THE GENETICALLY SIGNIFICANT DOSE BY THE X-Ray DIAGNOSTIC EXAMINATIONS IN JAPAN

by

Research Group

on

The Genetically Significant Dose by the Medical Use of X-ray in Japan

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Introduction

The ICRP[1] recommended, in 1958, the reduction of the minimum permissible dose for occupational exposure to ionizing radiations. In the same report, it also recommended the apportionment of the dose to whole population from genetical points of view. Although it is easily supposed that the medical use of ionizing radiation may have possible genetical effects on the population at large, an establishment of an international measure to control the amount of medical use of ionizing radiations is very difficult because its beneficial contribution may differ from country to country. In the same year, however, UNSCEAR[2] pointed out the importance of recognition of the amount in those countries in which related data were available. The survey of genetically significant dose of radiation in medical practice had not been carried out in Japan. Two years ago, the scientists who concern this problem organezed themselves a research group to obtain the dose. This report presents results obtained by the group, giving an outline of surveys and some experimental data collected.

The genetically significant dose described here has the same meaning as given in the report of the UNSCEAR 1958. According to the report, a genetically significant dose can be defined as the dose which, if received by every member of the population, would be expected to produce the same total genetic injury to the population as do the actual doses received by the various individuals. Approximation must be made to calculate this dose, the most obvious being consideration of groups rather than individuals. It is convenient to start with the approximate definition. The degree of appoximation involved in the use of equation depends on the definition of classes of exposure (j). In theory, there need be no approximation since the classes may be made so restrictive as to include one individual per class.

The following is the definition;

$$D=\frac{\sum_{j}\sum_{k}\left(N_{jk}^{(F)(F)(F)}d_{jk}W_{jk}+N_{jk}^{(M)(M)(M)}d_{jk}W_{jk}\right)}{\sum_{k}\left(N_{k}^{(F)(F)}W_{k}+N_{k}^{(M)(M)}W_{k}\right)}$$

1) The International Commission on Radiological Protection
2) The United Nations Scientific Committee on the Effect of Atomic Radiations

D: (annual) genetically significant dose
N_{jk}: (annual) number of individuals of age class k, subjected to class j exposure,
N_k: total number of individuals of age-class k,
W_{jk}: future number of children expected by an individual of age class k, subjected to class j exposure,
W_k: future number of children expected by an average individual of age-class k,
d_{jk}: gonad dose per class j exposure of an individual of age-class k,
(F) and (M) denote "female" and "male" respectively.

In the following, the notation n_{jk} will be used which is the measured value by the survey corresponding to N_{jk}.

Before UNSCEAR pointed the importance on a genetically significant dose, information had been scarce in Japan concerning distribution of age, sex and body parts examined. Measurement of gonad dose had been carried out on a small scale in some laboratories. There were some of the available data which may well be used as d_{jk} defined above. Such was the status of the research before we started our survey. The programs of our research group to carry out the survey and experiments are as described below:

A. Sample survey of diagnostic X-ray exposure in Japan.
B. Dosimetry of gonad dose in a phantom and human body.
C. Evaluation of genetically significant dose.

Methods of survey, of collecting and processing of data were sufficiently discussed until agreement was obtained among medical scientists, physicists, and a biometrician in order to attain the best possible results so far as the time and expense were permitted. The first part of the research project which was caried out from April 1959 through March 1960 involved (1) a preliminary survey, (2) a sample survey, and (3) measurements of gonad doses in phantoms. In the second part of it, sample survey and dosimetry in phantom and human materials were carried out from April 1960 to March 1961. The mass miniature examinations were excluded from these survey.

The first year activity:

1) Preliminary survey

Almost all X-ray films consumed in Japan are produced in our country. So the number of X-ray exposures was estimated from the amount of its production (Table 1). According to the information available in publications in 1955 of the Ministry of Health and Welfare, the number of X-ray examinations was estimated to be 17.4 million per year of which 11.7 million occurred in hospitals and the rest, 5.7 million, in general practitioners offices.

2) Sample survey

The sample size was not large enough to estimate a total population value because of economic reasons (the fund available was 1,4000,000 yen (about 3,900 dollar) for the first year). Therefore, the survey was intended to demonstrate possible differences in the selected districts which might have specific characteristics. These districts were

Tokyo, Nagoya, Tokushima, Hokkaido, Niigata, Hiroshima and Nagasaki*. Hospitals within each district were selected at random.

3) Measurement of gonad dose.

In order to make the direct measurement of the gonad dose in the human body, fundamental research was undertaken to construct the phantoms and dosimeters.

The second year activity:

This survey was conducted to obtain a new information which had not been collected by surveys of the first year and to make correction of the values already in hand.

1) The first survey showed that there were significant differences in the distribution of n_{jk} (F,M) among the seven districts selected (n_{jk} is the actual obtained value corresponding to N_{jk}). Therefore it was not reasonable to calculate a genetically significant dose in Japan from such heterogeneous data. Thus we should allocate the sample units all over Japan. From all medical facilities (general hospitals and general practitioners) one tenth of the hospitals and one fifth of the general practitioners which have X-ray diagnostic apparatus were selected at random. The extraction of these facilities was performed under the cooperation of the Division of Health and Welfare Statistics, Welfare Ministers Secretariat. The second survey was performed about these sampled medical facilities.

2) The third survey was performed about the previously non-answering medical X-ray facilities.

Survey

1) Surveys of X-ray diagnostic examinations performed by the hospitals in the selected districts in 1959.

Districts selected for survey were the cities of Sapporo, Muroran, Niigata, Hiroshima and Nagasaki, and Tokushima prefecture and the Tokyo area. There are 4 kinds of hospitals, general hospitals and the special hospitals for tuberculosis, mental and infectious diseases. Almost all X-ray diagnostics are performed by general hospitals; the chest X-ray examinations are performed in the hospital for tuberculosis to small extent compared to the total X-ray examinations. At first we classified the hospitals in 20 groups according to the number of bed and the organization; namely it was the combinations of 5 groups of general hospitals classified by the number of beds (1. 20-49; 2. 50-99; 3. 100-199; 4. 200-499; 5. over 500) and 4 groups of general hospitals classified by the organizations (1. Nation, under Welfare Ministry of Health and Welfare, Nation, others. Prefecture. City, town or village. Educational Organ; 2. Japan Red cross Society, Saisei Society, Agriculture Corporation and Social insurance; 3. Guridical Person for Public Utility or Medical Care. Company. other Guridical Person; 4. private).

The sampling of the hospitals were as follows:

a) All hospitals were sampled in all districts other than Tokyo and Nagoya

b) For Tokyo and Nagoya all hospitals of 100 beds or more were sampled; half of

* the expense of survey of Hiroshima and Nagasaki was afforded by ABCC.

the hospitals of 50-99 beds, and a quarter of the hospitals of 20-49 beds were sampled at random.

The member of the research group in each district and their collaborators visited all the sampled hospitals to request cooperation for this survey. The survey paper is shown in Table 2.

The survey was performed in a 7 consecutive day period from September to October in 1959 except that 2 consecutive weeks were chosen in Hiroshima and Nagasaki. The 81,135 survey papers were collected. Of these 1,379 were incompletely filled in, and 79,756 were used for the statistical analysis and calculations of the genetically significant dose in each district. The informations were punched on IBM cards to facilitate sorting. Numbers of hospitals, sampled hospitals and collaborating hospitals in each district are tabulated in Thables 3-a-1～3-a-8. The frequencies of X-ray diagnostic examinations classified by sex, age class, and type of X-ray diagnostic examinations in each district are shown in Tables 4-1～4-9. If there were no significant differences among the frequencies of X-ray examinations of the districts, we could calculate the genetically significant dose in Japan by inflating these data. However, this survey showed significant differencies in the frequency existed among the districts as shown in Fig 1.

There were significant differencies in distribution as to types of X-ray diagnostic examinations among the groups of hospitals classified by the number of their beds and their organizations except for a few cases. As the result of this survey in the selected districts, the genetically significant dose for the whole country could not be obtained by simple inflation of data, but we could calculate the genetically significant dose in each district and devise a possible method for the estimation of the genetically significant dose in Japan.

2) Survey of X-ray diagnostic examinations performed by hospitals and general practitioners selected at random in 1960.

This survey was performed in 7 conceutive days of November in 1960, and included one tenth of general hospitals and one fifth of general practitioners, which were selected at random from all general hospitals and general practitioners in Japan (Table 5). The hospitals for tuberculous disease, mental disease and infectious disease, health centers and dental clinics were not included in the survey. It is considered that their contributions to the genetically significant dose would be small compared with those of the general hospitals and general practitioners. Mass miniature examinations were not included as well for the same reason.

The survey papers (Table 6) were mailed to 473 hospitals and 6213 general practitioners on October 24 th, 1960. These were collected by mail until Jan. 15 th, 1961. The numbers of the answering hospitals and general practitioners in 7 groups (hospitals are classified by the number of beds in 5, general practitioners in 2) are tabulated in Table 7 together with the total number of medical X-ray examination. The answering hospitals and general practitioners were 61.0 and 34.7 percents of the sampled numbers respectively. It was considered that these figures were too small to be representative of Japan, so we

could not inflate these findings to obtain the national estimate for all Japan.

We made additional survey with postal cards, the content of which is listed in Table 8. This survey was simpler than the previous one. It was primarily intended to get the informations from the non-answering facilities about the possibility of returning the previously dispatched survey papers, about the total number of X-ray examinations in a week, and about the reason why they could not cooperate with the survey. The results are listed in Table 9. The most important information obtained was that the average frequency of X-ray diagnostic examinations thus obtained differed from that in the previously surveyed facilities (Table 10). From this information we estimated the frequency of examinations in the facilities which returned neither the survey paper nor the card. These results were all used for the calculation of the genetically significant dose in Japan.

We also tabulated the frequencies of 22 types of X-ray diagnostic examinatinations according to age and sex. Age was divided into the groups of 0–2 years, 3–7 years 8–14 years and the 5 year groups for ages more than 14 years (Table 11-1～11-8). The frequency of X-ray diagnostic examinations in each group of hospitals and general practitioners classified by the number of beds was significantly different. It is characteristic that large percentage of the X-ray examinations performed by the general practitioners who had no beds were duo to the chest X-ray examinations. This constituted about 80 percent of their total whereas similar examinations in other groups weighed about 40 percent of their respective total.

Dosimetry

There are many factors affecting the absorbed dose in gonad. These are divided into two kinds. The first kind of factors which are reproducible include tube voltage, tube current, filtration, time of exposure, focus to skin distance, field size, type of collimator, physical constitution, positioning, etc. These physical conditions can be reproduced in laboratory exactly in the same way as are described in survey papers of the first year. In the second kind of factors we include such factors as characteristics of X-ray generators, differences in individual patients, alignment of central axis of X-ray beam, etc. These factors are very difficult to be reproduced in a laboratory:

1) Preliminary experiments

Characteristics of X-ray generators. X-ray generators emit X-rays which are different not only in intensity but also in quality from one by one even if they are of the same type and used on the apparent same operational conditions. In order to check the range of variation in X-ray emission, the output was measured in 34 generators in 10 hospitals in Tokyo. Under operational conditions of 60 kVp and 10 mAs read from equiped measuring devices, exposure doses varied from 16 to 75 mr in the same geometry of measurement (Fig. 2).

Differences in individual patient. Considerable difference was observed in gonad dose

among patients of almost the same body size under the same conditions of irradiation. In the case of radiography of chest, the measured dose differed by a factor of two. In females, the positions of the ovaries played an important rôle in estimation of the dose received. Dose measurement was carried out with a dosimeter placed in a water phantom. An oval plastic cylinder containing a human pelvis was filled with water. The phantom was placed in the beams of 60 kVp X-ray and at 40 cm of TSD. Variation of dose is illustrated in Fig. 3 when a dosimeter was moved from front to back. If the position of ovary varies from 6 to 11 cm depth from the surface of the phantom, the gonad dose varies by a factor of three between minimum and maximum. Factors of 8.5 and 1.1 were obtained corresponding movement from up to down along trunk and left to right, respectively.

Alignment of a central axis of the beam. We adapted classification of examinations as was desided by ICRP/U. From the point of view of dose estimation for individual exposure, some of examinations are not adequately classified. For instance, class 5 includes oesophagus, stomach and duodenum. Exposure of the duodenum contributes a larger gonad dose than does oesophagus exposure even if physical parameters, such as, tube voltage, size of radiation field, etc., are identical. For a certain class of examinations, such a large variation of dose as is illustrated in figure 4 occurred by slight movement of central axis. Alignment of central axis is important as is illustrated in Fig.4. For instance in an examination of the upper abdomen much less dose is given to gonad when alignment of central beam is made to oesophagus than to duodenum.

2) Phantome

Five phantomes were used. One of them was provided by courtesy of the ABCC. It was constructed from human bones and Mix D and the size was identical to Japanese adult. Others were simulated to females of 8 months, 5,10, and 20 years of age. Cork of density of 0.3 was packed as the lung and the rest was poured with M3 plastics. The positions of the ovaries of an adult were assumed to be 5 cm apart laterally from the spine of the body, and in depth 12 cm from the front and 8 cm from the back. Measurements of gonad dose at the testis with phantom was made using an ionization chamber covered with 7 mm of M3 cylinder.

3) Dosimeter

The ionization chamber is 20 mm in diameter and 30 mm long with effective volume of 10 cc. The wall is made of X-ray film base coated with graphite. Energy dependency of our chamber was obtained by using a medium energy Victoreen chamber for 10 r (No. 326) and a low energy Victoreen chamber for 250 r (No. 651). These chambers calibrated beforehand by the standard chamber of the Electrotechnical Laboratory, Tokyo. Our chamber was connected to a Colonial dose meter which has an improved Nelson circuit. Full scale at maximum sensitivity is an integral dose of 1 mr, and the sensitivity can be varied by a factor or 10, 100 and 1,000. Zero drift is less than 0.2 divisions and the noise level is less than 0.1 division per minute when 1 mr corresponds to 100 divisions. Therfore, the contribution of 1 micro roentgen to gonad can be accurately measured by repetition of

exposure 10 times per minute. The chamber response is independent on dose rates up to 2,000 mr per second.

