next 5 years. A high incidence of thyroid cancer in Gomel will be regarded as reliable by scientists throughout the world if it is supported by careful follow up of the ten thousand individuals and histological examination of all nodular lesions detected. In conclusion, I know that all persons participating in this project have made great efforts during this year, but there is still much to be done in the future. Today, they have only presented the raw data obtained during the first year of the project. Finally, I would like to make a special request. The question asked a little while ago referred to ^{131}I. Of course, ^{131}I is rapidly eliminated from the body and cannot be detected at present. But data on the ^{131}I content in the thyroid gland were obtained from tens of thousand of children immediately after the accident and are being stored in Obninsk and Kiev. To examine the thyroid glands of each of these children is the best way of studying the possible adverse effects of exposure to radiation. I therefore hope that specialists from Obninsk and Kiev may cooperate in obtaining meaningful results on this subject.

4. Comments on the Reports—Part 2

Reports and comments on the first symposium of the Chernobyl Sasakawa Health and Medical Cooperation Project

Masaharu Hoshi

Associate Professor, Research Institute for Nuclear Medicine and Biology, Hiroshima University (Radiation biophysics)

I. Introduction

The first year of the 5-year Chernobyl Sasakawa Health & Medical Cooperation Project which is being carried out by Sasakawa Memorial Health Foundation has now been completed. A symposium was held in Mogilev in order to report the results and to chart the direction of future studies. In this report, I will comment on the determination of the whole body ^{137}Cs content using a chair-type counter as reported at the symposium. The methods and results were reported in the presentations made by the five centers in the afternoon of the first day (June 2) and at the radiation dose workshop held on the second day (June 3). The results are described in the section on "Reports from the Five Centers" in this (annual) report. This report covers the discussion of detailed data which was held on the second day and my comments on the data from the five centers.

II. Radiation dose workshop

On the second day of the symposium, discussions were held by each of the workshops. The proceedings of the radiation dose workshop were as follows: 1. Reports of detailed data by the five centers and discussion of the data, 2. questions and answers, and 3. suggestions by the Japanese specialists regarding future studies.

1. First, the Mogilev Regional Medical Diagnostic Center presented data on the whole body ^{137}Cs content using histograms. The results were expressed as the mean whole body ^{137}Cs content per kg of body weight for each age group, and the histograms showed the distribution of whole body ^{137}Cs content per kg with the frequency and percentage of the subjects in each stratum. For boys, the mean values tended to increase with age increased over the range of 5 to 15 years. This trend can also be explained by the increase in the percentage of muscle, which absorbs cesium better than fat, in male adolescents. However, no definite conclu-

sion could be determined, because no such tendency was observed in the data repored from the other centers. In the data from the other 4 centers, histograms for various age groups showed no age-related differences. Since histograms may show regional differences in the radiation levels between the different districts and villages I requested that the data from each center should be separated by districts under the direction of the Mogilev center. Participants from the centers pointed out that the season when the data were obtained should be specified, because there may be seasonal changes in the whole body cesium content based on changes in the diet. The Mogilev center proposed that the untit of cesium content plotted on the abscissa of the histograms should be changed from Bq/kg to μSv. Concerning this subject, Prof. Okajima suggested that the following formula could be used to convert the current cesium content to the annual radiation dose : 500 Bq/kg=43 mrem. As the cesium content in the body can also be converted to the lifelong radiation dose, the method of conversion should be specified. I pointed out that the unit of the abscissa of the histograms, which is 50 Bq/kg is so wide that the peak level could not be precisely defined. The centers agreed to change the unit to 15 Bq/kg, but only the Mogilev center presented histograms with the new scale.

2. In the second part of the workshop, participants other than the personnel of the centers asked why only the cesium content was measured, while the iodine content (another important index) was not measured. They also asked whether adequate correction for background radiation, which varies in different regions, was made. Prof. Okajima stated that the determination of elements other than cesium was technically difficult. I answered the second question in the affirmative. A person from one center asked how to handle subjects with an especially high radioactivity level. I advised the researcher to perform further studies on soil contamination in the region where the subject lives, the land where edible strawberries and mushrooms are collected, and the food that the subject eats. Then, measures against land and food contamination were discussed, including the use of suitable cooking method such as boiling and restriction of the intake of highly contaminated food.

3. It was suggested that the relationship between soil contamination, food contamination, and the whole body ^{137}Cs content should be investigated to determine the causes of contamination and countermeasures.

This suggestion was made to clarify whether the relationship between soil contamination, food contamination, and whole body ^{137}Cs content is important for the determination of measures against contamination and for the retrospective estimation of the radiation dose immediately after the accident. This suggestion has been submitted in detail in the report on our visit to the five centers in January. The summary was translated into Russian and presented to the five centers to obtain their opinions. All of the five centers agreed to perform such an investigation, although the individual republics have somewhat different situations. The protocol for the investigation includes the following 5 points.

1) The subjects are to be residents of the regions under the jurisdiction of the five centers (initially of the Mogilev center only), and they shall be divided into the following 5 categories :

a. Control group (residents in the least contaminated village) - about 20 individuals.

b. Residents with a low whole body ^{137}Cs content - about 20 individuals.

c. Residents with a moderate whole body ^{137}Cs content - about 20 individuals.

d. Residents with a high whole body ^{137}Cs content - about 20 individuals.

e. Residents with a very high whole body ^{137}Cs content - if necessary.

2) Determination of ground surface radiation levels in the districts of residence of the subjects (using the survey meters supplied by the Foundation) :

a. Indoor

b. Uncultivated land (surface and 1 m from the surface)

c. Cultivated land (surface and 1 m from the surface)

3) Collection of earth in the districts of residence of the subjects and determination of radioactivity levels (associated with ^{137}Cs) :

a. About 200 g of soil shall be collected from each of 10 locations in the field and these samples shall be sent to Japan for the determination of radioactivity levels. If determination can be performed in Mogilev, only aliguots shall be sent to Japan and assayed for comparison. (After this proposal was made, it was unfortunately found that the Mogilev center had no appropriate instrument for the determination.)

b. Collection of soil from sites where edible mushrooms are collected.

4) Determination of the ^{137}Cs radioactivity level in the diet of the subjects :

Each subject shall be instructed to prepare the usual meals eaten in one day. These meals shall be placed into a plastic bag and sent to Japan for determination of the radioactivity level. Any mushrooms in the meals must be placed in a separate bag. (After this proposal was made, some researchers suggested that the determination should be performed in each season.)

5) Collection of tooth samples :

Teeth extracted from any subjects or their family members shall be collected and sent to Japan. Using the ESR method, the external radiation dose will be determined. Both deciduous and permanent teeth are acceptable samples. A plastic bag and a label shall be supplied to each subject, and each center shall collect tooth samples. (After this proposal was made, we were told that the health authorities of Belarus recently forbade patients to take their extracted teeth home. According to the new regulation, all extracted teeth must be sent to Obninsk via Minsk. A participant suggested the possibility that the five centers may be permitted to collect extracted teeth as a special case if they make a formal application to the Ministry of Health of Belarus.)

III. Conclusion

The data on the whole body ^{137}Cs content presented at this symposium are not precise because they have not been sufficiently reviewed. Therefore, the values may change after further review and analysis. (However, even if such changes occur, the overall trend will not be altered greatly.)

Recently, a second chair-type counter was supplied by the Foundation. This instrument is designed to be installed in a room and not in a bus. It has various advantages compared with the first counter, since it receives less background radiation and is free from vibration problems, thus providing more stable data. Since good manuals written in Japasese and Russian have been prepared, it was easy for us to explain how to operate and maintain the instrument. A drastic alteration of the software has made operation of the instrument easier and more precise. Modification of the software is now being continued to achieve further automation and precision.

In conclusion, the seminar was a great success and the active discussions held reflected the great enthusiasm of the Russian scientists. I hope that we will make the best use of the results of these discussions to obtain more substantial data.

Results of the 1-year examination of children at the five centers and commets on the results - Hematological examination

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I. On Hematological Examination

1. Introduction

Routine hematological examinations were performed for the following parameters and the results were analyzed at the five centers (Mogilev, Klincy, Gomel, Kiev, and Korosten) .

(1) Hematological parameters

The white blood cell (WBC) count, red blood cell (RBC) count, platelet count (Plts) , Hb, Hct, MCV, MCH, and MCHC were determined or calculated using Sysmex K-1000.

(2) Normal values

The normal values for adults employed in Minsk Hospital were applied. Although it is somewhat inappropriate to apply the normal values for adults to children, these were the only available reference range. We will use the hematological data obtained in this project to establish normal values for chliren in the different republics. It is certainly not valid to make comparisons based on the normal values for adults because the normal values in children change with age. In Minsk Hospital, the normal range of the MCV for adults was given as 70-95 fl, which is also somewhat questionable.

The criteria to be used for abnormal hematological values is another issue. In the first year of the project, leukopenia and leukocytosis were defined as a WBC count$\leqq 3.5\times 10^9$/L and a WBC count$\geqq 12\times 10^9$/L, respectively.

Anemia was defined as an Hb$\leqq$110 g/L. A platelet count$\leqq 100\times 10^9$/L was diagnosed as thrombocytopenia, and a platelet$\geqq 400\times 10^9$/L was diagnosed as thrombocytosis. Regarding the differential WBC count, eosinophilia was defined as an absolute eosinophil count$\geqq 500\times 10^6$/L.

(3) Analysis

Data were analyzed for each parameter by age and sex. Data for each age group were expressed as the mean$\pm$standard deviation (SD).

2. Relationship between hematological parameters and age

The subjects were boys and girls aged from 4 to 16 years. Data on 5 hematologic parameters (RBC, Hb, Hct, WBC, Plts) and 3 indices (MCV, MCH, and MCHC) were reported. Examination of the blood picture was performed using smears which were prepared on the supplied glass slides and stained by the May-Giemsa method.

A common finding in the data reported from the five centers was that hemoglobin values in boys were around the lower limit of normal at the age of 4 to 7 years and then gradually increased with their physical development. In contrast, the hemoglobin values in females remained relatively constant within the age range of 4 to 16 years. MCV showed no significant age-related changes in either sex.

There was a slight tendency towards a decrease of the WBC count in both sexes along with their increase in age. Platelet counts were initially relatively high and then decreased along with an increase in age in both sexes. All these changes were within the normal physiological ranges accepted in Russia. The changes in the hemoglobin level are thought to reflect sex-related endocrine changes. The biological significance of the changes in the WBC and platelet count needs to be clarified in the future. Similar trends were observed in the data reported from the five centers. This fact means that the precision of the determinations was well controlled and allowed the data processing to be almost standardized. Thus, the results obtained during the first year of this project suggest the possibility that normal hematological values for Russian children may be established. In the second year or later, we are planning to select healthy children living in uncontaminated districts based on the records in the questionnaires and to establish age-dependent normal hematological values for the children.

3. Relationship between internal radiation dose and hematological data in the contaminated districts

At this symposium, no definite data could be presented because insufficient time and the small number of subjects precluded adequate statistical analysis. For example, the Klincy center carried out an examination on subjects from uniformly contaminated districts and therefore was not able to investigate correlations between the degree of contamination and changes in the hematological data. This was also the case with the Mogilev center. The Kiev center tried to investigate the relatioship between the radiation dose and the hematological data. However, because the number of subjects in the high dose group was too small, the center needs to collect further data over a longer period of time to perform a valid analysis. This subject may be of great interest to the participants. At present, no conclusions can be reached because of the small number of subjects and the low reliability of the data obtained from the quentionnaires. We will continue to grapple with this subject in the furture.