4) X-ray generators. Two generators were used throughout the expriments.

generators*	kVp	mA	X-ray tube	Total filtration
A	150 60	50 500	Oil immersion, rotating anode	1.5 mm Al
B	125	**	diito	1.5 mm Al

* Shimadzu Co., Ltd.

** Condenser discharge system with a condenser of 0.5 and 1.0 μF.

5) Sampling survey of exposure conditions

A total of 79,756 punch cards collected in the first survey were devided into 176 subgroups according to age-group (0–2, 3–7, 8–14 and over 15), sex and 22 classes of exposure. In each subgroup, 60 cards were selected at random. When a sample size of subgroups was less than 60, whole sample units were used. We measured gonad dose with phantom reestablishing the conditions of exposure found in the each sample, and calculated the average gonad doses as well as their standard deviations for each group. The results are shown in Table 12.

Estimation of Genetically Significant Dose

1) In order to obtain the genetically significant dose for the whole country, it is necessary to extrapolate n_{jk} to N_{jk}. n_{jk} was corrected for the facilities which answered in an incomplete way and could not be used for calculation of n_{jk}. fc in Table 14 is the correction factor for it. Further it should be noticed that the percentage of return of the survey paper were only 61 percent for general hospitals and 34.6 percent for general practionors. Simple inflation of n_{jk} would involve error. The informations obtained by postal card (incomplete response group) and the group which did not answer at all (none-response group) were taken into account in the following way. Considering the results of the postal card survey the same value for n_{jk} was assumed for all hospitals of each class whichever group, incomplete response or none-response, they may belong to. On the other hand for general practitionors, n_{jk}'s were different for the groups of (1) "Yes" or (2) "No" to the questionars "can you fill in and return the survey paper" (See Table 8). The average number of examination practiced in the general practitionors of none-response group is assumed as shows in Table 15. $\sum_{jk} n_{jk} d_{jk} W_{jk}$ corresponding to the medical facilities which did not return the survey paper was obtained by multiplising the factor fi, as is shown in Table 15.

2) Seasonal effect

The survey was performed in the 7 consecutive days in November of 1960. We do not know whether the frequency of X-ray examinations in November was larger or smaller than in any other month, but data obtained from a few hospitals indicated that the number of X-ray diagnostic examinations performed in November was about 10 percent

higher thac the average.

3) Calculation of genetically significant dose

Aocording to the preceding procedure, we can estimate the $\sum_{jk} N_{jk} d_{jk} W_{jk}$ for whole country (male and female) as 48.3×10^8 (Table 16). The future number of children expected to the present population of Japan is 1.25×10^8 (Table 18). According to the definition we have **38.6 mrem** as the genetically significant dose from X-ray diagnostic examinations. It should be noticed here that the important contribution of foetal exposure is excluded from this value.

If we limit ourselves to the calculation within the selected districts the lowest values of 25.0 mrem for Nagasaki and the highest value of 77.8 mrem for Hiroshima were obtained for the genetically significant dose resulting from X-ray diagnostic examinations practiced in the hospitals (Table 20). These figures could be multiplies by a factor of 1.3 in order to take into account the contribution of the general practitionors.

Consideration

The annual number of examination in Japan is between 30,000,000 and 38,000,000. If one takes into account the contribution of fluoroscopy these figures are fairly good agreement with estimate from the film production (Table 1). Main source of error may be due to d_{jk} and next due to n_{jk}. For example, it was estimation that the coefficient of variation of d_{jk} was nearly 100 percent or more in some case of X-ray diagnostic examination (Table 12) while for n_{jk} it was less than 10 percent for Tokyo. The following calculation was performed considering only the variation in d_{jk}, the variations in n_{jk} and W_{jk} being neglected.

$$\sigma_0^2 = \frac{1}{\left\{\sum_k^{(F)(F)(M)(M)} (N_k W_k + N_k W_k)\right\}^2} \sum' \left(\left\{ A\ (1+fi)\ fc \right\}^2 \sum_{jk}^{(F+M)} (n_{jk} W_{jk} \sigma_{jk})^2 \right)$$

fi : see Table 15
fc: see Table 14
A: 500 for hospitals, 250 for general practitioners.

We obtained 4.2 mrem as the standard deviation of the genetically significant dose value which weighed 38.6 (Table 17).

Summary

We obtained the genetically significant dose **38.6±4.2 mrem** in 1960 from X-ray diagnostic examinations. This value do not involve the contribution from foetal exposure and other minor contributions such as dental and mass miniature exposure. The standard deviation of it is large because of the large variance in the gonad dose.

Acknowledgment

The recearch group wishes to express its sincerely thanks to the medical facilities which cooperated in this survey, particularly many individuals of the facilities who filled up the survey cards, and also to express gratitude to the governmental and non-governmental bodies which offored useful materials to its use. It appreciate very much the energetic effcrt of individuals who treated the voluminous figures. It also thanks the Minister of Education for its financial support.

Fig. 1

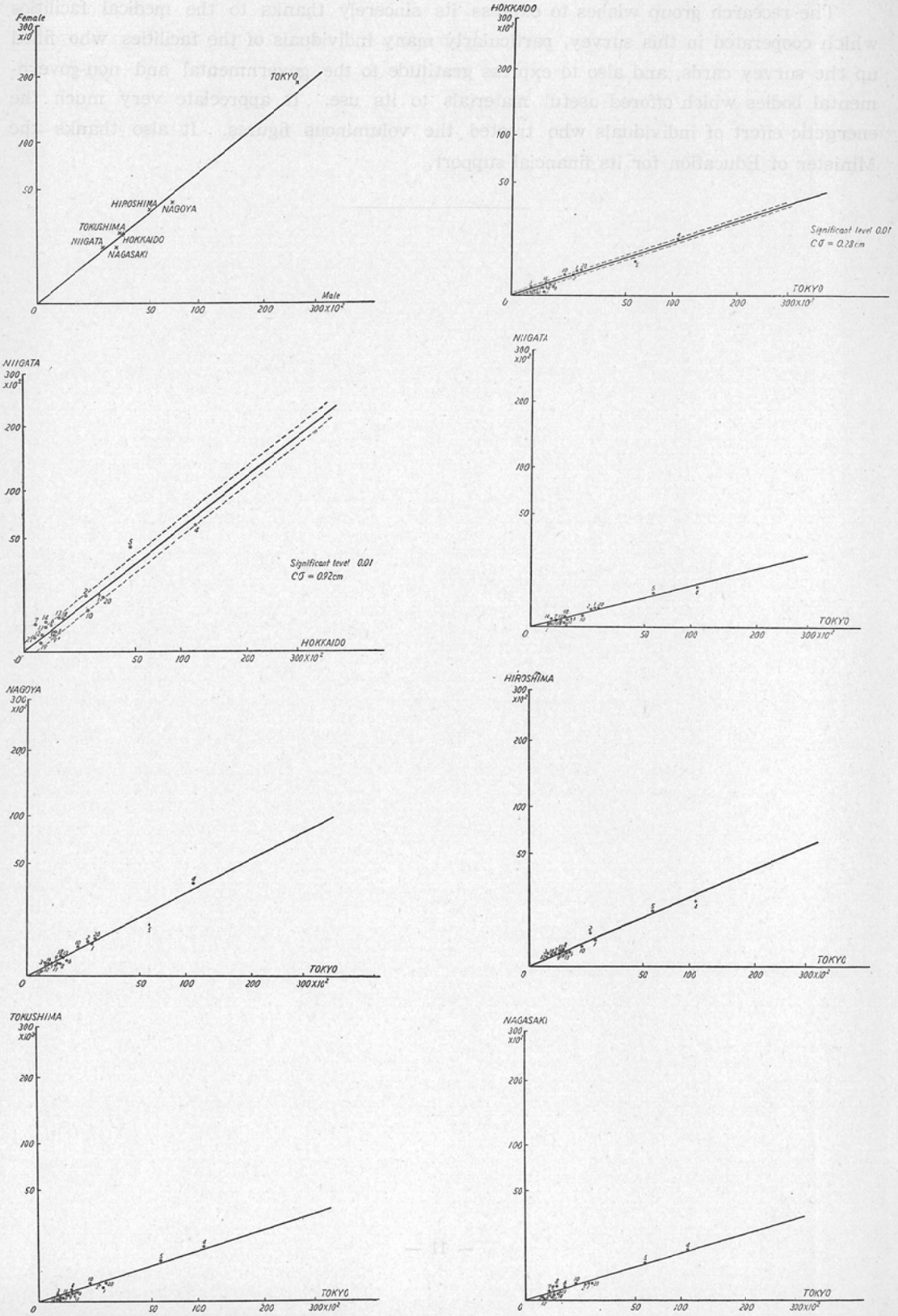

Female
Male
TOKYO
HIROSHIMA
NAGOYA
TOKUSHIMA
NIIGATA
HOKKAIDO
NAGASAKI
HOKKAIDO
Significant level 0.01
σ = 0.28cm
NIIGATA
Significant level 0.01
σ = 0.92cm
NIIGATA
HIROSHIMA
NAGOYA
TOKUSHIMA
NAGASAKI

Fig. 2 Charactoristics of X-ray generators (34) in 10 hospitals in Tokyo

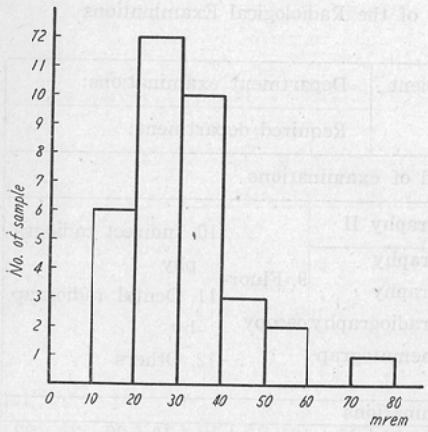


Fig. 3

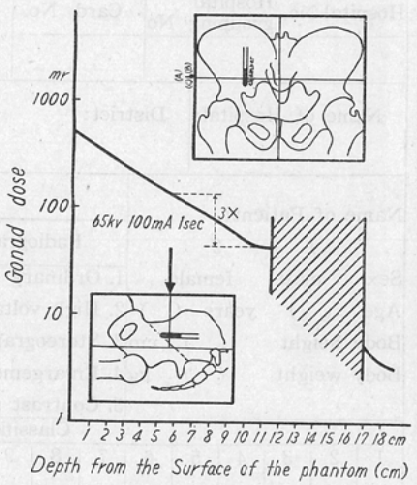
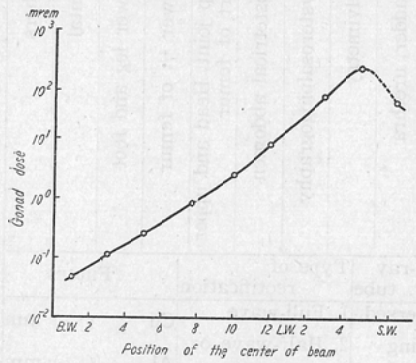


Fig. 4 Alignment of a center of beam



B.W.: dorsal vertebra
L.W.: lumbar vertebra
S.W.: sacral vertebra

Fig. 5. Energy dependency of dosimeter

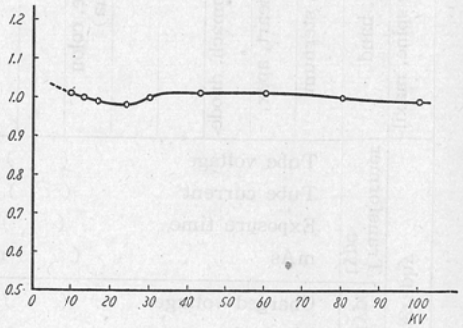


Table 1 Annual production of X-ray films

	1954	1955	1956	1957	1958	1959	1960
direct radiography	16, 600, 000	21, 603, 200	23, 716, 800	23, 944, 400	21, 912, 000	2, 932, 000	29, 800, 000
indirect radiography		45, 180, 000	49, 210, 000	57, 750, 000	59, 730, 000		
dental films		390, 000	410, 000	520, 000	1, 290, 000	2, 210, 000	1, 670, 000

* Deta from the Photosensitized Materials Manufacturer Association

Table 2 Survey paper in 1959

Hospital No.	Hospital grouping No	Card No.