4. Subjects with abnormal hematological values

The abnormal values reported are shown in the table. Anemia (0.09-0.65%), leukopenia (0.25-0.3%), and leukocytosis (1.3-3.0%) were detected at similar frequencies by the five centers. The frequency of thrombocytosis reported by the Kiev center (9.8%) was higher than at the other centers, which all ranged from 4.0 to 6.36%. It was difficult to make a valid comparison of the incidence of thrombocytopenia because it was defined as a platelet count $\leqq 100 \times 10^9/L$ at some centers and $\leqq 150 \times 10^9/L$ at other centers. Thrombocytopenia was very rare according to the former definition. Eosinophilia was detected in about 20% of the subjects at four of the five centers. Regarding the differential WBC count, the Klincy center reported atypical lymphocytes in some individuals and the Korosten center reported the incidence of monocytosis defined as an absolute monocyte count exceeding 600. We have not confirmed the cases of monocytosis reported by the Korosten center, because we have not received their blood smears.

These abnormal hematological values should be followed up because they may reflect the effects of specific pediatric diseases, such as viral infection, allergic diseases (we saw dandelion and horse chestnut seeds floating in the air at this visit), and parasitic diseases. The absence of significant differences in the incidence of abnormal values among the five centers suggests that the laboratory systems at these centers work in a similar way and have a comparable level of accuracy.

5. Subjects for future studies

As briefly mentioned in the previous section, hematological abnormalities sometimes reflect other underlying diseases, so that hematological examination is the most appropriate screening test for the diagnosis of a large number of diseases. Since children often have viral or bacterial infections, before analyzing hematological abnormalities it is also necessary to establish a system for the determination of immune function, inflammatory reactions, antiviral antibody titers, and liver function tests. We will have to discuss this subject and how to construct a network among the centers with the researchers from each center participating in this project.

II. Reports on the hematology workshop

The hematology workshop was held in the auditorium on the 13th floor of the Mogilev center on Wednesday June 3, 1992. This workshop was held (A) to make the best use of the comments and questions regarding the presentations made on day 1 of the symposium and the supplementary reports by the centers with respect to future studies in this Sasakawa Project, and (B) to have each center present problems regarding the results of the first year of the study and the subjects for future investigation, so that each one could understand the present situation of the others.

Many persons other than those directly participating in the project attended this workshop, indicating the great interest in this subject among Russian scientists. The participants from Japan were Prof. Miwa, Prof. Kuramoto, and Mr. Shimosugi, as well as those who have participated in this project from the beginning and contributed to build up the foundation (Drs. Imamura, Dohi, and Kusumi). (Interpreter : Mrs. Korchagina) .

A. The comments, questions, and supplementary reports regarding the first point are summarized below.

1. Mr. Shimosugi, Chairman of the Japanese Association of Medical Technologists made the following comments on how to control the precision of hematological examinations using Sysmex K-1000 :

1) Sysmex K-1000 is suitable for use in routine examination because of its easiness of operation and high precision.

2) Blood sampling

   A 1- to 2-ml sample should be collected in a vacutainer, which should immediately be inverted to achieve homogeneity. Caution should be exercised to ensure the correct labeling of all samples.

3) Maintenance of Sysmex K-1000

   The instrument should be washed completely before each use. Determination should not be started before all gauges point to zero.

4) Continuous 24-hour operation of the instrument is possible.

5) Standard values should be established using control blood cell (Eight Check). Attention should be paid to the expiration date of the product (about 1 month after its production), although this product does seem to retain its quality for 2-3 weeks after the expiration date. If Eight Check is not available, blood samples analyzed once should be stored and analyzed again on the following day. If no great difference is observed, the instrument can be assumed to have been sufficiently well calibrated.

6) Before analysis, blood samples should be inverted again to achieve homogeneity.

7) Samples which show a platelet count $\geqq$400,000 or a count $\leqq$100,000 and samples showing WBC count $\geqq$10,000 or a count $\leqq$2,000 should be analyzed again to confirm the abnormalities.

8) It is desirable to finish analysis of a sample within 2 hours after its collection.

Hematological examination must be performed with great accuracy and precision because it provides basic and essential data to achieve the purposes of this project. These comments prompted the center staff to see the importance of such basic procedures in a fresh light.

2. Prof. Vladimir G. Bebeshko (Director, Institute of Radiation Medicine, Ukraine) made the following comments on the presentations of five centers on the preceding day :

The data presented at this sumposium were obtained only in the spring and autumn, and no data were obtained in winter or summer. There may be a seasonal variation in hematological values. In the future, children under 4 years of age should also be enrolled in the examinations as controls. It would be desirable to perform examinations on all age groups from neonates to the elderly. Correlations between the radiation level and the hematological data should be investigated. It is also necessary to determine the ^{129}I levels with regard to thyroid disease. Among about 12,000 children who underwent examination during the last year, only a few showed abnormal hematological values. In particular, the incidence of anemia was low. Eosinophilia may occur in association with allergic or parasitic diseases, as well as due to toxoplasmosis.

3. Prof. Eugene Ivanov (Director, Research Institute of Hematology and Blood Transfusion, Belarus) made the following comments :

It has been of great concern to us to determine whether the incidence of leukemia increased after the Chernobyl accident. It seems to be very difficult to answer this question, however, because no epidemiological studies were conducted before 1986. After the accident, it became possible to register patients with hematolopoietic malignancy in the entire region of Belarus and the numbers of children and adults with these diseases as well as with hypoplastic anemia became clear. Accoring to the register, the number of patients with acute leukemia has only changed slightly during recent years. However, it should be noted that the number of patients with chronic myeloid leukemia and chronic lymphocytic leukemia began to increase from about 1988 and has since nearly doubled. The number of patients with hypoplastic anemia and multiple myeloma has also been increasing since 1988. From the answers given to the questions during the symposium, these data presented at this symposium appear to be more reliable than those reported previously with regard to the diagnosis and registration procedures. Future studies seem necessary to clarify multiple aspects of the effects of the accident on hematopoietic diseases.

4. Prof. Leonid P. Titov (Associate Professor, Immunological Department, Minsk Research Institute, Belarus) made the following comments :

Examination of the immune function of about 17,000 children revealed transient abnormalities of immunocompetent cells which normalized after 6 months. These immunological surveys have continued. Furture studies should focus on the relationship between the radiation dose to the thyroid and lymphocyte function, as well as on that between autoantibodies and immunoglobulins.

5. Prof. Igor V. Osechinsky (Chief of Department of Hematology Research Center, Russian Federation) made the following comments :

The subjects being studied in this project are aged from 5 to 15 years. In the future, the age range of the subjects should be widened. Immediately after the accident, about 60,000 children underwent determination of the radiation dose to the thyroid and other examinations. About 30,000-40,000 of these children would now be older than 15 years, and thus will not be enrolled in this project if the age range is not widened. As a result, it will be impossible for us to make use of the data obtained immediately after the accident. The cooperation of all parties should be requested to combine all data accumulated in this country with the data obtained in this projcect.

As is done in the Russian Federation, freezing and storage of residual serum samples after examination should also be recommended for this project.

In this manner, famous specialists and experts from each state made their comments on the presentations or presented preliminary original data as well as problems, requests, and suggentions for future studies. These suggestions should prove very helpful for carrying out the hematological examinations in the second year of the study.

B. Concerning the second point, it was mentioned at the symposium that some subjects showed qualitative abnormalities of leukocytes. Blood smears of these subjects were submitted by each center and reviewed. Examination of the smears generally showed atypical lymphocytes suggestive of viral infection, which is a transient finding peculiar to children. Examination of the blood smears also confirmed the presence of thrombocytosis and eosinophilia, which were reported at a high incidence by each center.

The Japanese specialists suggested that periodic follow-up should be made with respect to such quantitative and qualitative abnormalities, and the centers agreed with this idea.

The following hospitals were cofirmed as being the institutions to which patients with severe hematological disease are to be referred.

Mogilev……Research Institute of Radiation Medicine,

Gomel……Hospital of Gomel Regional Research Institute of Radiation Science

Klincy……Bryansk Children's Hospital

Kiev……Kiev Regional Hospital

Korosten……Zhitomir Regional Hospital

The five centers unanimously proposed to examine the immune function of the subjects in the future, and to prepare for such immunological examinations. The major aim of the examination will be to analyze lymphocyte subsets. Immunological studies were requested by many specialists in their comments, and these studies are important for understanding multiple aspects of the effects of radiation and the related hematological abnormalites. In the second year, the Chernobyl Sasakawa Project is planning to introduce instruments for the analysis of lymphocyte subsets (e. g., FACS scanners) at each center.

Center Cases	KLINCY 1544 (%)	MOGILEV 3427	GOMEL 3798	KIEV 1548	KOROSTEN 1977
Anemia ($Hb<110g/L$)	4(0.25)	3(0.09)	12(0.32)	10(0.65)	
Leukopenia ($WBC<3.5\times10^9/L$)	4(0.25)	10(0.29)	11(0.29)	4(0.26)	6(0.3)
Leukocytosis ($WBC<12.0\times10^9/L$)	21(1.3)	72(2.1)	101(2.66)	47(3.0)	46(2.33)
Thrombocytosis ($PLT>400\times10^9/L$)	62(4.0)	218(6.36)	210(5.54)	152(9.8)	95(4.81)
Thrombocytopenia ($PLT<100\times10^9/L$)	1(0.06)	3(0.09)	($<150\times10^9/L$) 37(0.97)	($<150\times10^9/L$) 2(0.1)	
Eosinophilia ($E>0.5\times10^9/L$)	359(23.2)	658(19.2)		356(23.0)	408(20.64)
Atypical Lymphocyte	38(2.46)				Basophilia ($>0.125\times10^9/L$)
Ly with basophilic cytoplasm	4(0.25)				158(7.99)
Monocyte with basophilic cytoplasm	5(0.32)				Monocytosis ($M>0.6\times10^9/L$)
Prolymphocyte	44(2.84)				239(12.09)
others		3(0.09)			Lymphocytosis 57(2.9)

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Comments on thyroid-related examinations and the data presented at the symposium

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I. Examination of the thyroid

Training of the staff to make them familiar with the new instruments was started in May 1991 in Obninsk. Thanks to the eagerness and the good efforts of the training staff, many difficulties were overcome. As soon as the new mobile units were transported to the five centers, examination was started at each base center.

The training for thyroid-related examinations covered : (1) how to operate ultrasonographic instruments for the diagnosis of thyroid disease and for measuring thyroid volume, (2) how to operate an Amerlite TM analyzer for the determination of blood TSH and free T4 levels, and (3) how to determine blood levels of anti-thyroid autoantibodies (anti-microsome antibody and anti-thyroglobulin antibody). At the beginning of the training, how to handle the accessory equipment was also explained.

The initial purpose of the training was to acquire a series of procedures for examination, data recording, storage, and analysis using the arch automatic scanning method for imaging diagnosis of the thyroid. At many centers, examinations were started in the middle of May. An ultrasonographic instrument was installed in the rear of a bus and carefully connected to the accessory equipment. The instrument survived several difficulties and worked for 1 year without any serious trouble. On a single floppy disk (2.5 inch), data from two subjects (24 images) were stored. The data were evaluated to determine the adequacy of the recording and the correctness of diagnosis, and then were used to calculate the thyroid volume according to the specified formula. The individual components used for the data input, output, analysis, and storage are small and portable. These components are stored in duralmin cases and are protected very carefully from theft at each center. As the subjects are children aged 5-15 years, the water bath for the arch probe used is tailored for children. Twelve scans (6 cm long) are recorded at 5-mm intervals for each subjects and the data are stored. During the initial phase of these examinations, the staff was trained to achieve adequate fine control for obtaining good imaging and to detect lesions by proper interpretation of the thyroid images. As the initial period involved learning by trial and error, it cannot be said that all the data they obtained were correct. Therefore, these data have been reviewed by the staff and the Japasese specialists to provide feedback for the subsequent examinations. In particular, much of the data obtained during the initial phase of the examination could not be interpreted. However, the data on the thyroid volume of each age group that were finally presented at this symposium have been made reliable by the staff members.