Survey Card of the Radiological Examinations

Name of Hospital:	District:	1. Admitted patient 2. Out patient	Department examinations: Required department:

Name of Patient:

1 2

Sex male female

Age ( ) years ( )

Body height ( ) cm

Body weight ( ) kg

Method of examinations

Radiography I	Radiography II		
1. Ordinary	6. Tomography	9. Fluoroscopy	10. Indirect radiography
2. High voltage	7. Kymography		11. Dental radiography
3. Stereography	8. Serial radiography and cinematography		12. Others
4. Enlargement			
5. Contrast medium			

Classification of the examinations

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Skull, cervical spine, maxilla, mandibula	Shoulder, arm, hand	Thorax (ribs, sternum, clavicle)	Chest (lung, heart, apex, bronchus)	Esophagus, stomach, dnodenum	Gall-bladder	Abdomen	Small intestine, colon (Barium enema)	Dorsal spine	Lumbar spine	Lumbosacral region	Pelvis and Hip	Urography (descending/intravenous pyelography)	Bladder, urethra	Pelvimetry	Hysterosalpingography	Obstetrical abdomen	Hip joint, Head and upper part of femur	Lower 2/3 of femur	Lower leg and foot	Dental	Others

Radiography

Transformer type

Tube voltage	( ) KV
Tube current	( ) mA
Exposure time	( ) sec
mAs	( ) mAs

Condenser type

Charged voltage	( ) KV
Max tube current	( ) mA
Capacity	( ) uF
Wave tail cut off	1 2 (+) (−)

Focus film distance ( ) cm

Type of X-ray tube	Type of rectification	Filters
1. Oil immersed	1. Full-wave	Cu ( ) mm
2. Air cooling	2. Half-wave or selfrectified	Al ( ) mm
3. Others		

Type of diaphragm and coned	Distance between Focus or diaphragm and the end of the cone	Size of the diaphragm or the cone
1. square 2. round 3. none	( ) cm	square ( ) cm ( ) cm round dia ( ) cm

Patient position	Direction	Gonad in beam
1. errect	1. V.D.	1. yes.
2. sit	2. D.V.	2. questionable
3. supine	3. lateral	3. no
4. prone	4. oblique	

Fluoroscopy

Tube voltage	( ) KV
Tube current	( ) mA
Exp. time	( ) sec
Focus-table distance	( ) cm

Scatter distance ( )cm

Calculated dose ( )

Size of Film

1.	14×17	6.	$6\frac{1}{2}\times 8\frac{1}{2}$
2.	14×14		
3.	11×14	7.	$4\frac{3}{4}\times 6\frac{1}{2}$
4.	10×12	8.	dental
5.	8×10	9.	others

1. 1 exp.
2. 2 exp.
3. 4 exp.
4. others

Date of measurement	Name of the reporter

Table 3-a-1 Hospitals involved in the survey in 1959

* / **	1			2			3		4		5		Total		
	a	b	c	a	b	c	a,b	c	a,b	c	a,b	c	a	b	c
1	29	19	11	20	18	16	24	21	27	26	19	18	119	107	92
2	12	7	6	10	8	8	11	10	16	16	3	3	52	45	43
3	136	51	28	57	34	25	42	32	25	22			260	152	107
4	218	98	44	25	15	13	4	3	1	1			248	118	61
Total	395	175	89	112	75	62	81	66	69	65	22	21	679	422	303

※ Class in No. of beds; 1 : 20—49 2 : 50—99 3 : 100—199 4 : 200—499
5 : over 500

※※Classified by organization;
1: Public hospital, University hospital.
2: Red cross, Saiseikai, others.
3: Industrial clinics, Corporations.
4. Private clinics.

a : Total No. of Hospitals b : No. of Surveyed Hosp c : No. of Answering Collaborated Hosp

Table 3-a-2 Hokkaido (Sapporo City, Muroran City)

* / **	1		2		3		4		5		Total	
	a,b	c	a,b	c	a,b	c	a,b	c	a,b	c	a,b	c
1	1		4	3	1	1	3	3	2	1	11	8
2	1	1	0	0	1	0	0	0	0	0	2	1
3	4	2	0	0	5	3	0	0	0	0	9	5
4	5	3	1	1	0	0	0	0	0	0	6	4
Total	11	6	5	4	7	4	3	3	2	1	28	18

Table 3-a-3 Niigata City

* / **	1		2		3		4		5		Total	
	a,b	c	a,b	c	a,b	c	a,b	c	a,b	c	a,b	c
1			3	2	1	1			1	1	5	4
2			1	1							1	1
3	2	2					2	2			4	4
4	5	4	1	1							6	5
Total	7	6	5	4	1	1	2	2	1	1	16	14

Table 3-a-4 Tokyo

* / **	1			2			3		4		5		Total		
	a	b	c	a	b	c	a,b	c	a,b	c	a,b	c	a	b	c
1	12	2	2	4	2	2	15	12	16	15	11	11	58	46	42
2	7	2	2	4	2	2	6	6	10	10	2	2	29	22	22
3	84	21	11	43	20	13	27	21	20	17			174	88	62
4	132	33	8	18	8	7	4	3	1	1			155	46	19
Total	235	58	23	69	32	24	52	42	47	43	13	13	416	202	145

Table 3-a-5 Nagoya City

* / **	1			2		3		4		5		Total		
	a	b	c	a,b	c	a,b	c	a,b	c	a,b	c	a	b	c
1	2	2	2	3	3	3	3	2	2	3	3	13	13	13
2	2	2	2	1	1	1	1	3	3	1	1	8	8	8
3	29	7	5	7	7	7	6	2	2			45	23	20
4	28	7	5	3	2							31	10	7
Total	61	18	14	14	13	11	10	7	7	4	4	87	54	48

Table 3-a-6 Hiroshima City

* / **	1		2		3		4		5		Total		
	a,b	c	a,b	c	a,b	c	a,b	c	a,b	c	a	b	c
1	3	1	1	1	2	2	3	3			9	9	7
2			1	1	1	1	1	1			3	3	3
3	5	3	2	2							7	7	5
4	34	22	1	1							35	35	23
Total	42	26	5	5	3	3	4	4			54	54	38

Table 3-a-7 Tokushima Prefecture

* / **	1		2		3		4		5		Total	
	a,b	c	a,b	c	a,b	c	a,b	c	a,b	c	a,b	c
1	9	4	5	5	2	2	1	1	1	1	18	13
2	2	1	1	1	2	2	2	2			7	6
3	7	3	3	2	2	1	1	1			13	7
4	11	1									11	1
Total	29	9	9	8	6	5	4	4	1	1	49	27

Table 3-a-8 Nagasaki City

* / **	1		2		3		4		5		Total	
	a,b	c	a,b	c	a,b	c	a,b	c	a,b	c	a,b	c
1	2	2					2	2	1	1	5	5
2			2	2							2	2
3	5	2	2	1	1	1					8	4
4	3	1	1	1							4	2
Total	10	5	5	4	1	1	2	2	1	1	19	13

Table 3-b-1 No. of response and incomplete response cards (1959)

District	Total No. of answered cards	No. of complete cards	incomplete cards	
			No.	percentage
Sapporo-city Muroran-city	4, 697	4, 541	156	3. 32
Niigata-city	2, 962	2, 888	74	2. 50
Tokyo-pref.	45, 848	44, 911	937	2. 04
Nagoya-city	11, 041	10, 958	83	0. 75
Hiroshima-city	8, 340	8, 300	40	0. 48
Tokushima-pref	4, 605	4, 568	37	0. 80
Nagasaki-city	3, 642	3, 590	52	1. 43
Total	81, 135	79, 756	1, 379	1. 70

Table 3-b-2 Number of response (male and female) and its percentage (1959)

districts	number			percentage	
	total	male	female	male	female
Sapporo city, Muroran city	4, 541	2, 824	1, 717	62. 2	37. 8
Niigata city	2, 888	1, 727	1, 161	59. 8	40. 2
Tokyo prefecture	44, 911	26, 436	18, 475	58. 9	41. 1
Nagoy city	10, 958	7, 104	3, 854	65. 0	35. 0
Hiroshima city	8, 300	4, 933	3, 367	59. 4	40. 6
Tokushima pref.	4, 568	2, 606	1, 962	57. 1	42. 9
Nagasaki city	3, 590	2, 442	1, 148	68. 0	32. 0
Total	79, 756	48, 072	31, 684	60. 3	39. 7

Table 4 Frequency of the X-ray examinations classified by the type of the

Table 4-1 (total of 7 districts)(male) Frequency of X-ray Examinations

Age	Classification of the										
	total	1	2	3	4	5	6	7	8	9	10
total	48,072	2,928	2,879	355	19,894	10,201	950	468	802	594	2,036
0—14	4,138	512	607	45	1,490	75	0	23	33	42	52
15—19	3,723	385	419	28	1,530	374	37	26	35	47	140
20—24	6,470	417	457	40	2,833	1,127	88	60	78	105	324
25—29	6,846	377	322	52	3,053	1,276	105	72	137	96	349
30—34	6,018	263	281	43	2,848	1,260	90	75	90	87	273
35—39	4,330	228	180	23	1,908	951	97	46	81	69	204
40—44	3,440	177	117	19	1,450	922	95	32	56	43	145
45—49	3,403	155	154	32	1,275	1,022	100	38	85	36	150
50—54	3,273	155	115	27	1,268	1,018	108	33	57	22	116
55—59	2,396	109	76	16	826	833	64	17	56	24	98
60—64	1,829	4	73	15	651	611	72	18	44	5	82
65—69	1,271	56	47	9	391	474	55	16	34	5	54
70—74	580	11	19	2	231	167	26	6	13	7	33
75—	355	9	12	4	140	91	13	6	3	6	16

Table 4-2 (total of 7 districts)(female) Frequency of X-ray Examinations

Age	Classification of the										
	total	1	2	3	4	5	6	7	8	9	10
total	31,684	1,598	1,174	139	13,427	6,231	875	275	767	533	1,103
0—14	3,571	297	332	27	1,179	50	3	22	28	34	44
15—19	2,608	212	126	7	1,362	342	56	16	58	34	53
20—24	4,912	237	135	12	2,690	705	87	41	87	90	142
25—29	4,742	191	88	11	2,424	754	92	48	113	99	143
30—34	3,876	154	77	10	1,792	776	111	31	129	59	161
35—39	2,635	114	71	16	1,047	619	107	34	64	57	116
40—44	2,013	96	48	8	682	608	99	18	38	42	89
45—49	1,986	85	60	15	683	715	69	15	60	21	84
50—54	1,663	72	76	12	504	517	74	15	41	28	80
55—	3,678	140	161	21	1,059	1,145	177	35	149	69	191

examinations, sex and age in each district (1959)

(olassified by age class and the parts of examinations)

examinations											
11	12	13	14	15	16	17	18	19	20	21	22
575	273	893	353	0	0	0	862	126	3, 450	294	139
13	50	29	11				505	27	564	37	22
27	38	49	9				66	9	474	11	19
85	36	112	38				51	22	544	35	18
89	30	167	53				60	16	540	42	22
70	29	120	35				51	15	314	51	11
77	14	100	38				26	11	233	30	13
56	6	45	15				20	8	199	20	15
45	14	70	28				14	4	151	26	4
34	11	71	24				26	4	157	20	7
38	12	46	20				14	1	124	8	4
20	11	31	18				7	2	85	9	3
14	6	16	23				17	6	45	3	
7	2	15	19				2	1	16	2	1
	4	22	22				3		4		

(classified by age class and the parts of examinations)

examinations											
11	12	13	14	15	16	17	18	19	20	21	22
288	248	558	104	98	420	196	1, 330	57	1, 856	326	81
15	52	10	2	3			1, 070	12	354	28	9
23	16	30	2			1	47	4	186	28	5
36	25	106	13	23	61	40	36	6	290	40	10
49	31	83	18	48	155	101	28	8	181	65	12
39	19	80	16	18	151	39	25		124	61	4
27	17	61	10	5	36	14	22	9	134	47	8
23	27	59	8	1	10	1	18	5	119	13	1
19	12	31	5		2		10	1	76	15	4
21	13	40	9		2		11	2	126	7	12
36	36	58	21		3		63	10	266	22	16

Table 4-3 Frequency of X-ray examinations (classified by age class and

Age	Classifications of										
	total	1	2	3	4	5	6	7	8	9	10
0—14	317	41	56	1	88 (5)	15 (6)		1	7 (2)		2
15	254	36	17	4	104 (9)	7 (3)			7 (3)	3	6
20	414	26	27	5	174 (18)	73 (23)				7	34
25	350	24	16	6	166 (11)	61 (24)	4	1		7	27
30	386	15	11	3	220 (14)	61 (21)	7	2	8 (5)	10	19
35	225	11	6	3	98 (6)	32 (14)	5	2		4	12
40	178	17	3	1	68 (3)	35 (10)	3		2 (1)	2	15
45	195	15	7	2	72 (4)	37 (10)		1	4 (1)	3	27
50	187	21	8	2	89 (1)	43 (13)	3		4 (2)	2	6
55	143	20	4	4	45 (5)	41 (15)	5		2 (1)		7
60	94	2	3	2	44 (2)	19 (9)	3		2		11
65	35				14	12 (4)	2				5
70	39		2		14	19 (8)			2 (1)		2
75—	7				1						
total	2,824	228	160	33	1,197	455	32	7	36	38	173

(female)

0—14	298	24	48	2	73 (1)	2 (1)	1	2	6 (1)		1
15	119	11	5	1	67 (2)	12 (6)			1 (1)	9	7
20	296	16	10	2	172 (10)	18 (9)	6		3 (2)	14	18
25	202	4	7	1	109 (5)	27 (8)	8	1	3 (1)	4	6
30	166	12	3		63 (5)	37 (15)		2	3 (1)	3	20
35	159	2	4	1	64 (7)	31 (12)		3	12 (7)	12	9
40	93	10	1		28 (3)	18 (11)	6	1	4	2	8
45	93	6	2	3	39 (2)	22 (9)	2			2	11
50	91	4	2		31 (1)	15 (6)		1	2 (1)	6	11
55—	200	15	10	2	37 (5)	51 (20)	22	3	5 (2)	12	14
total	1,717	104	92	12	683	233	45	13	39	64	105

( ) : parenthesized number is the frequency of fluoroscopy.

the parts of examinations) Hokkaido (male)

the examinations											
11	12	13	14	15	16	17	18	19	20	21	22
	4	2					35	5	50	4	6
	2	2	1				5		54		8
1	5	1	1				7	2	42		9
	1	6	3				3	4	21		
4		4					1		21		
4	2	18	7				1		20		
2		4					1	2	22	1	
6		5	2				2		12		
	1	3					3		1	1	
3		5	1				2		4		
	1		2				1		4		
			1				1				
		2	2						2		
20	16	52	20	0	0	0	62	13	253	6	23