To determine thyroid hormone levels, Amerlite automatic analyzers were planned to be installed at each center, but the instruments were actually received by the centers after July. As a result, training on how to use them was performed at individual centers. We asked engineers from AmerCard in Moscow to initially run the instrunents. Our guidance in Kiev, Korosten, Gomel and Mogilev emphasized the importance of accurate pipetting and sufficient care to prevent the mixing up of samples or addition of reagents in the wrong order. We instructed the staff to analyze all samples in duplicate, but at all the centers each sample was analyzed only once. This should be noted as a possible cause of great variability when interpreting the data. Quality control should be performed by using duplicate assays as well as blind controls. It was to be regretted that each center did not establish standard procedures for the supply, transportation, and storage of reagents, or specify that they be used before the expiry date. In the second year of the project, the route for supply of the reagents will be prescribed and materials will be maintained properly. Serum samples should be labeled carefully to distinguish them and should be stored in a refrigerator in good order. By preparing a register, the samples can then be made ready for re-examination.

Blood thyroid autoantibody levels were determined using a kit manufactured by Fuji Rebio Inc. The laboratory technicians in charge mastered the complete procedure and reading of the titers. Therefore, the data (titer values) presented and quality control checks performed using negative and positive controls generally seem to be reliable.

II. Symposium

The results of the 1-year examination using the program prepared by the Mogilev Regional Medical Diagnostic Center were successfully presented by each of the five centers owing to the great efforts of the staff at each of these centers. Thus, we finally managed to hold this symposium 1 year after the start of the Sasakawa Project. The symposium was a great success partly due to the presence of skillful interpreters, who facilitated the exchange of comments, questions, and answers concerning the data presented. This symposium shed light on various problems with the examination methods and the individual data. It also provided good guidance regarding what has to be done and how to perform future examinations. The importance of establishing normal values for the thyroid volume in each age group was recognized again. Each center assessed the presence of goiter based on standard values determined by conventional methods. This approach is actually quite meaningless, and it is of urgent necessity to establish normal values using the arch scanning method. For this purpose, the thyroid volumes of children living in Mogilev City, an uncontaminated region, can be used as a control for the children exposed to radiation. At present, we are reviewing the data to prepare the normal ranges of thyroid volume with stratification for age, sex, height, and weight. Each center will be able to use these normal ranges at the presentations made next year. Careful overall evaluation of a subject is necessary to obtain the exact incidence of thyroid disease, and a diagnosis of thyroid disease cannot be established based on a single abnormal laboratory value. In addition, as the results presented at the symposium are based on only imaging and not on histological findings, the incidence of nodular lesions cannot be exactly determined. However, it should be noted that male cases of abnormal ultrasonographic findings were reported by the Gomel center at the thyroid workshop. Therefore, further investigation of this issue is required.

Regarding the data on free T4 and TSH levels reported by each center, the extent of the error attributable to the variability caused by using single assays is unknown. Although the upper normal limit for TSH is set at 2.9 μU/ml, values 3-5 μU/ml or even up to 10 μU/ml may possibly be thought to be normal because of variations in the assay. In addition, there was no significant inverse relationship between free T4 and TSH levels, suggesting that such variations should be considered when interpreting the individual data. Several subjects with free T4 levels of around 2.9 pmol/L had no hyperthyroidism, suggesting that a correct diagnosis could not be made based on the data provided. Quality control should be strengthened to increase the precision of the assays performed. However, relatively accurate data was obtained on the thyroid autoantibody titers. The Gomel and Klincy centers reported a high incidence of subjects with positive titers and the levels of these titers indicated the need for a complete medical checkup. In the future, a correct diagnosis will be made from a synthesis of all the relevant data.

In consideration of the above-mentioned problems, the presentation on the thyroid-related studies can be assessed as follows :

(1) Remarkable progress was made in improving the know-how and skills of the staff members participating in this project. Their eagerness to learn and efforts are admirable.

(2) The data collected in the first year is thought to have contributed to elevation of the level of medical services at each center, although the contribution cannot

be evaluated according to uniform criteria because the five centers differ with regard to various circumstances.

(3) The presentations related to the thyroid at this symposium are highly appreciated as they suggested some useful trends, although more strict quality control is required in the future.

(4) It seems worthwhile to prepare a paper from a pure scientific point of view by reviewing the data on thyroid function as well as radiation dose and hematology. For this purpose, job assignments and contract relatioships (intellectual property rights, etc.) should be clarified.

(5) Reviewing the actual circumstances and support systems of the five centers, it seems appropriate for the Mogilev center to act as the leader of the thyroid examination activity, including data collection and storage. Analysis of the thyroid-related data was also performed primarily by the staff of this center. In the uncontaminated region of Mogilev and its vicinity, the incidence of thyroid diseases in children is comparable to that in Japan. At the Mogilev center, various examinations are systematically and precisely performed by the skillfull physicians and the medical and radiology technicians.

(6) The number of subjects (4,956) who underwent the examination at the Gomel center suggest the great efforts made by the staff there, but more adequate statistical analysis and data presentation are required in the future. However, it is a very significant finding that the incidence of thyroid disorders was higher there than in the other regions. This center should recruit doctors who are specialists in thyroidology. It is necessary to make a correct diagnosis and to collect accurate data for assessment of the relationship between thyroid disorders and the radiation dose. Japanese specialists should visit Gomel again in the near future to check the data in detail.

(7) The data presented by the Klincy center owe much to a personal effort. The exact frequency of subjects positive for thyroid autoantibody should be calculated, and a more complete diagnosis should be made. In the future, the Klincy center should reconsider its cooperation with the other institutions. The present staff members are satisfactory, but it would be desirable to perform examinations by a more systematized and specialized job assignment system. The presentation from the Klincy center appeared very reliable and provided very accurate data despite the small number of subjects. To allow examinations to be performed in winter, a garage with a heating system has been completed.

(8) The Kiev center has the greatest problems in many respects, and may have additional problems in the future. The current presentation suggested that this center does not allow their staff members to concentrate exclusively on the Chernobyl Sasakawa Health and Medical Cooperation Project, as it handles this project in juxtaposition with other projects. No scientific basis was provided for

the statement "most of the subjects had thyroids exposed to high radiation doses". The center has not performed reexamination of the 47 subjects with abnormal thyroid ultrasonographic findings or determination of thyroid antibody titers. It would be desirable to establish a system for more complete diagnosis using modalities other than imaging and to train specialized technicians. It is also necessary to establish an institutional support system which assists proper information management and the final diagnosis of thyroid disorders, including data storage and control of the precision of the data.

(9) The Korosten center, like the Klincy center, is expected to achieve great results in the future. As Korosten is included in a region characterized by iodine-deficiency and thyroid enlargement, much caution needs to be exercised when making a diagnosis of thyroid disease. I felt that this center is steadily achieving good results and I experienced the untiy of the staff members in their attitude at the symposium. The imaging diagnosis data obtained at this center were very good. However, it is necessary to re-examine the subjects with thyroid hypoplasia.

With the above comments on the presentations from each center, the preliminary results and the subjects for study in the second year can be summarized. It is hoped that close cooperation and frequent information exchange between the Japenese specialists supporting this project and the staff members engaged in the actual examination activity will make the data obtained more substantial and improve the local medical services.

Improving the quality of data and statistical analysis

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I. Introduction

More than 13,000 children were examined at the five centers during the past year and the smallest number of children examined at any one center was about 1,500. With the introduction of new instruments, the number of subjects is expected to double, and the cumulative number of subjects monitored by each center during the five-year period will likely exceed 20,000.

Because a wide variety of data must be obtained from each subject, an enormous amount of information has to be stored and analyzed each year at all of the centers.

No matter how much data is collected and however excellent are the statistical methods, the data cannot be regarded as reliable if its precision is low. On the other hand, even if the precision of the data is high, its meaning cannot be accurately understood if the statistical methods used are inappropriate.

Good quality control of the data and appropriate statistical analysis are thus the two watchwords of this project.

II. Data quality control

Quality control of the data means designing and executing measures to obtain correct and unbiased data. As the first step, causes of errors or biases should be clarified and their elimination attempted.

Medical examinations consist of the following three steps: (1) interview, (2) physical examination, and (3) input of the data obtained by interview and examination. Errors or biases may occur during each of these steps, but the greatest attention must be paid throughout to prevent specimens of one subject from being mistaken for those of another subject. In particular, individual children should be carefully identified at each step of the interview and examination. General precautions to be applied to these three steps are as follows:

(1) Interview: Answers may vary if a question is expressed in different ways. It is thus desirable to use a uniform format for questions.

(2) Examination: Each examination should be performed according to standard procedures. A checklist can be used to confirm that the procedures are being followed.

(3) Data input: Input errors are generally checked by the double input method or by collation. After confirming that data have been computerized without errors, the data should be checked. This check is a so-called logical check, where data are checked for unallowable values (e.g., values other than 1 to 12 for the months of the year) and then for inconsistency between items. This logical check can also be performed at the input step, but it then requires more time for data examination. It is more efficient to perform the logical check after checking for input errors.

III. Statistical analysis

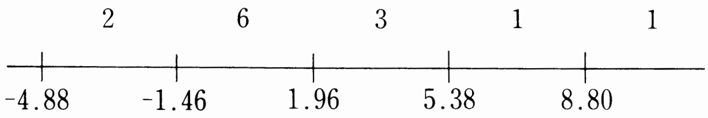
Summarization of data is a basic part of statistical analysis. In summarization, caution should be taken to minimize information loss. If observations are normally distributed, the data can be summarized by using mean and variance (standard deviation). In other words, the information can be comprehensively represented by these two statistics. However, body weight, radiation dose, thyroid volume, thyroid hormone level and other quantities usually follow distributions that are far from the normal distribution. If such data are summarized into the above two statistics, a large loss of information is inevitable.

Data are often summarized as mean$\pm$standard deviation, but this is suitable only for populations which are assumed to be (approximately) normally distributed. (The expression mean$\pm$standard error involves the estimate of the population mean and its precision, and is thus suitable regardless of population distribution if data size is large. This is because the sample mean appears to be approximately normally distributed according to the central limit theorem.) If a population distribution is asymmetric or has long tails, or if outliers are included in the data, it is not recommended to routinely calculate the mean and standard deviation or to summarize the data as mean$\pm$standard deviation. The form of the distribution and the presence of outliers should be examined using box-and-whisker plots, Q-Q plots and others.

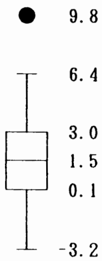
As an example, consider a set of the following 13 values.

$$-3.2,\ -1.7,\ -0.4,\ 0.1,\ 0.3,\ 1.2,\ 1.5,\ 1.8,\ 2.4,\ 3.0,\ 4.3,\ 6.4,\ 9.8$$

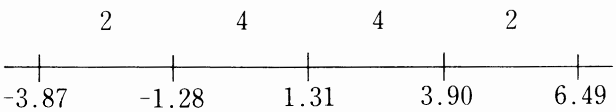
The mean and standard deviation (SD) are 1.96 and 3.42, respectively. Around the mean graduations are made at intervals of 1 SD. The 13 values are classified into the following 5 groups.



This figure shows that the distribution of the 13 values is asymmetric around the mean. The box-and-whisker plot of the data is shown below.



In this box-and-whisker plot, 1.5 represents the median, and 0.1 and 3.0 represent the 25th and 75th percentiles, respecitively. This plot suggests that the value 9.8 may be an outlier. However, if this value is to be excluded from the analysis, the rationale for doing so needs to be specified. If there is no such rationale, robust estimates such as the median should be used instead of the mean. If the value 9.8 is excluded, the mean and the standard deviation are 1.31 and 2.59, respectively. The remaining 12 values are almost symmetrically distributed around the mean.



Figures and graphs can convey a mass of information at a glance and are very useful if drawn properly. The reports from the individual centers made abundant use of figures and graphs, many of which were taken directly from the manuscripts presented at the symposium. While appealing to the eye, however, these tools run a high risk of data misinterpretation (Darrell Huff. *How to lie with statistics.* New York: W. W. Norton & Company Inc., 1954).

Two points should always be followed when preparing figures or graphs. One is to select an appropriate scale. In several cases, scales such as a log scale are more useful than the usual linear scale. The other point is not to use multiple scales in a series of figures or graphs. For example, the use of multiple age scales in the histograms by sex and age of whole body ^{137}Cs count and in the scatter diagrams of free T_4 and TSH levels precludes the comparison of data among age groups and may be misleading.

It is also desirable to arrange data using cross tabulation in addition to graphical representation. The following table is a part of the cross tabulation corresponding to Figure 1 in the reports of the Mogilev Center. It is desirable to make the best use of the characteristics of these methods.

Classification of subjects by whole body Cs-137 count per body weight (Bq/Kg), sex and age.

Age [a]	Sex [b]	Whole body Cs-137 count per body weight (Bq/Kg)							Total
		0–50	50–100	100–200	200–300	300–400	400–500	500–	
5	B	167(81.5)[c]	35(17.1)	3(1.5)	0	0	0	0	205
	G	153(81.0)	26(13.8)	9(4.8)	0	1(0.5)	0	0	189
	T	320(81.2)	61(15.5)	12(3.0)	0	1(0.3)	0	0	394
6	B	187(85.0)	26(11.8)	6(2.7)	0	1(0.5)	0	0	220
	G	177(88.1)	20(10.0)	4(2.0)	0	0	0	0	201
	T	364(86.5)	46(10.9)	10(2.4)	0	1(0.2)	0	0	421
14	B	103(89.6)	9(7.8)	2(1.7)	0	0	0	1(0.9)	115
	G	117(92.9)	8(6.3)	1(0.8)	0	0	0	0	126
	T	220(91.3)	17(7.1)	3(1.2)	0	0	0	1(0.4)	241
15	B	36(90.0)	2(5.0)	0	1(2.5)	0	0	1(2.5)	40
	G	63(92.6)	4(5.9)	1(1.5)	0	0	0	0	68
	T	99(91.7)	6(5.6)	1(0.9)	1(0.9)	0	0	1(0.9)	108

a. In years.
b. B, G and T stand for boys, girls and total of boys and girls, respectively.
c. Parenthetic entries refer to the percentage of the subjects.

IV. Conclusion

It is gratifying indeed that the results of data analysis obtained during the first year of this project exceeded our initial expectations. I would like to express my appreciation for the great efforts of those engaged in data analysis at the five centers, especially the staff members in the Computer Section, Mogilev Regional Medical Diagnostic Center. I hope that all the staff members will continue their efforts to enhance quality control of data and to conduct excellent statistical analyses.

Appendix

Appendix(1) Centers : Address and list of staff

1. Mogilev Regional Medical Diagnostic Center

Pervomayskaya 59, Mogilev,
Belarus, 212030
Tel : 0222-22-4745 Fax : 0222-22-2997
Head Docter/Dr. T. A. Krupnik

Doctor	: Yuryeva Baranova Duplevsky Kobzova Rafienko Lizikov	Engineer/ Laboratory technician	: Dolbeshikin Yermochenko Tolsryakova Danilchik Gaiduk Kovalev Gomanova
Nurse	: Nikitina Lobaryova Babrikina Tishkova Kopilova Monokova		

2. Gomel Regional Specialized Prophylactic Center

Bratyev Lizyukovich 5, Gomel,
Belarus, 246029
Tel : 0232-48-71-20 Fax : 0232-53-1903
Head Doctor/Dr. V. E. Derzhitsky

Doctor	: Kazakevich Demidenko Ermolitsky Derzhiskaya Kotsur	Engineer/ Laboratory technician	: Tryoyanovsky Leonovich Anikina
Nurse	: Zhoglo Troyanovskaya Lemesh	Driver	: Gorlenko

3. Children City Hospital

Sverdlovskaya 76, Klincy, Bryansk area,
Russian Federation, 243100
Tel : 08336-2-0454 Fax : 08336-2-2411
Head Docter/Dr. A. A. Averichev

Doctor	: Karevskaya Steputin	Enginner/ Laboratory technician	: Aksyonov Kovalev
Nurse	: Ushakova Troyanova Ashitok	Driver	: Sarkisov Burlakov Borisovich

4. Kiev Regional Diagnostic Center

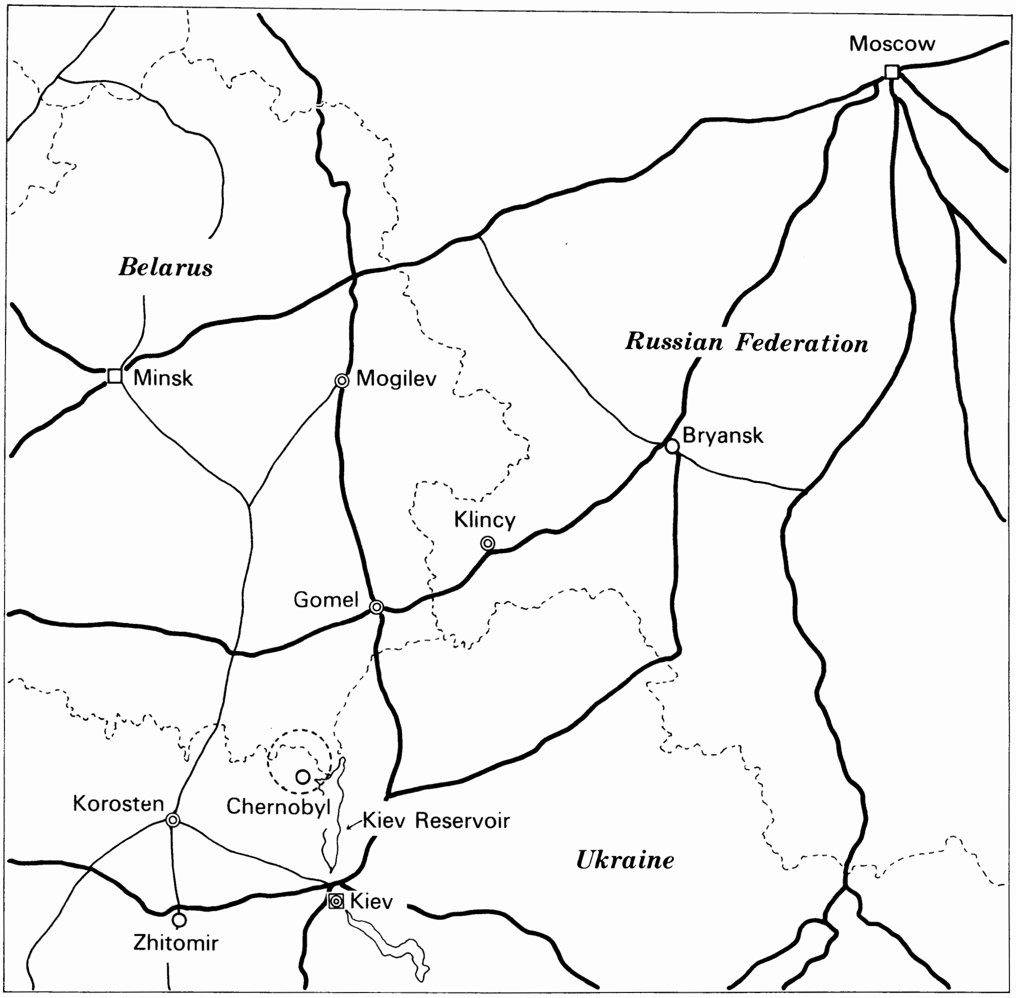
Marshala Budenogo 1, Kie, Ukraine, 254107
Tel : 044-2130576
Deputy Head Doctor : Dr. V. S. Shvetzov

Doctor	: Shvetsov Grinko Nedozhdy Klevik Krivyakova Vidiborets Tkachuk	Enginner/ Laboratory technician	: Kochubey Nakonechny Linnik
Laboratory Assistant	: Dzigar Rumyantseva Karagamova Koziychuk Shmigun	Driver	: Krotov Yashuk

5. District Diagnostic Center

Kievskaya 21b, Korosten, Zhitomir area, Ukraine, 260100
Tel : 04142-3-2001 Fax : 04142-3-0459
Head Docter/Dr. V. V. Danyljuk

Doctor	: Danilyk Petrova Saiko	Enginner/ Laboratory technician	: Goncharenko
Nurse	: Harchenko Korzun Krisan		



◎ Location of Center for Chernobyl-Sasakawa Project

□ Capital

Appendix(2) Symposium : Program

「Chernobyl Sasakawa Medical Symposium」

Theme : 「Chernobyl Sasakawa Health and Medical Cooperation Project …To review the first year progress of scientific aspects in the health screeinig of children」

Date : June 1 (Mon) -June 3 (Wed), 1992
(Training June 4-June 5)

Venue : Palace of Justice
Mogilev Regional Medical Diagnostic Center
Mogilev, Belarus

Sponsored by : Mogilev Regional Medical Diagnostic Center
Sasakawa Memorial Health Foundation

Supported by : The Ministry of Health of Belarus
The Ministry of Helath of Ukraine
The Ministry of Health of Russian Federation

PROGRAM

Jund 2 (**Tuesday**)

9 : 30 Opening Address (at Palace of Justice)
Greeting by Yohei Sasaka (President of Sasakawa Foundation)
Greeting by Ivan A. Kenik (Deputy Minister of Health of Belarus
and others

10 : 00
I Introduction of the Project by Dr. Itsuzo Shigematsu

10 : 15-10 : 30 Intermission

10 : 30-13 : 30
II Reports from 5 Centers
(Chairpersons Japan : Kenzo Kiikuni
CIS : Vasily S. Kazakov／Minister of Health

Gomel	(Reporter V.S. Samoilenko)
Kiev	(Reporter V.S. Shvesov)
Klincy	(Reporter I.V. Karevskaya)
Korosten	(Reporter V.V. Daniluk)
Mogilev	(Reporter N.D. Yurieva)

13 : 30-15 : 00 Lunch

15 : 00-18 : 00
III Experts Comments on the reports from 5 Centers

①Dosimetry	S. OKajima
②Thyroidology	S. Nagataki
③Hematology	A. Kuramoto
	S. Miwa

June 3 (Wednsday)

9:00-12:30

IV Small grop session

①Dosimetry (Chaired by M. Hoshi)

②Thyroidology (Chaired by S. Yamashita)

③Hematology (Chaired by K. Fujimura)

12:30-14:00 Lunch

14:00-18:00

V Small group session (Cont'd)

①Dosimetry (Chaired by M. Hoshi)

②Thyroidology (Chaired by S. Yamashita)

③Hematology (Chaired by K. Fujimura)

June 4 (Thursday)

9:00-12:30

VI Small group session (Chaired by Y. Shibata)

①Revited questionnaire

②Sampling of the subjects

③Data recording

12:30-14:00 Lunch

14:00-18:00

Trainig of newly provided instruments

①Whole body counter

②Ultrasound thyroid diagnostic system

③Urinary iodine analyzer

④Automated hemato stainer

June 5 (Friday)