1	1						98	2	31		6
1									5		
3	4				5	4	2	2	14		3
	3	6				8	3		12		
3		6			2	2	2		6		2
1	1	7					2	2	6		2
	3	2					7		3		
	1	2	1				1				1
					2		2		15		
	1	2					1	2	23		
9	14	25	1	0	9	14	118	8	115		14

Table 4-4 Frequency of X-ray examinations (classified by age

Age	total	Classification of the 1	2	3	4	5	6	7	8	9	10
0—14	169	25	32	3	36 (3)	4		2	2 (1)	4	
15	112	11	26	2	35 (9)	22 (8)		3			
20	191	25	15	1	48 (11)	64 (22)	2	2	1		15
25	192	10	6	4	69 (11)	44 (16)	1	2		4	14
30	209	8	7	2	83 (14)	73 (19)		2			5
35	146	6	8		78 (10)	31 (11)	4	2			
40	171	7	5	2	63 (9)	57 (13)	7	3	2 (1)	2	9
45	155	9	3	2	66 (8)	46 (16)	1	2	4 (2)		4
50	126	8	6		51 (13)	31 (10)	4	2	7		7
55	97	10	7		43 (12)	14 (5)		1			2
60	42		2	1	15 (2)	5 (1)	10	1			3
65	56	4		1	12 (3)	19 (8)		1			5
70	23		3		9 (2)			1			2
75—	38				7 (2)	11 (3)		3			
total	1,727	123	120	18	615	421	29	27	16	10	66

(female)

0—14	168	13	14		35 (2)	7 (1)	2	2	5 (2)	2	6
15	57	4	5		29 (4)	3 (1)			3 (1)		2
20	125	7	5	2	53 (7)	15 (8)	1	4		4	5
25	131	5	4		58 (11)	24 (8)	2	1	3 (1)		8
30	156	15	5	1	57 (16)	54 (19)	2	3			1
35	104	3		2	42 (12)	26 (10)	18	3	1		2
40	100	5	2		31 (6)	40 (15)		2	2 (1)		
45	86	4			23 (7)	42 (17)	4	1			6
50	78	4	4		18 (5)	34 (9)	9	1			3
55—	156	3	8	2	41 (12)	36 (7)	9		7 (2)		11
total	1,161	63	47	7	387	281	47	17	21	6	44

( ) : parenthesized number is the frequency of fluoroscopy.

class and the parts of examinations) Niigata City (male)

examinations											
11	12	13	14	15	16	17	18	19	20	21	22
1	1	4					18		30	2	5
	4	2					2		5		
		2							15	1	
9		9					5		13	2	
2	1	3	2				8		10	1	2
5		5	5						2		
		2							12		
		3	3				3		8	1	
1	1	1	3					1	3		
4		3							13		
		1							4		
2	2	1	6				3				
		2	3				1	1			1
	1	5	10				1				
24	10	43	32				41	2	115	7	8

2		1	1				52		23	3	
							6	1	4		
4	1	8				2	7		7		
4	1	2				3	1		12	3	
6		2				1	3		6		
		2	1			2			2		
		4	1				1		11	1	
		1							5		
	1								4		
1	3	1					3		23	6	2
17	6	21	3			8	73	1	97	13	2

Table 4-5 Frequency of X-ray examinations (Classified

Age	Classifications of the										
	total	1	2	3	4	5	6	7	8	9	10
0—14	2,188	286	302	24	805 (31)	32 (16)		13	23 (3)	13	26
15	1,926	214	213	10	737 (78)	213 (67)	13	12	12 (5)	37	94
20	3,861	239	256	8	1,770(247)	619(212)	51	38	61 (20)	68	178
25	3,904	221	178	23	1,851(203)	663(225)	70	40	82 (34)	55	157
30	3,050	153	148	16	1,398(115)	700(232)	61	37	37 (18)	58	117
35	2,254	121	72	9	984 (87)	533(181)	55	21	35 (13)	36	116
40	1,849	102	52	7	784 (60)	539(162)	54	17	31 (14)	29	68
45	1,770	81	86	13	614 (51)	607(171)	80	18	27 (9)	17	76
50	1,853	94	48	6	639 (67)	696(208)	61	18	26 (16)	18	63
55	1,350	553	37	5	445 (30)	507(149)	45	5	42 (18)	10	50
60	1,101	44	42	3	400 (35)	372(115)	42	10	24 (10)	2	50
65	786	38	28	4	235 (15)	313 (98)	48	8	20 (9)	3	18
70	348	11	7	1	153 (13)	87 (29)	14	4	7 (3)	5	20
75—	196	5	9	2	82 (5)	45 (18)	13	2	2 (2)	2	12
total	26.436	1.662	1,478	131	10.897	5,926	607	243	429	353	1,045

(female)

0—14	1,802	153	156	13	583 (17)	25 (11)		14	7 (4)	15	26
15	1,347	107	61	2	706 (53)	179 (58)	36	6	36 (16)	6	24
20	3,199	153	67	3	1,787(132)	490(159)	50	29	64 (25)	41	77
25	3,071	137	58	8	1,627(100)	471(160)	57	25	46 (21)	65	91
30	2,266	88	43	6	1,121 (73)	391(147)	70	13	68 (26)	33	90
35	1,501	82	46	7	592 (40)	375(123)	50	13	19 (10)	31	68
40	1,142	57	20	3	407 (17)	374(122)	64	10	10 (5)	20	42
45	1,070	54	27	7	391 (22)	363(105)	40	9	24 (9)	11	54
50	1,004	41	42	7	270 (13)	340 (98)	46	9	26 (11)	14	48
55—	2,073	79	86	8	625 (33)	651(208)	106	21	58 (24)	36	115
total	18,475	951	606	64	8,109	3.659	519	149	358	272	635

( ) : Parenthesized number is the frequency of fluoroscopy.

by age class and the parts of examinations) Tokyo (male)

examinations											
11	12	13	14	15	16	17	18	19	20	21	22
5	25	16	6				286	12	299	8	7
15	20	26	4				20	6	262	7	11
62	29	72	23				23	18	331	16	8
58	19	104	27				21	9	299	17	10
40	13	68	17				23	10	135	11	8
41	9	49	12				16	4	113	16	12
35	4	17	9				3	4	74	5	15
24	10	36	15				4	2	52	5	3
10	7	43	16				12	1	85	3	7
26	6	17	15				5		76	2	4
16	5	20	13				3		51	1	3
7	3	12	12				8	4	24	1	
5	1	9	11				1		12		
	2	12	8								
344	144	501	188				425	70	1,813	92	88

4	29	2					573	6	189	6	1
9	12	15	2				26	1	104	12	3
23	11	60	7	17	41	26	16	4	211	17	5
34	14	62	14	31	101	57	20	8	120	13	12
20	9	50	10	11	99	30	11		76	27	
11	14	30	3	5	19	6	15	7	81	21	6
16	15	24	3	1	4		3	3	61	5	
4	6	16	4				6		47	6	1
16	8	29	8				8	2	75	3	12
20	23	27	17		1		31	2	145	8	14
157	141	315	68	65	265	119	709	33	1,109	118	54

Table 4-6 Frequency of X-ray examinations (classified by age

Age	Classifications of										
	total	1	2	3	4	5	6	7	8	9	10
1—14	606	83	72	3	207 (6)	4 (1)		1		10	8
15	631	52	85	8	284 (12)	30 (7)	13	5	5 (2)	2	16
20	906	45	75	15	447 (25)	124 (26)	19	3	2 (2)	10	49
25	1,171	66	71	7	514 (12)	209 (61)	4	8	1 (1)	16	84
30	1,049	39	43	8	551 (8)	156 (34)	11	12	13 (7)	10	70
35	641	27	25	5	355 (8)	98 (25)	7	7	8 (5)	10	36
40	416	16	16	1	182 (10)	75 (15)	16	4	11 (4)	4	23
45	482	23	23	4	239 (5)	86 (24)	6	5	8 (3)	6	14
50	414	18	25	7	188 (1)	65 (18)	16	6	5 (4)	2	20
55	336	14	11	4	157 (6)	81 (20)	4	7	3	5	14
60	243	16	7	2	101 (8)	89 (22)	3	1	6 (2)		2
65	126	5	5	2	50 (3)	38 (10)		3			2
70	42				25 (1)	3 (3)					4
75—	41	2	1		22	5 (1)				2	2
total	7,104	406	459	66	3.322	1.063	99	62	62	77	344

(female)

0—14	574	48	37	5	197 (3)	3 (2)		1	3 (1)	8	9
15	482	53	33	2	245 (11)	64 (12)	3	3		2	6
20	536	32	22	2	287 (5)	52 (12)	12	3	8 (3)	5	21
25	472	26	3		263 (3)	34 (12)	3	9	12 (5)	12	8
30	461	13	9	1	229 (7)	87 (22)	13	7	8 (4)	4	12
35	285	9	5	3	137 (4)	24 (8)	6	3	9 (5)	6	16
40	235	11	9	2	71 (2)	41 (13)	7	1	9 (4)	12	18
45	235	10	12	1	86 (7)	84 (15)	1	1	8 (2)	2	3
50	205	14	13		88 (3)	35 (8)	8	3	7 (3)	4	4
55—	369	16	13	3	124 (7)	76 (20)	14	2	30 (9)	8	13
total	3,854	232	156	19	1,727	500	67	33	94	63	100

( ) : parenthesized number is the frequency of fluoroscopy.

class and the parts of examinrtions) Nagoya City (male)

the examinations											
11	12	13	14	15	16	17	18	19	20	21	22
	16	3	2				102	3	75	15	2
4	4	9	1				19		92	2	
4	4	16	7				7	1	72	6	
14	5	24	14				13	2	108	1	
13	7	27	8				4	3	64	9	1
6	1	11	3				2	6	29	4	1
4	1	9	4				7		38	5	
6	2	13	5				3		33	6	
3		13					3		34	9	
2	9	4	1				2	1	15	2	
		1	1				1	2	10	1	
	1	3	1				3	2	10	1	
	1	3	1						4	1	
		3	2				2				
56	51	139	50				168	20	584	72	4

3	15	4					194		38	9	
11		11					10		30	7	2
2	1	24	4	4	11	2	5		29	8	2
	5	9	2	7	15	16	3		27	18	
	3	13	2	2	20	1	4		19	12	2
	1	16	3		5	5	4		26	7	
4	7	18	1				4		18	2	
4		9					2		8	4	
3	4	7	1					1	12	1	
6	4	10			2		7		37	4	
33	40	121	13	13	53	24	233	1	244	72	6

Table 4-7 Frequency of X-ray examinations (classified by age

Age	Classifications of										
	total	1	2	3	4	5	6	7	8	9	10
0—14	443	36	73	12	174 (7)	18 (8)		3	1	8	7
15	441	57	53	3	163 (21)	54 (16)	4	5	4 (2)	2	6
20	523	46	54	4	146 (21)	110 (36)	8	3	8 (2)	13	23
25	594	31	36	5	184 (25)	160 (58)	2	14	16 (6)	4	28
30	677	31	51	8	256 (20)	147 (55)	11	14	14 (5)	4	24
35	483	31	45	1	168 (13)	95 (35)	14	6	24 (12)	13	13
40	429	13	21	4	169 (18)	126 (40)	4	3	8 (6)	4	9
45	372	15	16	8	110 (5)	116 (47)	10	8	13 (6)	9	13
50	313	9	15	9	114 (15)	82 (32)	13	6	9 (2)		7
55	260	11	11	1	61 (5)	110 (37)	3	2	6 (3)	3	13
60	168	4	16	3	30 (3)	64 (24)	4	3	6 (3)	2	8
65	123	4	9	2	27 (4)	50 (18)		2	4 (1)	2	12
70	63		6	1	11	32 (11)	4		2		2
75—	42	2	2		15 (5)	19 (5)		1			2
total	4,931	290	408	61	1,628	1,183	77	70	115	64	167

(female)

0—14	370	36	46	4	127 (8)	10 (3)		2	4 (3)	2	2
15	309	20	13	2	132 (12)	51 (18)	6	6	9 (3)	15	6
20	380	12	16	3	167 (13)	83 (31)	9	3	6 (3)	15	7
25	479	17	12	2	176 (5)	108 (51)	8	6	37 (17)	9	21
30	407	15	11		142 (18)	109 (47)	9	2	32 (15)	7	14
35	300	13	13	2	97 (13)	76 (28)	16	10	12 (5)	1	9
40	259	8	13	1	86 (9)	80 (34)	10	4	6 (1)	4	9
45	238	5	11		63 (9)	105 (39)	3	1	6 (2)	2	6
50	177	6	12	2	64 (5)	58 (27)	7	1	6 (1)		6
55—	448	18	30	3	94 (7)	160 (60)	15	4	37 (15)	11	18
total	3,367	150	177	19	1,148	840	83	39	155	66	98

( ) : parenthesized number is the frequency of fluoroscopy.

class and the parts of examinations) Hiroshima City (male)

the examinations											
11	12	13	14	15	16	17	18	19	20	21	22
5	3		3	0			24	4	66	6	
18	7	6	2				13	3	49	2	
13	6	4	6				10		60	9	
8	5	8	6				12	1	66	8	
9	4	14	7				10		52	21	
11	1	10	11				2	1	29	8	
8	1	12	1				8		31	7	
6	1	11	3					2	19	11	1
10	2	8	5				6		12	6	
3	6	10	2				4		10	4	
4	3	7	2						7	5	
3			3						4	1	
		1	3							1	
	1										
88	40	91	54	0	0		89	11	405	89	1

5	5	1		3			72	2	42	7	
2	4	3					2	2	30	6	
4	4	5	1	1	9	5	6		19	12	
7	7	2	2	2	29	8	1		1	24	
6	1	2	1		21	4	4		12	15	
13		4	3		8				10	13	
	1	8	3		4		2	2	12	5	1
9	2	1			2		1		16	4	1
2							1		10	2	
4	3	12	1				13	2	21	2	
52	27	38	11	6	66	17	102	8	173	90	2

Table 4-8 Frequency of X-ray examinations (clasified by

Age	Classifications of the										
	total	1	2	3	4	5	6	7	8	9	10
0—14	246	18	52	1	119 (4)	3 (1)				2	3
15	189	6	14		105 (30)	27 (11)	7	1	2	3	6
20	300	9	19	5	130 (13)	86 (47)	4	7		3	9
25	330	13	11	4	143 (16)	91 (53)			16 (6)	6	19
30	284	5	4	4	163 (13)	48 (23)		2	9 (2)	3	19
35	309	11	9	4	124 (6)	91 (39)		1	5 (2)	4	21
40	211	8	10	3	88 (12)	50 (26)	5	3		2	16
45	181		7	2	71 (3)	58 (25)	3	1	9 (4)	1	9
50	164	4	4	2	74 (3)	37 (22)	4		2 (1)		1
55	126		4	2	47 (1)	38 (13)	7	2	3 (1)	2	8
60	134	4	2	4	48 (4)	49 (26)	6		2 (1)	1	4
65	72	1	3		21 (1)	18 (8)	4	2	8 (2)		8
70	48		1		17	17 (7)	4	1	2 (2)	2	2
75—	12			2	3	3 (1)				2	
total	2.606	79	140	33	1,153	616	44	20	58	31	125

(female)

0—14	217	6	26	2	114 (7)	2				3	
15	201	15	8		122 (3)	22 (13)	5		5 (2)	2	5
20	254	13	11		160 (14)	37 (19)		1	1	11	5
25	261	2			122 (7)	68 (32)	7	5	12 (6)	9	4
30	270	3	3	1	117 (6)	74 (35)	7	2	17 (8)	6	16
35	157	4	1	1	75 (2)	39 (23)			10 (4)	7	8
40	111	3	2	2	33 (1)	36 (22)	2		6 (3)	2	10
45	153	3	4	1	44 (1)	62 (34)	6	3	20 (9)	2	4
50	71	3	3	1	20	27 (14)	4			4	8
55—	267	5	8	3	71 (9)	108 (43)	11	2	12 (5)	2	11
total	1,962	57	66	11	878	475	42	13	83	48	71

( ) : parenthesized number is the frequency of fluoroscopy.

age class and the parts of examinations) Tokushima Prefecture (male)

examinations											
11	12	13	14	15	16	17	18	19	20	21	22
2	1						17		27	1	
		4	1				7		6		
4	1	6					1		12	3	1
		1	1				4		19	2	
	1						3	2	16	5	
4	1	2					4		26	2	
7		1	1				1	2	12	2	
3							1		14	2	
10		3					2	2	18	1	
		7	1						5		
	2						2		8	2	
2							2		3		
2											
									2		
34	6	24	4	0			44	6	168	20	1

	2						30	2	27	1	2
						1	3		11	2	
	2	6	1		2	1			2	1	
2		2		5	7	6			6	4	
2	5	2		4	8	1	1			1	
	1						1		7	3	
		3				1	1		10		
2	1										1
									1		
5	1	5	1				8	2	11	1	
11	12	18	2	9	17	10	44	4	75	13	3

Table 4-9 Frequency of Y-ray examinations (classified

Age	Classification of the										
	total	1	2	3	4	5	6	7	8	9	10
0—14	167	23	20	1	61			3		5	6
15	170	9	11	1	102 (1)	21 (4)			7 (3)		12
20	275	27	11	2	118 (3)	51 (23)	4	7	6 (2)	4	16
25	305	12	4	3	126 (1)	48 (25)	24	7	22 (8)	4	20
30	363	12	17	2	177 (5)	75 (23)		6	9 (3)	2	19
35	272	21	15	1	101	72 (21)	12	7	9 (3)	2	6
40	186	14	10	1	96 (1)	40 (9)	6	2	2 (1)		5
45	248	12	12	1	103	72 (22)		3	20 (7)		7
50	216	1	9	1	113 (2)	64 (17)	7	1	4		12
55	84	1	2		28 (3)	42 (19)				4	4
60	47	4	1		13	11 (2)	4	3	4 (1)		4
65	73	4	2		32 (3)	24 (5)	1		2 (1)		4
70	17				2	9 (2)	4				1
75—	19				10	8 (2)			1		
total	2,442	140	114	13	1,082	537	62	39	86	21	116

(female)

0—14	142	17	5	1	50	1 (1)		1	3	4	
15	93	2	1		61	11 (3)	6	1	4		3
20	122	4	4		64 (1)	10 (8)	9	1	5 (1)		9
25	126		4		69 (1)	22 (6)	7	1			5
30	150	8	3	1	63 (1)	24 (8)	10	2	1	6	8
35	129	1	2		40 (2)	48 (12)	17	2	1		4
40	73	2	1		26	19 (8)	10		1 (1)	2	2
45	111	3	4	3	42 (4)	37 (16)	13		2 (1)	2	
50	37			2	13	8 (6)					
55	165	4	6		67 (7)	63 (16)		3			9
total	1,148	41	30	7	495	243	72	11	17	14	40

( ) : parenthesized number is the frequency of fluoroscopy

by age class and the parts of examinations) Nagasaki City (male)

examinations											
11	12	13	14	15	16	17	18	19	20	21	22
		4					23	3	17	1	
	1								6		
1		11	1				3	1	12		
		15	2				2		14	2	
2	3	4	1				2		16	4	12
6		5					1		14		
									10		
	1	2					1		13	1	
									4		
	1						1		1		
		2							1		
									4		
			1								
9	6	43	5				33	4	112	8	12

		2	1				51		4	2	
		1							2	1	
	2	3		1					8	2	
2	1			3	3	3			3	3	
2	1	5	3	1	1				5	6	
2		2			4	1			2	3	
3	1				2				4		
	2	2								1	
		4							9	1	
	1	1	2					2	6	1	
9	8	20	6	5	10	4	51	2	43	20	

Table 6 Survey paper in 1960

Survey Card of the

Card No.		

Name of institution

Class in No. of beds	Hospital	Practitioner	Organization	
	1. 20—49 2. 50—99 3. 100—99 4. 200—99 5. 500—	6.1—19 7.0		1. Welfare Ministry 2. Other Ministry 3. Prefecture 4. City, Town 5. Red cross

Card No.	Name of patient	Sex	Age	Radiography (R) or Fluoroscopy (F)	Classification								
					1 Skull, cervical spine, maxilla mandibula	2 Shoulder, arm, hand	3 Thorax (ribs, sternum, clavicle)	4 Chest (lung, heart, apex, bronchus)	5 Esophagus, stomach, dnodenum	6 Gall-bladder	7 Abdomen	8 Small intestine,colon (Barium enema)	9 Dorsal spine
01		M F		R F									
02		M F		R F									
03		M F		R F									
04		M F		R F									
05		M F		R F									
06		M F		R F									
07		M F		R F									
08		M F		R F									
18		M F		R F									
19		M F		R F									
*20		M F		R F									
X-ray equipment					1	2	3	4	5	6	7	8	9
Corn 1. +2. —	1. Transformer type 2. Condencer type	1. Fixed 2. Portable 3. Indirect 4. Jomography											
Commercial name													

Radiological Examinations (1960)

District		H.P.	Institution No.		

District

6. Saiseikai
7. Nookyo
8. Health insurance
9. Public Corporation
10. Medical Corporation
11. Company
12. Other corporation
13. Private

of the examinations

No.	Conad in beam 1. yes 2. no 3. quesitonable	22 Others	21 Dental	20 Lower leg and foot	19 Lower 2/3 of femur	18 Hip joint, Head and upper part of femur	17 Obstetrical abdomen	16 Hysterosalpingography	15 Pelvimetry	14 Bladder, urethra	13 Urography (descending/intravenous pyelography)	12 Pelvis and Hip	11 Lumbosacral region	10 Lumbar spine
	1 2 3													
	1 2 3													
	1 2 3													
	1 2 3													
	1 2 3													
	1 2 3													
	1 2 3													
	1 2 3													
	1 2 3													
	1 2 3													
	1 2 3													
	1 2 3													
No.	Gonad in beam 1. yes 2. no 3. questionable	22	21	20	19	18	17	16	15	14	13	12	11	10

Date of measurement

Name of measurement

Table 5 Number of medical facillities and sampled medical facilities (1960)

Class in No. of beds		No. of medical facilities	No. of medical facilities with X-ray equipment	No. of surveyed medical facilities
General hospital	20—49	2,417	2,417	242
	50—99	1,033	1,033	103
	100—199	747	747	74
	200—499	489	489	49
	500—	107	107	11
	Total	4,793	4,793	479
General practitioner	1—19	22,696	14,513	2,865
	0	34,812	16,807	3,348
	Total	57,308	31,320	6,213

Table 7 No. of the sampled and answering medical facilities and No. of their X-rayexaminations (1960)

Class in No. of beds		No. of surveyed m.f.	No. of answered m.f.		No. of examinations		No X-ray examinations
			No.	percentage	Total No.	No. of one m.f.	
General hospital	20—49	242	126	52.0	5,623	44.6	
	50—99	103	65	63.1	6,829	105	4
	100—199	74	56	75.6	7,756	138.5	
	200—499	49	38	77.5	11,286	297	
	500—	11	7	63.6	7,139	1,020	
	Total	479	292	61.0	38,533	132	
General practitioner	1—19	2,865	1,011	35.2	13.273	13.1	4
	0	3,348	1,143	34.2	12,441	10.9	
	Total	6,213	2,154	34.7	25,714	11.9	
Total		6,692	2,446		65,903		95

Table 8 Postal card for survey in 1960

1. Please check
   Can you fill in and return the survey cards which were sent to you already? (1) Yes (2) No.
2. If you can not return the survey cards, pleas write the number of X-ray examinations in a week in November, 1960.
   Total_____Cases
   Radiography_____Cases
   Fluoroscopy_____Cases
3. Please check appropriate heading in the case of 1. (2).
   1. No X-ray examinations
   2. Occupied by business
   3. too many examinations
   4. too few examinations
   5. forgot
   6. other reasons:

Table 9 Results of postal card survey (1960)

Reasons	Hospital		Practitioner		No. answer
	Can you fill in the survey card?		Can yon fill in the survey card?		
	yes	no	yes	no	
1. No. X-ray examinations	0	2	19	561	
2. Occupied by business	14	16	48	158	
3. Too many examinations	0	0	0	7	
4. Too few of examinations	0	7	39	399	
5. Forgot	4	5	75	126	
6. Others	9	14	171	164	56
Total	27	44	352	1, 415	56
Reasons of 6.					
Unacceptance of survey card	4	6	8	18	33
Loss of survey card	1	3	20	29	
Absence or desease	1	1	4	40	
Death		1			
Incompletion of exposure record		1			
Forgot to post			5		
Unknown of meaning			2		
Posted already			48	1	
No reasons	3	2	84	33	23
Rebuilding				24	
Trouble in X-ray equipment				19	

Table 10 Average frequency of X-ray examinations per medical facillity (1960)

Class in No. of beds		Can you fill in the survey card?					
		Yes			No		
		No. of answered medical facilities	No. of the examinations	average No. of the examinations per one medical facilities	No. of answered medical facilities	No. of the examinations	average No. of the examinations per one medical facilities
General hospital	20— 49			27			26
	50— 99			—			25
	100— 199			48			150
	200— 499			149			398
	500—			—			—
	total						80
General practitioner	1— 19	85	1, 057	12. 4	606	2, 440	4. 0
	0	81	387	5. 0	772	2, 308	3. 0
	total	166	1, 444	8. 7	1, 378	4, 748	3. 4

Table 11-1 Table 11 Frequency of X-ray Frequency of X-ray Examinations

	1	2	3	4	5	6	7	8	9	10	11
0— 2	29	51	3	94	2		3		2	4	
3— 7	91	70	13	219	2		1	10	8	5	4
8—14	99	259	19	395	12	1	5	4	17	9	2
15—19	116	265	17	583	120	10	6	17	22	70	13
20—24	149	241	37	896	267	31	14	22	33	84	54
25—29	128	232	37	999	394	59	17	27	58	136	65
30—34	165	138	39	966	378	35	17	25	53	152	58
35—39	84	119	43	815	304	54	13	26	27	71	36
40—44	40	61	26	716	313	41	5	24	14	70	16
45—49	82	56	20	621	296	58	11	20	26	63	10
50—54	76	83	17	590	303	32	4	14	15	43	19
55—59	39	53	14	407	245	17	1	23	3	23	22
60—64	45	25	17	312	190	16	9	8	5	22	16
65—69	49	15	12	212	98	10	4	12	4	22	10
70—74	13	8	6	93	44	14	7	17	3	20	2
75—		2	5	54	18	1	3	2	1	6	2
Total	1,205	1,678	325	7,972	2,986	379	120	260	291	800	329

Table 11-2 Frequency of X-ray Examinations

	1	2	3	4	5	6	7	8	9	10	11
0— 2	25	41	2	64	1		4				
3— 7	29	33	8	183		1		3		5	
8—14	63	124	9	315	12	5	4	3	18	13	3
15—19	80	78	20	700	93	17	5	18	14	25	9
20—24	95	57	10	709	227	54	19	29	26	39	22
25—29	87	46	9	718	213	48	23	18	46	55	14
30—34	57	41	17	572	245	27	10	22	41	47	34
35—39	36	42	10	455	168	39	15	14	31	37	18
40—44	51	37	9	339	157	19	9	39	25	36	12
45—49	65	42	12	271	174	25	6	16	17	34	8
50—54	54	28	8	196	168	52	6	23	16	30	19
55—	76	96	23	543	369	49	28	31	35	73	30
Total	718	665	137	5,065	1,826	336	129	216	269	394	169