9:00-13:00 Training

14:00- Luncheon

Participants

A. Staff engaged in screening activities

Mogilev

Tadeush A. Krupnik	Head Doctor
Nikolai K. Dolbeshkin	Deputy Head Doctor
Sergei A. Danilchik	Chief of Technical Department
Natalya D. Yuryeva	Dhief of mobile team
Svetlana M. Rafeenko	Endocrinologist
Vladimir R. Lyzikov	US diagnostician, doctorr
Ella A. Baranova	Pediatrician
Tamara I. Kopylova	Registrar
Svetlana M. Lobareva	Nurse
Vladimir N. ermachenko	Dosimetrist, driver
Nina G. Nikitina	Nurse
Anjela S. Kuzina	Registrar
Valentina K. Miramkova	Registrar

Gomel

Victor Ye. Derzhitsky	Head doctor
Valery A. Samoilenko	Deputy head doctor, dispensary
Nikolai M. Yermolitski	US specialist, doctor
Yelena V. Derzhitskaya	Laboratory assistand, doctor
Nelly K. Derzhitskaya	Laboratory assistand, doctor
Inna V. Anikina	Programmer
Kozur	US diagnostician
Zhoglo	Dosimetrist
Kazachenko	

Klincy

Irina V. Karevskaya	Hematologist
Leonid A. Steputin	US diagnostician, doctor
Andrei I. Kovalev	Registrar
Sergei A. Sarkissov	Driver
Alexander S. Aksyonov	WBC operator

Kiev

Vadim S. Shvetsov	Deputy head doctor, regional hospital
Sergei S. Kochubey Engineer	
Vadim I Grinko	Hematologist
Stanislav V. Vydyborets	Endocrinologist
Yelena V. Krivyakova	Dosimetrist
Sergei I. Yashchuk	driver

Korosten

Alexei S. Saiko	Chief of department
Anjela A. Petrova	Head of laboratory
Igor N. Sokolovsky	Engineer
A. N. Detkovsky	Driver

B. Participants from Belarus

Ivan A. Kenik	Vice Chairman of the Council of Ministers, Chairman of "Goskomchernobyl" Committee
Vasily S. Kazakov	Minister of Health
Vladimir A. Matyukhin	Director, Research Institute of Radiation Medicine
Yevgeny P. Ivanov	Director, Research Institute of Hematology and Blood Transfusion
Anatoly K. Ustinovich	Director, Research Institute of Maternity and Children Protection
Gennady I. Lazyuk	Director, Reserch Institute oe Maternity and Children Protection
Yevgeny A. Korotkevich	Director, Research Institute of Oncology and Medicine Radiology
Yavgeny P. Demidchik	Professor, Head of Oncology Chair, Medical Institute
Zinaida A. Sevkovskaya	Deputy Chief of Childhood and Obsteric Aid Department
Larissa N. Astakhova	Deputy Director, Research Institute of Radiation Medicine
Sergei S. Karytko	Head Doctor of Clinic, Research Institute of Radiation Medicine
Valery A. Rzheutsky	Head Docter of Polyclinic, Research Insti-

	tute of Radiation Medicine
Victor F. Minenko	Chief of Laboratory, Dosimetry and Radiation Situation Estimation
Olga V. Aleinikova	Chief children's hematologist, Ministry of Health
Klaudia A. Radyuk	Chief children's endocrinologist, Ministry of Health
Yelena A. Khomedova	Chief endocrinologist, Ministry of Health
Valentin A. Steshko	Chief of Department, Ministry of Health Boris D. Shitikov Chief of Department, Science Managing, Ministry of Health
Sergei V. Zhavoronok	Professor, Director, Branch of Research Institute of Radiation Medicine, Vitebsk-city
Vladimir N. Matveenko	Acting Deputy Director, Science, Medical Radiology Institute, Vitebsk-city
Victor N. Buryak	Vice Chairman of "Goskomchernobyl" Committee
Leonid P. Titov	Associate Professor, Minsk Research Institute, Immunology Department

C. Participants from Russian Federation

Nikolai N. Vaganov	Vice Minister of Health
Boris B. Spassky	Chief Expert of Radiation Medicine Department Ministry of Health
Anatoly F. Tsyb	Chief Adviser for President of Russia on Radiation Problems, Academician, Director of Research Institute of Radiation Medicine
Victor K. Ivanov	Cor. Member, Chief of Department, Research Institute of Radiation Medicine
Igor V. Osechinsky	Chief of Department, Hematology Research Centre
Larissa S. Baleva	Chief pediatrist of Russia
Alexandr G. Rumyantsev	Chief children's hematologist
Ivan I. Dedov	Director, Institute of Endocrinology
Vladimir D. Prokopenko	Head Doctor of Clinic, Institute of Immunology
Ludmila V. Luss	Chief of Department, Institute of Im-

	munology
Mikhail F. Logachev	Chief children's endocrinologist

D. Participants from Ukraine

Olga A. Bobyleva	Cheif of Republican Department, Medical Problems caused by the Chernobyl Accident
Yelena I. Bomko	Chief Expert of Republican Department, Medical Problems caused by the Chernobyl Accident
Vladimir G. Bebeshko	Director, Institute of Radiation Medicine
Valery P. Tereshchenko	Director, Institutte of Endocrinology
Yevgeny V. Epshtein	Chief of Radioimmunology Laboratory, Institute of Endocrinology
Yelena V. Bolshova	Chief children's endocrinologist of Ukraine
Vera D. Drozdova	Chief hematologist of Ukraine
Vladimir N. Buchaev	Cheif of Special Code Registers, Ukranian Scientific Centre of Radiation Medicine (USCRM)
Victor S. Repin	Research Assistant, Dosimetry Department of USCRM
Yevgenia I. Stepanova	Chief of Department, USCRM
Vladimir v. Bragin	Chief of Regional Health Department Zhitomir-city
Boris A. Ledoshchuk	Chief of Code Registers Department, USCRM
Gennady I. Kartushkin	Deputy Chief of Regional Health Department, Kiev-city
Tamara P. Sivachenko	Chief of Laboratoty, Kiev Advanced Medical Institute

E. Participants form Japan

1. Mr. Yohei Sasakawa
   President
   Sasakawa Foundation
2. Dr. Itsuzo Shigematsu

Chairman, Radiation Effects Research Foundation

3. Dr. Teruhiko Saburi
   Chairman, Japan foundation for Aging and Health
4. Prof. Shunzo Okajima
   Professor Emeritus
   Nagasaki University, School of Medicine
5. Dr. Shiro Miwa
   Director, Okinaka Memorial Institute for Medical Research
6. Prof. Atsushi Kuramoto
   Director General and Professor of Internal Meicine
   Research Institute for Nuclear Medicine and Biology
   Hiroshima University
7. Prof. Shigenobu Nagataki
   Profssor of Internal Medicine I,
   Nagasaki University, School of Medicine
8. Mr. Tetsuo Sato
   President, The Japan-Russia Trade Association
9. Prof. Kenzo Kiikuni
   Professor, Institute of Community Medicine, The University of Tsukuba
10. Dr. Kingo Fujimura
    Associate Professor of Internal Medicine
    Research Institute for Nuclear Medicine and Biology
    Hiroshima University
11. Dr. Masaharu Hoshi
    Associate Professor
    Scientific Material Center for Nuclear Disasters
    Research Institute for Nuclear Medicine and Biology
    Hiroshima University
12. Dr. Nobutaka Imamura
    Internal Medicine Department
    Research Institute for Nuclear Medicine and Biology
    Hiroshima University
13. Prof. Shunichi Yamashita
    Professor of Atomic Disease Institute
    Nagasaki University, School of Medicine
14. Dr. Hiroyuki Nanba
    Atomic Disease Institute
    Nagasaki University, School of Medicine
15. Dr. Naokata Yokoyama
    Internal Medicine I

Nagasaki University, School of Medicine

16. Dr. Toshihiro Takatuji
    Nagasaki University Radioisotope Center
17. Dr. Yoshisada Shibata
    Chief, Dept. of Epidemiology & Biometrics
    Radiation Efects Research Foundation (Nagasaki)
18. Dr. (Mrs.) Shizuyo Kuzumi
    Internal Medicine Department
    Radiation Effects Research Foundation
19. Dr. Hiroo Doi
    4th Internal Medicine Department
    Hiroshima Red Cross Hospital and Atomic Bomb Survivors Hospital
20. Mr. Akio Shimosugi
    President, Japanese Association of Medical Technologists
21. Mr. Takeshi Iseki
    Managing Director, The Japan Association of Radiological Tchnologists

F. Observer

Vladimir M. Volodin	Medical Officer, Radiation Medicine, Division of Noncommunicable Diseases and Health Technology

40 representations from the government of Mogilev oblast

18 representatigves from the Health Bureau of Mogiliv oblast

*　*　*　*　*　*

G. Organizing Committee

Yevgency V. Kostyukovich	Vice Chairman of Mogilev Regional Executive Commitee
Vladimir M. Orekhovsky	Deputy Chief of Mogilev Health Department
Tadeush A. Krupnik	Head Doctor, Mogilev Medical Diagnostic Center
Nikolai K. Dolbeshkin	Deputy Head Docotor, Mogilev Medical Diagnostic Center
Alexandr M. Dashkovsky	Deputy Head Doctor, Mogilev Medical Diagnostic Center
Sergei A. Danilchik	Chief of Technical Department, Mogilev Medical Diagnostic Center
Larissa Z. Blagove	Cheif Nurse, Mogilev Medical Diagnostic Center
Lyubov I. Godum	Adviser, Mogilev Medical Diagnostic Center
Natalya D. Yuryeva	Chief of "cchernobyl-Sasakawa" Project, Mogilev Medical Diagnostic Center