Table 11-3 Frequency of X-ray Examination

	1	2	3	4	5	6	7	8	9	10	11
0— 2				3	1						
3— 7				9	4			5			
8—14	1	4		18	6		1	5		1	
15—19		2		58	71	1		9	1	1	
20—24		3		42	162	7	1	21	1	2	2
25—29		3	1	51	220	5	1	19	1	2	1
30—34	5	1		56	238	7	1	19	3	4	2

examinations (1960)

Hospitals-Radiography-male

12	13	14	15	16	17	18	19	20	21	22	Total
10						172	4	51			425
3	2	1				50	2	94	10		585
14	12					57	17	272	10		1,204
14	18	11				29	19	271	11	11	1,623
14	51	11				38	24	347	9	5	2,327
13	39	38				22	25	302	20	15	2,626
13	60	18				38	9	210	18	19	2,411
24	34	4				13	9	155	12	18	1,861
2	45	12				11	10	130	8	4	1,548
12	26	6				12	6	113	16	4	1,458
5	16	10				8	5	92	4	6	1,342
2	12	1				6	2	40	3		913
8	45	12				12	2	43	1	8	796
5	21	16				8	2	31		2	542
4	9	6				6	1	23	4	2	282
3	8	5				8		10			128
146	398	151				490	137	2,184	126	94	20,071

Hospitals-Radiography-female

12	13	14	15	16	17	18	19	20	21	22	Total
14		2				447	4	48			652
4						52	2	64	2		386
12	5					58	1	132	9		786
10	25	1			2	15	6	115	18	9	1,260
18	45	8	5	5	27	8	5	94	17	2	1,521
15	27	2	10	45	50	14	4	63	29	8	1,549
13	19	2	1	34	20	6	3	73	28	7	1,319
9	26	4	1	9	7	12	2	66	22	5	1,028
14	59	7		5	1	7	2	68	14	5	915
8	22	8		4		2		44	8		766
9	22	2		1		6	1	30	4	4	679
24	23	2	1			28	13	141	6	8	1,599
150	273	38	18	103	107	655	43	943	157	48	12,460

Hospitals-Fluoroscopy-male

12	13	14	15	16	17	18	19	20	21	22	Total
											4
								1			19
1						4	3	4		1	49
1											144
						2		2			245
								1		1	306
								1			337

35—39		1	2	39	160	7		24			
40—44	1	1		29	162	2		16		1	
45—49		1	1	29	152	5	1	23	1		
50—54		2		22	161	5		28			
55—59				20	124	3		20			1
60—64	1			12	103	1	1	13			
65—69				15	64			16			
70—74				3	30	1		11			
75—				1	17			5			
Total	8	18	4	407	1,675	44	6	234	7	11	6

Table 11-4 Frequency of X-ray Examination

	1	2	3	4	5	6	7	8	9	10	11
0— 2				1	3		1				
3— 7		1		8				1	1		
8—14		1		17	9			4			
15—19		2		47	62			14			
20—24		2		62	109	2	1	35			
25—29		1	1	54	120	6	1	13			
30—34		2		27	136	4		21			
35—39	1	2		31	100	6		13			
40—44				13	121	4		31			
45—49				11	105	9		14			
50—54				19	96	7		19			
55—		2		38	225	6	1	30			1
Total	1	13	1	328	1,086	44	4	195	1		1

Table 11-5 Frequency of X-ray Examinations

	1	2	3	4	5	6	7	8	9	10	11
0— 2	7	35	6	83			1	1			
3— 7	23	70	12	241	2		1	2	5		2
8—14	24	221	15	293	10		6		3	2	
15—19	56	204	17	806	62	3	1	3	8	16	10
20—24	54	189	25	918	162	6	2	10	5	34	19
25—29	47	128	22	860	296	12	3	11	16	46	24
30—34	29	91	26	908	270	20	8	14	5	28	18
35—39	28	71	31	757	247	32	7	12	11	22	31
40—44	15	47	24	541	179	17		7	5	20	10
45—49	14	50	23	506	208	28	4	6	2	9	13
50—54	6	38	20	413	205	25	1	11	6	14	17
55—59	10	19	16	259	139	3	1	5	5	7	16
60—64	8	17	11	215	107	12	1	1	2	3	10
65—69	1	14	11	148	41	2	2	7		2	9
70—74	1	3	4	69	44		1	2			
75—		3	2	29	16			3			1
Total	323	1,200	265	7,046	1,988	160	39	95	73	203	180

								1			234
								1		3	216
	1							1		1	216
							2	2			222
								1			169
	2										133
											95
	1										46
											23
2	4					6	5	15		6	2,458

Hospitals-Fluoroscopy-female

12	13	14	15	16	17	18	19	21	20	22	Total
								1			6
											11
											31
											125
								1		1	213
								3			199
				1				1			192
										2	155
1	3			1				4			178
											139
											141
						2					305
1	3			2		2		10		3	1,695

General practitioners-Radiography-male

12	13	14	15	16	17	18	19	20	21	22	Total
5						26	2	20			186
3						21	5	68			455
6	3					23	6	114	2		728
12	1	1				10	6	139	8		1,363
5	3	1				6	8	168	21	12	1,648
11	14	1				3	10	129	15	9	1,657
12	9	4				8	10	130	11	10	1,611
5	8	3				6	2	97	6	17	1,393
8	77	2				3	5	58	15	12	975
6	4	2				5	6	66	6	15	973
5	9					5	3	63	2	7	850
1	3	2				2	1	54	1	10	554
	9	8				5		28	1		438
2	5	1				5		17			267
1		3				1		3			132
	3	1				1		6			65
82	78	29				130	64	1,160	88	92	13,295

Table 11-6 Frequency of X-ray Examinations

	1	2	3	4	5	6	7	8	9	10	11
0— 2	3	19	2	72			2				
3— 7	6	40	5	226	1			1			
8—14	12	83	5	256	3	3		1	2	2	2
15—19	31	58	1	579	41		2	9	6	11	1
20—24	29	45	9	556	101	11	2	19	12	10	3
25—29	19	21	4	500	70	10	1	13	6	15	9
30—34	12	28	4	438	129	17	2	11	7	5	3
35—39	22	24	7	335	124	5	3	11	5	11	8
40—44	9	15	3	252	141	25	2	7	10	9	10
45—49	9	12	5	222	109	19		8	4	6	5
50—54	11	29	12	173	93	8	3	3	4	4	5
55—	21	67	11	451	269	19	2	19	10	10	11
Total	184	441	68	4,060	1,081	117	19	102	66	83	57

Table 11-7 Frequency of X-ray Examinations

	1	2	3	4	5	6	7	8	9	10	11
0— 2		9	1	12				2			
3— 7		18	2	38	2		1	1			
8—14	1	33	4	47	8						
15—19	1	20	3	65	57	1		4			
20—24	1	22	3	72	118	2		7		1	1
25—29		9	1	102	179	4		15			
30—34	1	8	3	106	188	5	3	11			
35—39	1	10	2	57	166	9	2	15		1	
40—44		4	3	31	101	4	1	6			
45—49		3		39	108	6	1	9			
50—54		4	2	44	125	6		8			
55—59			1	30	94	3		6			
60—64	1	4	1	21	69	3		4			
65—69		1	2	17	32	2		9			
70—74				11	41			1			
75—				5	10			1			
Total	6	145	28	697	1,298	45	8	99		2	1

Table 11-8 Frequency of X-ray Examinations

	1	2	3	4	5	6	7	8	9	10	11
0— 2		5		11	5			5			
3— 7		6		24	1						
8—14		21	1	43	5	3		1			
15—19		6		63	29			9			
20—24		5		89	76	4	1	14			
25—29		4		70	72	6	1	21			
30—34		1	1	64	148	6	1	23			
35—39		4	3	48	95	3		10			

General practitioners-Radiography-female

12	13	14	15	16	17	18	19	20	21	22	Total
9						75	3	13			198
3	1					10		40	1		334
1						4	9	55	5		443
1	2	1			4	3	1	69	6	4	830
8	11			2	13	1	2	40	15	14	903
5	3	1		4	20	2	1	30	12		746
5	6	1		4	6	5		23	5	13	724
5	5		2	1	1	1		23	3	2	598
10	2					2	2	24	5		528
1	3					2		27	3		435
4	2	1				4	2	38	8		404
5	16	1		2		16	2	76			1,008
57	51	5	2	13	44	125	22	458	63	33	7,151

General practisioners-fluoroscopy-male

12	13	14	15	16	17	18	19	20	21	22	Total
						1					28
1						2	1	5			71
						2	2	14			111
						1		13			165
								7			234
1								6		1	318
	1	1					2	6		1	336
							1	11		1	276
								3			153
								5			171
								2		3	194
								4			138
								4			107
											63
								2			55
											16
2	1	1				6	6	85		6	2,436

General practitioners-Fluoroscopy-female

12	13	14	15	16	17	18	19	20	21	22	Total
						5	2	1			34
						1		2			34
						1		8			83
	1							4			112
						1		4		2	196
1	1										176
				2	1	2					249
				1				2			166

40—44		3		40	91	11		8	1		
45—49		5		37	84	5	1	11	1	1	
50—54	1	6	1	26	74	6		5			
55—		7		77	207	11		24			
Totul	1	73	6	592	887	5	4	131	2	1	

Table 12-1 Gonad dose (male) (unit: mrem)

Age class		0— 2		3— 7		8—14		15—	
*		Gonad dose	No. of sample	Gonad dose	No. of sample	Gonad dose	No. of sample	Gonad dose	No. of sample
Radiography	1	2.5± 7.1	26	0.4±0.5	52	0.17± 0.27	48	0.013±0.03	49
	2	9.3± 16.0	23	5.2±12.5	51	0.27± 0.59	53	0.126±0.37	48
	3	28.0± 28.9	7	5.4±8.5	13	4.36± 9.74	16	0.52±2.6	47
	4	94.0± 11.2	12	9.9±14.6	44	3.8± 4.9	45	1.04±1.7	42
	5	41.9± 31.3	7	31.5±45.1	6	10.2± 15.9	19	4.33±6.1	32
	6	—	—	—	—	—	—	2.1±3.9	44
	7	117.5± 256.4	9	105.0±37.7	6	486.7± 471.7	4	220.0±454.8	47
	8	—	—	42.6±31.7	19	175.0± 98.0	2	220.0±356.0	31
	9	2.7± 1.5	3	121.5±221.9	12	116.8± 248.7	21	1.5±2.6	53
	10	77.9± 63.5	8	96.6±105.9	10	584.5± 548.2	26	767.0± 1,774.0	53
	11	521.0± 443.5	3	—	—	1,035.0± 876	8	1,730.0± 1,611	53
	12	38.5± 24.7	7	184.4±234.6	12	246.3± 190.4	12	1,485.0± 1,163	56
	13	260.7± 6.6	4	225.5±115.9	11	108.5± 82.9	9	631.0±875.9	
	14	130.3± 30.3	2	165.0	1	415.3± 49.3	7	1,106.0±626.6	
	15	—	—	—	—	—	—	—	—
	16	—	—	—	—	—	—	—	—
	17	—	—	—	—	—	—	—	—
	18	53.0± 49.4	25	115.0±151.5	54	238.4± 226.2	54	691.0±608.0	53
	19	50.0		13.5±1.62	2	112.9± 112.2	21	79.0±89.2	57
	20	44.6± 41.7	25	7.6±8.8	50	3.5± 5.3	50	5.8±10.4	52
	21	—	—	0.023±0.03	15	0.016± 0.01	12	0.017±0.07	53
Fluoroscopy	4	66.0	1	141.0	1	8.1± 10.27	2	0.56±0.98	51
	5	5,750± 4,780	5	1,904± 2,310	10	381.0± 365.6	8	27.8±40.1	47
	8	—	—	8,375± 6,230	3	—	—	2,390.0± 4,059	47

* Classification of the examinations

± : Standard deviation of gonad dose

2								2			158
	1							1			147
								3			122
								1		1	328
3	3			3	1	10	2	28		3	1,805

Table 12-2 Gonad dose (female) (unit: mrem)

Age class		0—2		3—7		8—14		15—	
*		Gonad dose	No. of sample	Gonad dose	No. of sample	Gonad dose	No. of sample	Gonad dose	No. of sample
Radiography	1	3.2± 8.8	20	2.7± 16.0	49	0.12± 0.22	50	0,068± 0.119	59
	2	5.3± 9.7	32	2.8± 4.3	53	0.53± 0.97	51	0.27± 0.85	52
	3	35.9±31.9	6	26.1± 22.2	8	2.0± 3.4	5	0.72±14.0	46
	4	11.1±13.8	18	13.8± 19.5	38	6.7± 8.1	40	7.95±19.7	45
	5	14.5	1	523.9± 338.3	4	117.0± 153.6	14	74.3±99.2	30
	6	—	—	—	—	—	—	80.1±94.2	44
	7	16.0	1	57.8± 58.3	2	58.0± 20.6	4	48.9±29.1	48
	8	2,240.0	1	84.2± 9.8	2	82.5± 33.9	12	80.7±76.2	33
	9	4.3	1	46.1± 47.2	4	78.1± 69.1	25	15.0±31.2	55
	10	—	—	184.0± 120.0	8	179.0± 156.9	25	121.0±99.2	55
	11	72.6± 9.3	2	225.0± 200.1	5	117.0± 63.9	6	116.0±91.6	52
	12	21.5±15.8	17	41.9±21.8	5	118.0± 105.5	16	80.0±62.2	51
	13	—	—	195.0	1	112.0± 131.8	7	92.0±82.0	53
	14	—	—	5.3	1	50.0	1	77.0± 145.5	58
	15	39.6± 4.7	2	—	—	—	—	322.0± 198.9	53
	16	—	—	—	—	—	—	71.0±71.0	57
	17	—	—	—	—	—	—	162.0± 117.7	60
	18	36.1±25.8	23	40.0±36.3	51	52.8± 40.3	53	30.5±23.8	53
	19	26.2± 8.8	3	0.14	2	2.8± 1.9	4	1.1± 1.6	36
	20	26.9±47.5	25	1.4± 3.2	44	0.14± 0.36	59	0.049±0.10	54
	21	—	—	0.024± 0.02		0.0084± 0.018	15	0.0087±0.02	50
Fluoroscopy	4	355± 198	3	2,320±2910	11	168.0± 357	11	78± 271.6	45
	5	1,372	2	1,232± 871	2	7,007± 5,477	8	2,660± 3,670	41
	8	5,984	1	9,592	2	3,637± 2,865	6	4,320± 5,830	47

* Classification of the examinations

± Standard deviation of gonad dose

Table 13-1 $\sum_{jk} n_{jk} d_{jk} W_{jk}$ in medical facilities (male) [1960]

Class in No. of beds		Total No. of the examinations [n]	$\sum_{jk} n_{jk} d_{jk} W_{jk}$ [Radiography]	$\sum_{jk} n_{jk} d_{jk} W_{jk}$ [Fluoroscopy]	$\sum_{jk} n_{jk} d_{jk} W_{jk}$ [Radiography, Fluoroscopy]
General hospital	20— 49	3,415	399,186	58,127	457,313
	50— 99	4,097	315,887	119,933	435,820
	100— 199	4,510	308,316	92,389	400,705
	200— 499	6,416	512,173	115,556	627,729
	500—	4,091	616,618	245,676	862,294
	Total	22,529	2,152,180	631,681	2,783,861
General practitioner	1— 19	8,220	570,535	272.010	842,545
	0	7,511	178,437	99,414	277,851
	Total	15,731	748,972	371,424	1,120,396

Table 13-2 $\sum_{jk} n_{jk} d_{jk} W_{jk}$ in medical facilities (female) [1960]

Class in No. of beds		Total No. of the examinations [n]	$\sum_{jk} n_{jk} d_{jk} W_{jk}$ [Radiography]	$\sum_{jk} n_{jk} d_{jk} W_{jk}$ [Fluonoscopy]	$\sum_{jk} n_{jk} d_{jk} W_{jk}$ [Radiography, Fluoroscopy]
General hospital	20— 49	1,796	34,902	298,086	332,988
	50— 99	2,350	52,498	516,194	568,692
	100— 199	2,821	45,814	318,533	364,347
	200— 499	4,285	81,935	449,402	531,337
	500—	2,903	67,138	377,564	444,702
	Total	14,155	282,287	1,959,779	2,242,066
General practitioner	1— 19	4,911	67,664	1,025,154	1,092,818
	0	4,045	39,127	399,984	439,111
	Total	8,956	106,791	1,425,138	1,531,929

Table 14 The ratio of total answered cards to complete answered cards. (1960)

Class in No. of beds		No. of punched cards used for calculation				Total	Fluoroscopy×100 / Radiography Fluoroscopy		No. of incomplete cards	Total No. of the examinations	* fc
		male		female			male	female			
		Radiography	Fluoroscopy	Radiography	Fluoroscopy						
General hospital	20— 49	3,085	330	1,530	266	5,211	9.7	14.8	310	5,521	1.06
	50— 99	3,576	521	1,944	406	6,447	12.7	17.3	382	6,829	1.06
	100—199	3,985	525	2,493	328	7,331	11.5	11.6	424	7,755	1.05
	200—499	5,771	645	3,899	386	10,701	10.1	9.0	585	11,286	1.05
	500—	3,654	437	2,594	309	6,994	10.7	10.7	144	7,138	1.02
	Total	20,071	2,458	12,460	1,695	36,684	10.9	12.0	1,845	38,529	1.05
General practitioner	1— 19	6,755	1,465	3,846	1,065	13,132	17.8	21.7	1,039	14,171	1.10
	0	6,540	971	3,305	740	11,556	12.9	18.3	885	12,441	1.08
	Total	13,295	2,436	7,151	1,805	24,688	15.5	20.2	1,924	26,612	1.09
Total									4,525**		

* fc: total number/total number of cards used for calculation

** 756 incomplete cards which could not classify the organizations were added.

Table 15 $\sum_{jk} n_{jk} d_{jk} W_{jk}$ in nonswering medical facilities (1960)

Class in No. of beds				No. of unanswered medical facilities	average No. of the X-ray examinations per one medical facilities	f_i	$f_i \times fc \times \sum_{jk} n_{jk} d_{jk} W_{jk}$ (F+M)
General hospital		20— 49		116	25	0.53	443, 991
		50— 99		38	50	0.28	298, 139
		100— 199		18	150	0.35	281, 158
		200— 499		11	300	0.29	352, 935
		500—		4	1, 000	0.57	758, 875
General practitioner	1—19	Can you fill in the survey cards?	yes	85	12.4	0.075	159, 662
			no	606	4.0	0.172	366, 159
			no answer	1, 163	4.0**	0.330	702, 514
	0	Can you fill in the survey cards?	yes	81	5.0	0.031	24, 004
			no	772	3 0	0.184	142, 475
			no answere	1,352	3.0**	0.325	251, 653

* $f_i = \dfrac{\text{number of X-ray examinations in unanswered medical facilities}}{\text{number of X-ray examinations in answered medicol facilities}}$

* The estimate

Table 16 $\sum_{jk} N_{jk} d_{jk} W_{jk}$/year in all medical facilities

(Radiography, Fluoroscopy) (male, fomale) (1960)

Class No. of beds		$fc \times \sum_{jk} n_{jk} d_{jk} W_{jk}$ for answered m.f.	$fi \times fc \times \sum_{jk} n_{jk} d_{jk} W$ jk for unanswered m.f.	$\sum_{jk} N_{ik} d_{jk} W_{jk}$ for answered and unanswered m.f.	$\sum_{jk} N_{jk} d_{jk} W_{jk}$ for all m.f. in Japan	$\sum_{jk} N_{jk} d_{jk} W_{jk}$/ year
General hospital	20— 49	837, 719	443, 991	1, 281, 710	1.28×10^7	6.4×10^8
	50— 99	1, 064, 783	298, 139	1, 362, 922	1.36×10^7	6.8×10^8
	100— 199	803, 305	281, 158	1, 084, 463	1.08×10^7	5.4×10^8
	200— 499	1, 217, 019	352, 935	1, 569, 954	1.57×10^7	7.85×10^8
	500—	1, 333, 136	758, 875	2, 092, 011	2.09×10^7	10.45×10^8
	Total					36.9×10^8
General practitioner	1—19	2, 128, 830	1, 228, 355	3, 357, 165	1.68×10^7	8.4×10^8
	0	774, 318	418, 132	1, 192, 450	0.60×10^7	3.0×10^8
	Total					11.4×10^8
Total						48.3×10^8

Table 17 Standard deviation of Genetically Significant Dose (1960)

Class in No. of beds			$\sum_{jk} (n_{jk} W_{jk} \sigma_{jk})^2$	fc	fi	$[A(1+fi)fc]^2$	$A^2 (1+fi)^2 fc^2 \times \sum_{jk} (n_{jk} W_{jk} \sigma_{jk})^2$
General Practitioners Hospitals	1	20— 49	5.0653×10^{10}	1.06	0.53	657, 559	3.330865×10^{16}
	2	50— 99	10.9574×10^{10}	1.06	0.28	460, 227	5.042891×10^{16}
	3	100— 199	3.9007×10^{10}	1.05	0.35	502, 327	1.959427×10^{16}
	4	200— 499	11.7613×10^{10}	1.05	0.29	458, 668	5.394532×10^{16}
	5	500—	9.1101×10^{10}	1.02	0.57	641, 120	5.840667×10^{16}
	6	1— 19	24.9335×10^{10}	1.10	0.58	188, 074	4.689343×10^{16}
	7	0	5.6293×10^{10}	1.08	0.54	172, 890	0.97325×10^{16}
Total (B)							27.230975×10^{16}

Square of Future Number of children in Japan (C)

$$[\sum_{k} (N_k W_k + N_k W_k)]^2 \cdots\cdots\cdots 1.56 \times 10^{16}$$

Standard deviation $\sigma_D = \sqrt{\dfrac{B}{C}}$ 4.2 (mren)

Table 18 Mean future number of children per head

Age class	Male	Female
0—14	2.6541	2.2216
15—19	2.6523	2.1959
20—24	2.4965	1.6562
25—29	1.6551	0.7732
30—34	0.8080	0.2712
35—39	0.3292	0.0560
40—44	0.1162	0.0031
45—49	0.0349	0.0002
50—54	0.0109	0
55—59	0.0035	
60—64	0.0011	
65—69	0.0003	
70—74	0.0001	
75—	0	

Table 19 Future number of children in Japan (1955)

	Populations		Future number of children	
	male	female	male	female
0— 4	4,770,100	4,538,000		
5— 9	5,647,600	5,444,900	40,560,752	32,701,508
10—14	4,854,600	4,736,900		
15—19	4,293,300	4,246,000	11,387,120	9,323,791
20—24	4,159,400	4,168,300	10,383,942	6,903,538
25—29	3,764,700	3,829,200	6,230,955	2,960,737
30—34	2,799,400	3,335,200	2,261,915	904,506
35—39	2,338,000	2,812,400	769,670	157,494
40—44	2,326,300	2,621,000	270,316	8,125
45—49	2,126,000	2,215,300	74,197	443
50—54	1,934,300	1,922,400	21,084	
55—59	1,595,300	1,586,500	5,584	
60—64	1,219,900	1,265,400	1,342	
65—69	904,000	1,033,800	271	
70—74	595,200	805,600	60	
75—79	344,300	536,600		
80—84				
85—89				
90—94	174,000	330,200		
95—99				
100—				
unknown	200	600		
Total	43,846,600	45,428,300	71,967,208	52,960,142
	89,274,900		124,927,350	

Table 20-1 $\sum_{jk} n_{jk} d_{jk} W_{jk}$ in each district [male] (1959)

District	Total No. of the examinations(n)	$\sum_{jk} n_{jk} d_{jk} W_{jk}$ (Radiography)	$\sum_{jk} n_{jk} d_{jk} W_{jk}$ (Fluoroscopy)	$\sum_{jk} n_{jk} d_{jk} W_{jk}$ (Radiography Fluoroscopy)	$\frac{\sum_{jk} n_{jk} d_{jk} W_{jk}}{n}$ (Radiography Fluoroscopy)
Sapporo-city Muroran-city	2, 824	244, 325	109, 296	353, 621	125
Niigata-city	1, 727	118, 153	27, 268	145, 421	81
Tokyo-pref.	26, 436	2, 546, 001	540, 493	3, 086, 494	116
Nagoya-city	7, 104	797, 290	610, 053	858, 343	121
Hiroshima-city	4, 933	538, 362	121, 014	659, 376	134
Tokushima-pref	2, 606	174, 513	48, 322	222, 835	96
Nagasaki-city	2, 442	203, 165	71, 612	274, 777	112
Total	48, 072	4, 621, 809	979, 058	5, 600, 867	117

Table 20-2 $\sum_{jk} n_{jk} d_{jk} W_{jk}$ in each district [female] (1959)

District	Total No. of the examinations(n)	$\sum_{jk} n_{jk} d_{jk} W_{jk}$ (Radiography)	$\sum_{jk} n_{jk} d_{jk} W_{jk}$ (Fluoroscopy)	$\sum_{jk} n_{jk} d_{jk} W_{jk}$ (Radiography Fluoroscopy)	$\frac{\sum_{jk} n_{jk} d_{jk} W_{jk}}{n}$ (Radiography Fluoroscopy)
Sapporo-city Muroran-city	1, 717	36, 531	155, 723	192, 254	112
Niigata-city	1, 161	34, 570	143, 235	177, 805	152
Tokyo-pref.	18, 475	397, 820	2, 129, 386	2, 527, 206	150
Nagoya-city	3, 854	90, 167	255, 026	345, 193	90
Hiroshima-city	3, 364	65, 600	622, 399	687, 999	205
Tokushima-pref.	1, 962	34, 167	328, 345	362, 512	184
Nagasaki-city	1, 148	22, 561	101, 966	124, 527	108
Total	31, 684	681, 416	3, 736, 080	4, 417, 496	139

Table 21 Genetically significant dose in each district; (1959)

District	Total No. of beds in general hospital	No. of beds in general hospital surveyed	Correction factor (f)	$\sum_{jk} n_{jk} d_{jk} W_{jk}$ (obtained by survey) (F+M)	$f \times \sum_{jk} n_{jk} d_{jk} W_{jk}$ (F+M)	$f \times \sum_{jk} n_{jk} d_{jk} W_{jk}$ (per year) (F+M)	Population (F+M)	No. of children expected (F+M)	Genetically significant dose (mrem/year)
Sapporo-city Muroran-city	4,231	2,779	1.54	545,875	841,000	42,050,000	42,662	798,706	52.6
Niigata-city	1,816	1,734	1.05	323,226	339,000	16,950,000	261,758	368,599	46.0
Tokyo-pref.	41,973	30,309	1.38	5,613,700	7,747,000	387,350,000	8,037,084	11,350,518	34.1
Nagoya-city	7,390	7,073	1.04	1,203,536	1,252,000	62,600,000	1,336,780	1,883,725	33.2
Hiroshima-city	3,095	2,703	1.13	1,347,375	1,523,000	38,075,000	357,287	489,365	77.8
Tokushima-pref.	3,982	3,222	1.23	585,347	720,000	36,000,000	878,109	1,208,250	29.8
Nagasaki-city	1,832	1,660	1.10	399,304	439,000	10,975,000	303,724	438,270	25.0