Appendix(3) Major equipment donated in the first year of the project

1. TOYOTA Coaster type Mobile laboratory

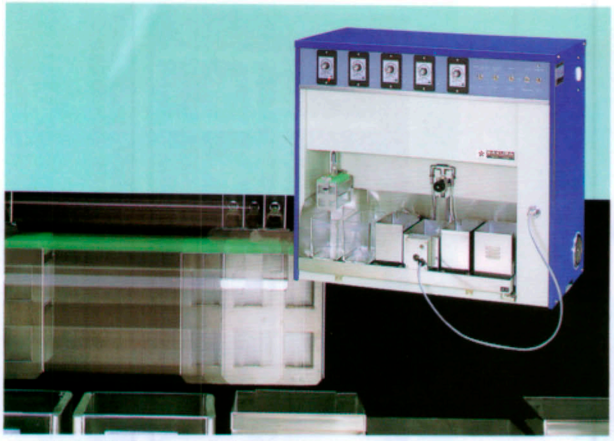
2. ALOKA Whole body counter, WBC-100

3. ALOKA Scintillation survey meter TCS-161

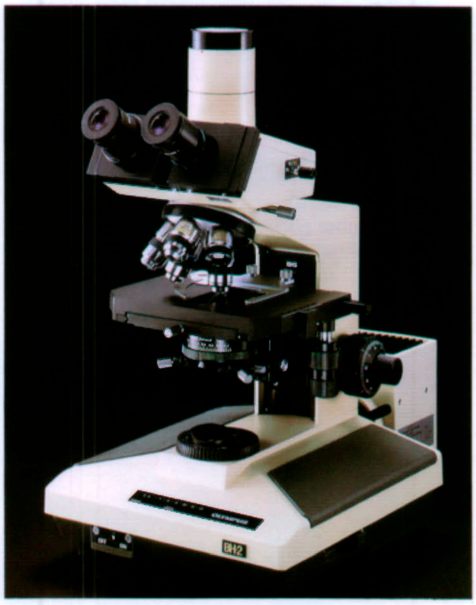
4. ALOKA Ultrasound thyroid scanner

5. SYSMEX 8-Parameter, Automated hematology analyzer K-1000

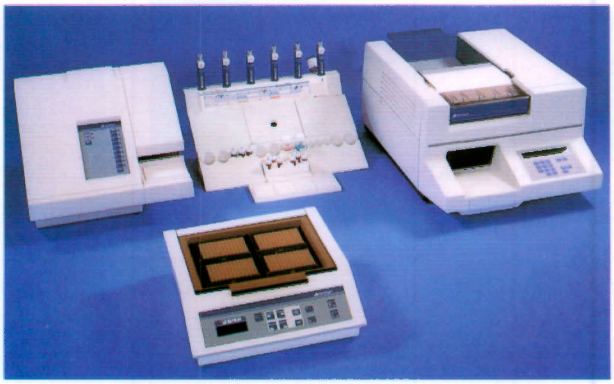
6. KUBOTA Centrifuge 2010



7. SAKURA Automatic hemato stainer RSG-50



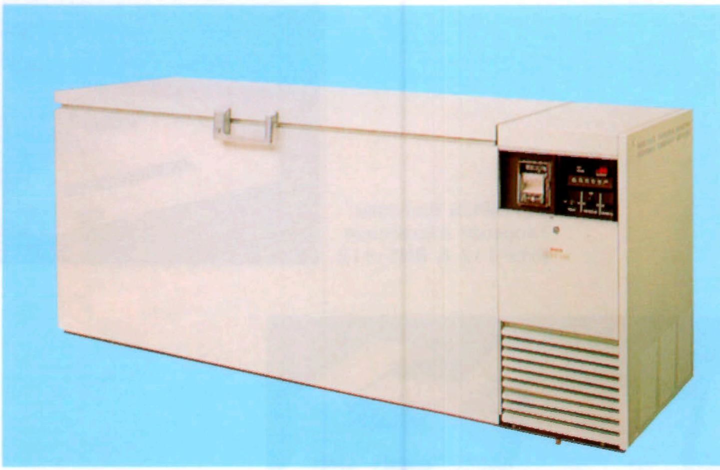
8. OLYMPUS Binocular/ Trinocular microscope BHS-112 & BHS-312



9. AMERLITE TM analyzer

10. FUJIREBIO
Microtiter particle
agglutination test kit

11. SANYO Pharmaceutical
refrigerator MPR-510R



12. SANYO Deep freezer. −85°C MDF-292AT 180L type.

13. SANYO Deep freezer. −85°C MDF-392AT 309L type.

Appendix(4) Questionnaire on in-depth medical examination (English translation of original Russian version)

IMPORTANT !

Please read the following instructions carefully before filling in the questionnaire.

Instructions for the "questionnaire ON IN-DEPTH MEDICAL EXAMINATION"

1. Please write dates in Arabic numerals as follows:
   01 for January, 02 for February, 03 for March, 04 for April,
   05 for May, 06 for June, 07 for July, 08 for August,
   09 for September, 10 for October, 11 for November, 12 for December

2. Please indicate the year by the last two digits. For example, please write 92 for 1992.

3. If the number of boxes exceeds the number of numerals to write, please fill the left by 0s. For example, if your date of birth is the 1st October 1980, please answer Question 6 in Section II as follows:

day		month		year	
0	1	1	0	8	0

4. For questions without boxes, please enter your answer in the underlined space using block letters in Russian or Arabic numerals.

5. For questions followed by numbered boxes ☐, please choose one and only one answer, and enter a ✓ mark in the relevant box, as ☑. For example, if you are male, please answer the Question 5 in Section II as follows:

1 ☑ male 2 ☐ female

QUESTIONNAIRE ON IN-DEPTH MEDICAL EXAMINATION

I. Basic information on examination

1. Date of examination — day ☐☐ month ☐☐ year ☐☐

2. Place of examination ____________________

II. Subject's identification

1. Personal identification number assigned in the given bus ☐☐☐☐☐☐☐☐☐☐

2. Personal identification number assigned by the government ☐☐☐☐☐☐☐☐☐☐☐☐

3. Identification card
   3-1. Type of card
   1 ☐ passport 2 ☐ birth certificate 3 ☐ military document

   3-2. Document series ☐☐☐☐☐☐

   3-3. Document number ☐☐☐☐☐☐

   3-4. Date of issue — day ☐☐ month ☐☐ year ☐☐

4. Name
   4-1. Surname ____________________
   4-2. Name ____________________
   4-3. Patronymic ____________________

5. Sex 1 ☐ male 2 ☐ female

6. Date of birth — day ☐☐ month ☐☐ year ☐☐

7. Place of birth
   7-1. Region (Oblast) ____________________
   7-2. District (Raion) ____________________
   7-3. Settlement ____________________

III. Residence

1. Settlement address
   1-1. Postal code ____________________
   1-2. Region (Oblast) ____________________
   1-3. District (Raion) ____________________
   1-4. Settlement ____________________
   1-5. Street/House/Block/Flat ____/____/____/____

2. Were you living in the present settlement before the 26th April 1986?
   1 ☐ yes 2 ☐ no

3. If you have moved to the present settlement after the 26th April 1986, please indicate the date of arrival.
   Date of arrival day month year
   ☐☐ ☐☐ ☐☐

4. Where did you come from?
   4-1. Region (Oblast) ____________________
   4-2. District (Raion) ____________________
   4-3. Settlement ____________________

5. Where were you living when the accident took place?
   5-1. Region (Oblast) ____________________
   5-2. District (Raion) ____________________
   5-3. Settlement ____________________

IV. Food consumption

1. During the current year, have you been eating any of the following foods from individual farms situated in the present settlement or in a neighboring contaminated settlement? If yes, please enter a √ mark in the relevant boxes.
   1-1. meat of cows 1 ☐ yes 2 ☐ no
   1-2. milk of cows 1 ☐ yes 2 ☐ no

1-3. vegetable crops and greens 1 ☐ yes 2 ☐ no
1-4. meat of other cattle 1 ☐ yes 2 ☐ no

2. Do you regularly eat mushrooms picked in territory near contaminated settlements?
   1 ☐ yes 2 ☐ no

3. Do you regularly eat the meat of wild animals killed near contaminated settlements?
   1 ☐ yes 2 ☐ no

V. Animals kept by the family

1. Are there any animals kept by your family? 1 ☐ yes 2 ☐ no

2. If yes, please enter a √ mark in the relevant boxes.

2-1. cow	1 ☐ yes	2 ☐ no
2-2. goat	1 ☐ yes	2 ☐ no
2-3. bird	1 ☐ yes	2 ☐ no
2-4. dog	1 ☐ yes	2 ☐ no
2-5. cat	1 ☐ yes	2 ☐ no
2-6. others	1 ☐ yes	2 ☐ no

VI. Parents' occupation and family size

1. Father's occupation involves mainly
   1 ☐ being indoors constantly
   2 ☐ field-working
   3 ☐ cattle-breeding
   4 ☐ machine-operating
   5 ☐ work in the individual husbandry
   6 ☐ other

2. Mother's occupation involves mainly
   1 ☐ being indoors constanlty
   2 ☐ field-working
   3 ☐ cattle-breeding
   4 ☐ machine-operating
   5 ☐ work in the individual husbandry
   6 ☐ other

3. How many people are there in your family? ☐☐ persons

VII. Family history of disease

1. Has one of your family members ever had a serious disease?

   1 ☐ yes   2 ☐ no   9 ☐ unknown

2. If yes, please enter a √ mark in the relevant boxes.

2-1. anemia	1 ☐ yes	2 ☐ no	9 ☐ unknown
2-2. leukemia	1 ☐ yes	2 ☐ no	9 ☐ unknown
2-3. malignant tumor (cancer)	1 ☐ yes	2 ☐ no	9 ☐ unknown
2-4. others	1 ☐ yes	2 ☐ no	9 ☐ unknown

3. How many of your blood relatives have had thyroid diseases?

   3-1. Parents (0,1 or 2. Leave blank if unknown.) ☐ persons

   3-2. Uncles and Aunts (Enter 9 if you have no blood-related uncles or aunts, and enter 8 if you have 8 or more uncles and aunts with thyroid diseases. Leaveblank if unknown.) ☐ persons

   3-3. Siblings (Enter 9 if you have no blood-related siblings, and enter 8 if you have 8 or more siblings with thyroid diseases. Leave blank if unknown.)

   ☐ persons

4. Do any of your family members have hereditary diseases or congenital abnormalities?

   1 ☐ yes   2 ☐ no   9 ☐ unknown

VIII. Past history

1. Were you born by a full-term normal delivery? 1 ☐ yes 2 ☐ no

2. Birth weight (grams) ☐☐☐☐ grams

3. Lactation history

   1 ☐ fed by mother's milk

   2 ☐ fed by powder (and/or cow's) milk

   3 ☐ fed by both mother's and powder (and/or cow's) milk

4. Puberty

4-1. Have you experienced the signs of puberty (menstration, voice change, pubic hair, etc.)?

1 □ yes 2 □ no 9 □ unknown

4-2. If yes, please give the age when you experienced these signs.
(Enter 99 if the age is unknown.) □□ years old

5. Inoculation

5-1. Have you had any inoculations? 1 □ yes 2 □ no 9 □ unknown

5-2. If yes, please enter a √ mark in the relevant boxes.

5-2-1. measles 1 □ yes 2 □ no 9 □ unknown
5-2-2. tetanus 1 □ yes 2 □ no 9 □ unknown
5-2-3. poliomyelitis 1 □ yes 2 □ no 9 □ unknown
5-2-4. mumps 1 □ yes 2 □ no 9 □ unknown
5-2-5. others 1 □ yes 2 □ no 9 □ unknown

6. Tuberculin reaction test

6-1. Have you ever had a tuberculin reaction test?

1 □ yes 2 □ no 9 □ unknown

6-2. If yes, please give the age when the reaction became positive.
(Enter 99 if the age is unknown) □□ years old

7. Disease

7-1. Did you have any serious diseases in the past?

1 □ yes 2 □ no 9 □ unknown

7-2. If yes, please enter a √ mark in the relevant boxes.

7-2-1. thyroid diseases 1 □ yes 2 □ no 9 □ unknown
7-2-2. tuberculosis 1 □ yes 2 □ no 9 □ unknown
7-2-3. anemia 1 □ yes 2 □ no 9 □ unknown
7-2-4. blood diseases other than anaemia
1 □ yes 2 □ no 9 □ unknown

8. Do you catch a cold easily? 1 □ yes 2 □ no 9 □ unknown

9. If you catch a cold, do you easily recover?

1 □ yes 2 □ no 9 □ unknown

10. Did you ever have an asthma attack?

1 □ yes 2 □ no 9 □ unknown

11. Do you bleed easily? 1 ☐ yes 2 ☐ no 9 ☐ unknown

12. Have you ever had a skin disease?
1 ☐ yes 2 ☐ no 9 ☐ unknown

13. Exposure of thyroid
13-1. Have you been measured for thyroid exposure?
1 ☐ yes 2 ☐ no 9 ☐ unknown
13-2. If you have been measured for thyroid exposure, indicate the date of measurement and the dose.
13-2-1. Date of measurement day ☐☐ month ☐☐ year ☐☐
13-2-2. Dose (μSv) ☐☐☐☐☐☐☐ μSv

14. Past history of thyroid diseases
14-1 a. Have you ever been diagnosed as having Basedow's disease?
1 ☐ yes 2 ☐ no 9 ☐ unknown
14-1 b. If yes, please give the age at the first diagnosis.
(Enter 99 if the age is unknown.) ☐☐ years old
14-2 a. Have you ever been diagnosed as having thyroid cancer?
1 ☐ yes 2 ☐ no 9 ☐ unknown
14-2 b. If yes, please give the age at the first diagnosis.
(Enter 99 if the age is unknown) ☐☐ years old
14-3 a. Have you ever been diagnosed as having chronic thyroiditis?
1 ☐ yes 2 ☐ no 9 ☐ unknown
14-3 b. If yes, please give the age at the first diagnosis.
(Enter 99 if the age is unknown.) ☐☐ years old
14-4 a. Have you ever been diagnosed as having hypothyroidism?
1 ☐ yes 2 ☐ no 9 ☐ unknown
14-4 b. If yes, please give the age at the first diagnosis.
(Enter 99 if the age is unknown.) ☐☐ years old
14-5 a. Have you ever been diagnosed as havig adenomatous goiter?
1 ☐ yes 2 ☐ no 9 ☐ unknown
14-5 b. If yes, please give the age at the first diagnosis.
(Enter 99 if the age is unknown.) ☐☐ years old
14-6 a. Have you ever been diagnosed as having any other thyroid diseases?

1 ☐ yes 2 ☐ no 9 ☐ unknown

14-6 b. If yes, please give the name of the disease and the age at the first diagnosis. (Enter 99 if age is unknown.)

The name of the disease is ________________ ☐☐ years old

15. Therapeutic history of thyroid disease

15-1 a. Have you ever undergone thyroid surgery?

1 ☐ yes 2 ☐ no 9 ☐ unknown

15-1 b. If yes, please give the age at the operations.

(Enter 99 if the age is unknown.) ☐☐ years old

15-2 a. Have you ever had your thyroid treated with radioisotope iodine 131 (^{131}I)?

1 ☐ yes 2 ☐ no 9 ☐ unknown

15-2 b. If yes, please give the age at the treatment.

(Enter 99 if the age is unknown.) ☐☐ years old

15-3 a. Have you ever received any thyroid hormones?

1 ☐ yes 2 ☐ no 9 ☐ unknown

15-3 b. If yes, please give the age at the first administration.

(Etner 99 if the age is unknown.) ☐☐ years old

15-3 c. Do you still take thyroid hormones?

1 ☐ yes 2 ☐ no 9 ☐ unknown

15-4 a. Have you ever received any antithyroid medicine?

1 ☐ yes 2 ☐ no 9 ☐ unknown

15-4 b. If yes, please give the age at the first administration.

(Enter 99 if the age is unknown.) ☐☐ years old

15-5 a. Have you ever received iodide therapy?

1 ☐ yes 2 ☐ no 9 ☐ unknown

15-5 b. If yes, please give the age at the first treatment.

(Enter 99 if the age is unknown.) ☐☐ years old

15-5 c. Do you still receive the therapy?

1 ☐ yes 2 ☐ no 9 ☐ unknown

15-6 a. Have you ever had your thyroid treated in some other way?

1 ☐ other type of medicine 2 ☐ other type of therapy

3 ☐ no 9 ☐ unknown

15-6 b. If yes, please give the type of treatment and the age at the first treatment. (Enter 99 if age is unknown.)

The type of treatment is ________________ ☐☐ years old

15-6 c. Are you still under treatment?

1 ☐ yes 2 ☐ no 9 ☐ unknown

16. Have you been taking iodine tablet to supply iodine?

1 ☐ yes 2 ☐ no 9 ☐ unknown

17. Have you been taking iodinated salt?

1 ☐ yes 2 ☐ no 9 ☐ unknown

18. X-ray examination

18-1. Have you ever had a chest X-ray examination?

1 ☐ yes 2 ☐ no 9 ☐ unknown

18-2. Have you ever had a dental X-ray examination?

1 ☐ yes 2 ☐ no 9 ☐ unknown

18-3. Have you ever had other X-ray examinations?

1 ☐ yes 2 ☐ no 9 ☐ unknown

19. Have you ever had a bone marrow examination?

1 ☐ yes 2 ☐ no 9 ☐ unknown

IX. Recent health conditions

1. Have you had any complaints in the last two months?

1 ☐ yes 2 ☐ no 9 ☐ unknown

2. If yes, please enter a √ mark in the relevant boxes.

2-1. fatigue	1 ☐ yes	2 ☐ no	9 ☐ unknown
2-2. fever	1 ☐ yes	2 ☐ no	9 ☐ unknown
2-3. loss of appetite	1 ☐ yes	2 ☐ no	9 ☐ unknown
2-4. predisposition to hemorrhage	1 ☐ yes	2 ☐ no	9 ☐ unknown
2-5. tonsillitis	1 ☐ yes	2 ☐ no	9 ☐ unknown
2-6. loss of hair	1 ☐ yes	2 ☐ no	9 ☐ unknown
2-7. increase in weight	1 ☐ yes	2 ☐ no	9 ☐ unknown
2-8. weight loss	1 ☐ yes	2 ☐ no	9 ☐ unknown
2-9. abdominal pain	1 ☐ yes	2 ☐ no	9 ☐ unknown
2-10. diarrhea	1 ☐ yes	2 ☐ no	9 ☐ unknown
2-11. constipation	1 ☐ yes	2 ☐ no	9 ☐ unknown
2-12. joint pain	1 ☐ yes	2 ☐ no	9 ☐ unknown
2-13. blood in stool	1 ☐ yes	2 ☐ no	9 ☐ unknown
2-14. blood in urine	1 ☐ yes	2 ☐ no	9 ☐ unknown

2-15. failing eyesight 1 ☐ yes 2 ☐ no 9 ☐ unknown

2-16. others 1 ☐ yes 2 ☐ no 9 ☐ unknown

RESULTS OF IN-DEPTH MEDICAL EXAMINATION

I. Basic information on examination

1. Date of examination day month year

   □□ □□ □□

2. Place of examination ____________________

II. Subject's identification

1. Personal identification number assigned in the given bus

   □□□□□□□□□□

2. Personal identification number assigned by the government

   □□□□□□□□□□□□

III. Dosimetry data

1. Cs-137 activity according to the spectrometry measurement (whole body counting) (Bq)

   □□□□□□□ Bq

2. Mean dose-rate at the height of one meter from unprocessed soil (μSv/h)

   □□□ . □□□ μSv/h

IV. Physical data

1. Height (cm) □□□ cm
2. Weight (kg) □□□ kg
3. Chest circumference (cm) □□□ cm
4. Chest thickness (cm) □□ cm
5. Systolic blood pressure (mmHg) □□□ mmHg
6. Diastolic blood pressure (mmHg) □□□ mmHg
7. Pulse (beats/min) □□□ beats/min

V. Thyroid ultra scanning investigation (USI) data

1. Was USI conducted? (1—yes; 2—no) □

If no, the following items of this section do not need to be encoded.

2. Thyroid gland volume (cm^3; encode as 999.9 if the volume was not determined)

☐☐☐ . ☐ cm^3

3. Nodules (1—isoechogene; 2—hypoechogene; 3—hyperechogene; 4—mixed; 5—no nodules) ☐

4. Halo of nodule (1—present; 2—absent) ☐

5. Number of nodules (1—one; 2—two; 3—three; 4—four or more; 9—questionable) ☐

6. Cystic lesions of thyroid (1—clear hypoechogene; 2—cystic degeneration; 3—no) ☐

7. Multiple fine cystic degeneration (1—present; 2—absent) ☐

8. Number of cystic lesions (1—one; 2—two; 3—three; 4—four or more; 9—questionable) ☐

If nodules or cystic lesions were found, the next item is not encoded.

9. Echogenity of thyroid (1—normal; 2—diffuse decrease; 3—diffuse increase; 4—local decrease; 5—local increase; 6—mixed) ☐

10. Calcification (1—present; 2—absent) ☐

11. Anomaly (1—aplasy; 2—hypoplasy; 3—local structure; 4—no) ☐

VI. Thyroid function tests data

1. Were the tests conducted? (1—yes; 2—no) ☐

If no, the folowing items of this section do not need to be encoded.

2. Free T_4 □□□.□ pmol/l

3. TSH □□□.□ μU/ml

4. Microsome test □□□ ×100

5. Thyroid test □□□ ×100

VII. Urinary iodine and creatinine data

1. Was urine examination conducted? (1—yes; 2—no) □

If no, the following items of this section do not need to be encoded.

2. Urinary iodine □□□□.□ μg/dl

3. Urinary creatinine □□□.□ mg/dl

VIII. Aspiration biopsy

Was aspiration biopsy of thyroid gland conducted? (1—yes; 2—no) □

IX. Hematologic indices brought out on K-1000 analyzer

1. Was the analysis condcted? (1—yes; 2—no) □

If no, the following items of this and the next sections do not need to be encocoded.

2. Leukocytes (WBC)($\times 10^9$/l) □□□.□ $\times 10^9$/l
3. Erythrocytes (RBC) ($\times 10^{12}$/l) □.□□ $\times 10^{12}$/l
4. Hemoglobin (Hb) (g/l) □□□ g/l
5. Hematocrit (Ht) □.□□□
6. Mean corpuscular volume (MCV) (fl) □□□.□ fl

7. Mean corpuscular hemoglobin (MCH) (pg) ☐☐.☐ pg

8. Mean corpuscular hemoglobin concentration (MCHC) (g/l) ☐☐☐ g/l

9. Platelet (PLT) ($\times 10^9$/l) ☐☐☐☐ $\times 10^9$/l

X. Analysis of leukocytes (%)

1. Eosinophil ☐☐.☐ %

2. Basophil ☐☐.☐ %

3. Band Neutrophil ☐☐.☐ %
4. Polymorphonuclear Neutrophil ☐☐.☐ %
5. Lymphocyte ☐☐.☐ %
6. Monocyte ☐☐.☐ %
7. Blast (include Lymphoblast and Myeloblast) ☐☐.☐ %
8. Promyelocyte ☐☐.☐ %
9. Myelocyte ☐☐.☐ %
10. Metamyelocyte ☐☐.☐ %
11. Plasma cell ☐☐.☐ %
12. Atypicla lymphocyte ☐☐.☐ %
13. Others ☐☐.☐ %
14. Erythroblast (per 100 leukocytes) ☐☐ /100 leukocytes

Appendix(5) Memorandum of understanding exchanged with five centers

[Mogilev]

MEMORANDUM OF UNDERSTANDING
FOR
CHERNOBYL SASAKAWA MEDICAL & HEALTH COOPERATION PROJECT

This Memorandum of Understanding is exchanged among:

SASAKAWA MEMORIAL HEALTH FOUNDATION, a non-profit organization established and existing under the laws of Japan, with its office at 12-12, Mita 3-chome, Minato-ku, Tokyo 108 (hereinafter called "the Foundation") and,

MOGILEV REGIONAL MEDICAL DIAGNOSTIC CENTER at Pervomaiskaya, 59, Mogilev (hereinafter called "the Center") and,

MINISTRY OF HEALTH OF BELORUSS at Sovetskaya, 11, Minsk, in order to smoothly carry out the Chernobyl Sasakawa Medical & Health Cooperation Project as specified below.

Item 1. [Purpose of the Project]

The purpose of the Projects, on humane grounds, to carry out health screening of the people (in particular, children of 0 to 10 years of age at the time of Accident) in the affected area of the Chernobyl Accident of 1986 in the region, using the mobile unit and other medical equipments as well as human resources provided by the Foundation, and

To utilize the scientific data obtained from the above health screening for the well-being of mankind.

Item 2. [Responsibility of the Foundation]

(1) The Foundation proposes to offer medical and health cooperation to the Center in terms of goods as well as human resources (Specialists) as deemed necessary for the Project.

(2) The details of the cooperation will be determined by mutual consultation of both the Center and the Foundation, based upon the principles set by the Chernobyl Sasakawa Committee.

(3) The Foundation will not at any time be liable for the loss of or damage to any of the said goods after its arrival in the Center.

(4) The Foundation and the Japanese Specialists will assist to implement the Project, but will not be responsible for final diagnosis and treatment of any patient.

Item 3. [Responsibility of the Center]

(1) The Center will fully assume the custody, maintenance and operation of the goods and equipments donated by the Foundation after its arrival to the Center.

(2) The Center will be responsible for providing the suitable accommodations/meals/local transportation for the Specialists sent to the Center by the Foundation.

(3) The Center will take full responsibility for the stability and safety of all operations and methods of health screening of the Project.

Item 4. [Intellectual Property]

(1) All the data resulting from the health screening of this project will be the property of both the Center and the Foundation on condition that the existing legislation is observed.

(2) Disclosure of the data to a third party (including publication of the data, in any form, by an individual or by a group) must receive prior approval of both the Center and the Foundation.

Item 5. [Training]

The training of the staff engaging in the Project may take place at appropriate institutions in Japan or in CIS if deemed necessary.

Item 6. [Indemnity]

The Center will indemnify the Foundation and the Specialists against all losses and claims with respect to injuries or damages to any person, materials, or any property whatsoever which may arise out of or in consequence of works at the Center.

Item 7. [Transfer of Property]

The goods and equipments sent to the Center by the Foundation for the purpose of use in the Project will be donated to and become the property of the Center after its arrival to the Center.

Item 8. [Evaluation of the Project]

Evaluation will be made once a year, on the date to be mutually agreed, by the special committee composed of members suggested by both the Center and the Foundation.

Item 9. [Settlement of Dispute]

All disputes arising from the implementation of the Project will be settled in the light of the purpose and the nature of the Project through mutual consultation of both the Center and the Foundation in good faith.

Item 10. [Term]

This Memorandum of Understanding will be in force for a period of one year from the date of signing, and will be subject to change, renewal and termination by mutual consent.

Item 11. [Coordinator]

The Ministry of Health of Beloruss will fully extend its cooperation as the Coordinator for the smooth implementation of the Project.

In Witness Whereof, this Memorandum of Understanding is executed in 6 official copies, 3 in English and 3 in Russian, by authorized representatives of the Center, the Foundation and the Ministry of Health of Beloruss and the Parties will retain one copy each.

For the Center

(Signature)
Name: Krupnik Tadeush A.
Title: Chief Physician
Date: January 25, 1992
Place: Moscow

For the Foundation

(Signature)
Name: Sasakawa, Yohei
Title: President
Date: January 25, 1992
Place: Moscow

For the Ministry (as Coordinator)

(Signature)
Name: Krysenko Nikolai A.
Title: Deputy Minister
Date: January 25, 1992
Place: Moscow

MEMORANDUM OF UNDERSTANDING
FOR
CHERNOBYL SASAKAWA MEDICAL & HEALTH COOPERATION PROJECT

This Memorandum of Understanding is exchanged among:

SASAKAWA MEMORIAL HEALTH FOUNDATION, a non-profit organization established and existing under the laws of Japan, with its office at 12-12, Mita 3-chome, Minato-ku, Tokyo 108 (hereinafter called "the Foundation") and,

GOMEL REGIONAL SPECIALIZED PROPHYLACTIC CENTER at Bratyev Lizukovykh, 5, Gomel (hereinafter called "the Center") and,

MINISTRY OF HEALTH OF BELORUSS at Sovetskaya, 11, Minsk, in order to smoothly carry out the Chernobyl Sasakawa Medical &

executed in 6 official copies, 3 in English and 3 in Russian, by authorized representatives of the Center, the Foundation and the Ministry of Health of Beloruss and the Parties will retain one copy each.

For the Center

(Signature)
Name: Derzhitsky Viktor E.
Title: Chief Physician
Date: January 25, 1992
Place: Moscow

For the Foundation

(Signature)
Name: Sasakawa, Yohei
Title: President
Date: January 25, 1992
Place: Moscow

For the Ministry (as Coordinator)

(Signature)
Name: Krysenko Nikolai A.
Title: Deputy Minister
Date: January 25, 1992
Place: Moscow

[Klintsy]

MEMORANDUM OF UNDERSTANDING
FOR
CHERNOBYL SASAKAWA MEDICAL & HEALTH COOPERATION PROJECT

This Memorandum of Understanding is exchanged among:

SASAKAWA MEMORIAL HEALTH FOUNDATION, a non-profit organization established and existing under the laws of Japan, with its office at 12-12, Mita 3-chome, Minato-ku, Tokyo 108 (hereinafter called "the Foundation") and,

KLINTSY DIAGNOSTIC CENTER at Sverdlova, 76, Klintsy (hereinafter called "the Center") and,

MINISTRY OF HEALTH OF RUSSIAN FEDERATION at Vadkovski Per. 18/20, Moscow,

in order to smoothly carry out the Chernobyl Sasakawa Medical &

executed in 6 official copies, 3 in English and 3 in Russian, by authorized representatives of the Center, the Foundation and the Ministry of Health of Russian Federation and the Parties will retain one copy each.

For the Center

(Signature)
Name: Kudriavtsev Vladimir A.
Title: Public Health Care, Bryansk Region
Date: January 25, 1992
Place: Moscow

For the Foundation

(Signature)
Name: Sasakawa, Yohei
Title: President
Date: January 25, 1992
Place: Moscow

For the Ministry (as Coordinator)

(Signature)
Name: Vaganov Nikolai N.
Title: Deputy Minister
Date: January 25, 1992
Place: Moscow

[Kiev]

MEMORANDUM OF UNDERSTANDING
FOR
CHERNOBYL SASAKAWA MEDICAL & HEALTH COOPERATION PROJECT

This Memorandum of Understanding is exchanged among:
SASAKAWA MEMORIAL HEALTH FOUNDATION, a non-profit organization established and existing under the laws of Japan, with its office at 12-12, Mita 3-chome, Minato-ku, Tokyo 108 (hereinafter called "the Foundation") and,
KIEV REGIONAL DIAGNOSTIC CENTER at Marshala Budenogo, 1, Kiev (hereinafter called "the Center") and,
MINISTRY OF HEALTH OF UKRAINE at Grushevskogo, 1, Kiev, in order to smoothly carry out the Chernobyl Sasakawa Medical

executed in 6 official copies, 3 in English and 3 in Russian, by authorized representatives of the Center, the Foundation and the Ministry of Health of Ukraine and the Parties will retain one copy each.

For the Center

(Signature)
Name: Shvetsov Vadim S.
Title: Deputy Chief Physician
Date: January 25, 1992
Place: Moscow

For the Foundation

(Signature)
Name: Sasakawa, Yohei
Title: President
Date: January 25, 1992
Place: Moscow

For the Ministry (as Coordinator)

(Signature)
Name: Bomko Elena I.
Title: Chief Specialist,Adm.for Chernobyl Med. Problems
Date: January 25, 1992
Place: Moscow

[Korosten]

MEMORANDUM OF UNDERSTANDING
FOR
CHERNOBYL SASAKAWA MEDICAL & HEALTH COOPERATION PROJECT

This Memorandum of Understanding is exchanged among:
SASAKAWA MEMORIAL HEALTH FOUNDATION, a non-profit organization established and existing under the laws of Japan, with its office at 12-12, Mita 3-chome, Minato-ku, Tokyo 108 (hereinafter called "the Foundation") and,
KOROSTEN DIAGNOSTIC CENTER at Kievskaya, 216, Korosten (hereinafter called "the Center") and,
MINISTRY OF HEALTH OF UKRAINE at Grushevskogo, 1, Kiev,
in order to smoothly carry out the Chernobyl Sasakawa Medical &

executed in 6 official copies, 3 in English and 3 in Russian, by authorized representatives of the Center, the Foundation and the Ministry of Health of Ukraine and the Parties will retain one copy each.

For the Center

(Signature)
Name: Daniljuk Valery V.
Title: Chief Physician
Date: January 25, 1992
Place: Moscow

For the Foundation

(Signature)
Name: Sasakawa, Yohei
Title: President
Date: January 25, 1992
Place: Moscow

For the Ministry (as Coordinator)

(Signature)
Name: Bomko Elena I.
Title: Chief Specialist, Adm. for Chernobyl Med.Problen
Date: January 25, 1992
Place: Moscow

Appendix (6)

Record of Activities of the Chernobyl Health and Medical Cooperation Project (as of August, 1992)

1) August 8-15, 1990 - Dispatch of mecical investigation team comprised of 9 specialists headed by Dr. Itsuzo Shigematsu, Chairman, Radiation Effects Research Foundation.
2) November 8-14, 1990 - Observations at All-Union Scientific Center of Radiation Medicine (Kiev) and Hospital No. 6 (Moscow) (by Professor Atsushi Kuramoto of Hiroshima University and two specialists.)
3) December 24, 1990 - Pledge (Hospital No. 6) (attended by Mr. Yohei Sasakawa, President of Sasakawa Foundation and others)
4) March 6, 1991 - Conference for Japanese and USSR specialists at USSR Academy of sciences in Moscow (attended by Mr. E. T. Velikhov., Deputy President of Academy of Science and 17 specialists)
5) March 13-15, 1991 - Training seminar for the medical doctors and technicians to be dispatched on the usage of medical equipment to be installed in the mobile laboratory (Tokyo) (attended by Professor Shunichi Yamashita of Nagasaki University and 16 specialists)
6) April 26, 1991 - Donation Ceremony of the mobile laboratory vehicles (Red Square, Moscow) (attended by Mr. Yohei Sasakawa, President of Sasakawa Foundation and Mr. Velikhov E. T., Deputy President of USSR Academy of Science and others)
7) May 6-10, 1991 - Training for local doctors and technicians (Obninsk) (attended by Dr. Shunzo Okajima, Professor Emeritus of Nagasaki University and 13 Japanese specialists)
8) May-June, 1991 - On-site technical cooperation activities (five conters) (by Professor Shunichi Yamashita and 24 specialists)
9) July 23-August 10, 1991 - On-site technical cooperation activities (five centers) (by Associate Professor Motomori Izumi of Nagasaki University and 2 specialists)
10) September 24-October 5, 1991 - Training for medical doctors and technicians from the five centers (9 in total) (Nagasaki, Hiroshima and Chiba)
11) October 9-13, 1991 - Liaison meeting with local specialists (Moscow) (participated by Yoshisada Shibata, Chief of the Eoidemilogy and Biological Statistics Department, Radiation Effects Research Foundation in Nagasaki and 2 other specialists.)
12) December 15-23, 1991 - Maintenance and inspection of donated equipment (five centers) (by technicians in charge)

13) January 15-27, 1992 - On-site technical cooperation activities (five centers) (by Associate Professor Masaharu Hoshi of Hiroshima University and speicalist)
14) January 25, 1992 - Signing of "Memorandum of Understanding" (Moscow) (attended by Mr. Yohei Sasakawa and others)
15) April 26-May 1, 1992 - Preparation meeting for Symposium and on-site technical cooperation activities (Moscow and Mogliev, respectively) (participated by Associate Professor Kingo Fujimura of Hiroshima University and 2 others)
16) May 17-22, 1992 - Installation of donated equipment (Mogliev) (by technicians in charge)
17) June 1-5, 1992 - 1st Chernobyl Sasakawa Medical Symposium organized and training program for newly donated medical equipment (Mogliev) (attended by 21 Japanese specialists headed by Dr. Itsuzo Shigematsu)
18) June 24-July 5, 1992 - Installation of donated medical equipment (four centers) (by technicians in charge)

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