Table 23 Contribution of each examination class to the Genetically Significant dose in Japan. (in %) (1960)

Class of examination	Male	Female	Total
1	0.00624	0.0067	0.01294
2	0.0684	0.0493	0.1177
3	0.0266	0.0246	0.0512
4	1.05	2.77	3.82
5	1.8	28.3	30.1
6	0.0292	1.0	1.0292
7	1.16	0.686	1.846
8	10.4	11.1	21.5
9	0.154	0.113	0.267
10	11.3	0.497	11.797
11	11.5	0.166	11.666
12	4.1	0.1995	4.2995
13	3.30	0.348	3.648
14	2.42	0.0218	2.4418
15	0	0.0795	0.0795
16	0	0.10	0.10
17	0	0.301	0.301
18	5.0	1.18	6.18
19	0.389	0.00835	0.39735
20	0.474	0.0804	0.5544
21	0	0	0
22	0	0	0
Total	53	47	100

Table 22-1 The annual number of medical exposures in different groups of examination in Japan. (Male) (1960)

Classification of examination / Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total
00—02	25,300 (0)	56,112 (3,852)	5,310 (434)	111,663 (7,400)	2,165 (811)	0 (0)	2,645 (0)	1,302 (868)	1,354 (0)	2,956 (0)	0 (0)	9,809 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	136,736 (416)	3,908 (0)	46,897 (1,284)	0 (0)	0 (0)	406,1 (15,0
03—07	78,636 (0)	88,742 (7,740)	15,406 (868)	288,580 (22,546)	6,269 (3,817)	0 (0)	1,669 (434)	13,317 (4,439)	8,314 (0)	3,385 (0)	3,604 (0)	3,905 (416)	1,602 (0)	577 (0)	0 (0)	0 (0)	0 (0)	46,640 (868)	4,208 (416)	101,693 (2,963)	7,272 (0)	0 (0)	673,9 (44,5
08—14	85,385 (1,125)	301,776 (17,098)	21,921 (1,718)	455,100 (33,539)	20,534 (7,788)	709 (0)	6,893 (677)	6,716 (3,758)	14,082 (0)	8,622 (801)	1,418 (0)	13,091 (678)	10,294 (0)	0 (0)	0 (0)	0 (0)	0 (0)	55,412 (3,775)	17,986 (2,897)	254,873 (8,934)	7,942 (0)	709 (709)	1,283,4 (83,4
15—19	111,601 (416)	290,803 (10,079)	20,779 (1,302)	824,220 (68,311)	187,626 (75,353)	9,399 (1,125)	4,800 (0)	21,288 (8,219)	20,179 (811)	58,917 (811)	14,015 (0)	16,326 (811)	13,832 (0)	8,006 (0)	0 (0)	0 (0)	0 (0)	25,905 (416)	16,988 (0)	262,235 (5,588)	11,411 (0)	7,517 (0)	1,925,8 (173,2
20—24	133,929 (434)	269,319 (11,577)	38,629 (1,302)	1,083,919 (60,496)	430,186 (168,416)	30,787 (5,901)	11,776 (709)	38,634 (18,545)	27,293 (801)	77,534 (1,922)	51,757 (1,954)	12,256 (0)	39,027 (0)	8,268 (0)	0 (0)	0 (0)	0 (0)	31,303 (1,386)	21,580 (0)	331,642 (4,455)	15,588 (0)	8,505 (0)	2,661,9 (277,8
25—29	115,238 (0)	230,858 (6,188)	37,545 (1,112)	1,165,241 (80,202)	644,735 (234,857)	52,268 (5,206)	14,612 (709)	44,989 (20,432)	51,021 (677)	122,719 (1,478)	59,492 (677)	14,970 (434)	34,255 (0)	30,014 (0)	0 (0)	0 (0)	0 (0)	17,133 (0)	22,753 (0)	281,761 (3,264)	20,516 (0)	15,163 (1,111)	2,975,2 (356,3
30—34	141,347 (3,819)	144,151 (4,131)	40,533 (1,302)	1,162,491 (84,928)	643,295 (234,777)	40,659 (7,323)	17,953 (2,095)	42,843 (18,783)	44,348 (2,155)	127,204 (2,832)	53,335 (1,478)	14,746 (0)	48,630 (416)	15,071 (416)	0 (0)	0 (0)	0 (0)	31,622 (0)	11,429 (868)	215,109 (3,263)	17,434 (0)	17,600 (434)	2,829,8 (389,0
35—39	75,459 (416)	124,243 (5,097)	47,011 (2,224)	951,991 (52,071)	507,196 (185,360)	60,754 (9,065)	13,295 (850)	47,460 (24,016)	24,443 (0)	63,903 (434)	40,965 (0)	20,304 (0)	28,554 (0)	4,098 (0)	0 (0)	0 (0)	0 (0)	11,790 (0)	7,714 (434)	160,849 (5,416)	11,502 (0)	20,343 (434)	2,221,8 (285,8
40—44	36,029 (677)	67,483 (2,445)	30,781 (1,302)	773,878 (33,387)	460,964 (159,044)	40,047 (3,178)	4,234 (434)	35,773 (14,705)	12,626 (0)	61,445 (678)	15,706 (0)	4,906 (0)	35,904 (0)	9,329 (0)	0 (0)	0 (0)	0 (0)	9,579 (0)	9,313 (0)	122,319 (1,993)	12,179 (0)	9,860 (2,095)	1,752,3 (219,9
45—49	65,979 (0)	64,049 (2,113)	25,392 (678)	693,320 (36,714)	452,185 (153,753)	60,493 (6,375)	11,272 (1,235)	38,187 (20,875)	20,505 (677)	50,117 (0)	12,672 (0)	11,821 (0)	21,837 (677)	5,242 (0)	0 (0)	0 (0)	0 (0)	10,961 (0)	6,791 (0)	114,526 (2,981)	14,023 (0)	9,715 (709)	1,689,0 (226,7
50—54	59,126 (0)	79,491 (3,256)	22,043 (850)	632,842 (34,301)	474,911 (169,977)	40,762 (6,362)	3,442 (0)	39,128 (24,318)	13,511 (0)	36,662 (0)	20,763 (0)	5,645 (0)	15,332 (0)	7,330 (0)	0 (0)	0 (0)	0 (0)	7,712 (0)	6,739 (1,622)	96,960 (2,472)	3,757 (0)	8,440 (1,284)	1,574,5 (244,4
55—59	34,069 (0)	47,432 (0)	17,346 (416)	431,301 (26,913)	366,510 (130,278)	17,000 (3,439)	1,245 (0)	37,160 (17,742)	4,202 (0)	19,766 (0)	25,189 (801)	1,922 (0)	9,742 (0)	1,679 (0)	0 (0)	0 (0)	0 (0)	5,120 (0)	1,790 (0)	54,718 (2,529)	2,867 (0)	4,268 (0)	1,083,3 (182,1
60—64	37,482 (1,235)	27,409 (1,700)	17,616 (434)	333,601 (17,684)	287,988 (104,195)	19,168 (2,049)	7,992 (801)	18,039 (11,627)	4,637 (0)	17,329 (0)	16,275 (0)	6,253 (0)	36,829 (1,356)	11,968 (0)	0 (0)	0 (0)	0 (0)	11,104 (0)	1,622 (0)	45,682 (1,736)	1,125 (0)	5,422 (0)	907,5 (142,8
65—69	37,709 (0)	17,015 (434)	14,727 (868)	234,106 (18,336)	149,641 (60,579)	8,826 (868)	3,714 (0)	35,197 (15,934)	2,833 (0)	16,824 (0)	10,678 (0)	4,392 (0)	17,880 (0)	12,506 (0)	0 (0)	0 (0)	0 (0)	8,158 (0)	1,418 (0)	30,042 (0)	0 (0)	1,355 (0)	607,0 (97,0
70—74	10,105 (0)	6,952 (0)	5,967 (0)	104,774 (6,823)	90,262 (39,112)	10,757 (801)	5,426 (0)	23,114 (8,937)	2,165 (0)	14,620 (0)	1,622 (0)	3,252 (0)	7,641 (678)	6,108 (0)	0 (0)	0 (0)	0 (0)	4,888 (0)	678 (0)	19,344 (868)	3,020 (0)	1,354 (0)	322,0 (57,2
75—	0 (0)	2,658 (0)	4,719 (0)	54,069 (2,793)	36,313 (16,760)	677 (0)	2,064 (0)	6,807 (4,205)	677 (0)	4,312 (0)	2,036 (0)	2,157 (0)	6,823 (0)	3,886 (0)	0 (0)	0 (0)	0 (0)	6,118 (0)	0 (0)	9,934 (0)	0 (0)	0 (0)	143,2 (23,7
Total	1,047,394 (8,122)	1,818,493 (75,710)	365,725 (14,810)	9,301,096 (586,444)	4,760,780 (1,764,877)	392,306 (51,692)	113,032 (7,944)	449,954 (217,453)	252,190 (5,121)	686,315 (8,956)	329,527 (4,910)	145,755 (2,339)	328,182 (3,127)	124,182 (416)	0 (0)	0 (0)	0 (0)	420,181 (6,861)	134,917 (6,237)	2,148,584 (47,746)	128,636 (0)	110,251 (6,776)	23,057,5 (2,819,5

Figure indicated in this table include both radiography and flouroscopy.
The parenthesized figures stand only for flouroscopy.

Table 22-2 The annual number of medical exposures in different groups of examination in Japan. (Female) (1960)

Classification of examination / Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total
00—02	19,435 (0)	40,192 (2,152)	2,339 (0)	82,264 (5,375)	4,810 (4,132)	0 (0)	4,424 (709)	2,170 (2,170)	0 (0)	0 (0)	0 (0)	14,755 (0)	0 (0)	1,354 (0)	0 (0)	0 (0)	0 (0)	365,930 (2,134)	5,179 (868)	42,141 (1,245)	0 (0)	0 (0)	584,9 (18,7
03—07	24,287 (0)	43,677 (3,361)	8,051 (0)	248,310 (16,575)	832 (416)	709 (0)	0 (0)	3,620 (801)	678 (678)	3,921 (0)	0 (0)	4,251 (0)	434 (0)	0 (0)	0 (0)	0 (0)	0 (0)	42,820 (434)	1,354 (0)	64,384 (850)	1,852 (0)	0 (0)	449,1 (23,1
08—14	53,845 (0)	137,125 (9,648)	8,952 (416)	376,079 (30,429)	19,514 (9,102)	6,353 (1,302)	3,081 (0)	6,055 (3,433)	13,888 (0)	10,551 (0)	2,901 (0)	8,935 (0)	3,881 (0)	0 (0)	0 (0)	0 (0)	0 (0)	43,060 (434)	4,565 (0)	122,397 (3,400)	8,643 (0)	0 (0)	829,8 (58,1
15—19	73,231 (0)	87,003 (4,190)	15,272 (0)	862,966 (59,799)	139,402 (56,569)	12,035 (0)	4,503 (0)	30,982 (14,114)	12,861 (0)	22,433 (0)	7,559 (0)	7,654 (0)	20,583 (434)	1,235 (0)	0 (0)	0 (0)	3,256 (0)	12,554 (0)	5,119 (0)	116,018 (1,700)	16,286 (0)	7,886 (0)	1,398,8 (136,8
20—24	82,417 (0)	65,672 (3,774)	10,836 (0)	828,228 (82,463)	315,592 (110,973)	45,567 (3,170)	15,929 (1,094)	61,406 (31,912)	24,396 (0)	33,124 (0)	16,959 (0)	16,872 (0)	38,516 (0)	5,822 (0)	3,790 (0)	4,413 (0)	24,765 (0)	6,558 (434)	4,701 (0)	87,564 (2,511)	18,443 (0)	8,895 (1,545)	1,720,4 (237,8
25—29	72,622 (0)	43,780 (2,414)	8,922 (811)	801,028 (70,168)	300,975 (117,578)	46,438 (7,053)	18,152 (1,125)	37,354 (18,686)	36,204 (0)	47,305 (0)	13,949 (0)	13,438 (416)	22,465 (416)	1,788 (0)	7,174 (0)	34,474 (0)	44,788 (0)	11,352 (0)	3,394 (0)	64,196 (2,032)	25,592 (0)	5,672 (0)	1,661,0 (220,6
30—34	48,031 (0)	43,322 (2,056)	14,140 (416)	641,081 (46,984)	392,247 (160,290)	32,156 (5,534)	8,461 (434)	47,299 (25,740)	32,704 (0)	36,705 (0)	26,163 (0)	11,729 (0)	17,067 (0)	1,790 (0)	677 (0)	28,401 (1,545)	17,840 (443)	7,482 (868)	2,033 (0)	63,952 (811)	22,579 (0)	10,347 (0)	1,506,2 (245,1
35—39	37,412 (709)	44,812 (3,189)	11,793 (1,284)	508,873 (43,388)	288,118 (112,990)	35,906 (5,960)	12,647 (0)	28,784 (14,017)	24,483 (0)	32,184 (0)	16,680 (0)	8,573 (0)	21,618 (0)	2,977 (0)	1,633 (0)	7,459 (434)	5,580 (0)	9,818 (0)	1,602 (0)	59,424 (850)	17,400 (0)	5,737 (1,355)	1,183,6 (184,1
40—44	42,873 (0)	34,723 (1,284)	7,889 (0)	375,494 (26,306)	300,684 (127,365)	32,405 (7,812)	7,633 (0)	56,622 (25,977)	23,303 (434)	30,617 (0)	12,912 (0)	16,303 (1,545)	46,326 (2,034)	5,039 (0)	0 (0)	4,292 (709)	709 (0)	5,735 (0)	2,204 (0)	63,296 (3,788)	12,261 (0)	3,385 (0)	1,084,7 (197,2
45—49	51,621 (0)	38,125 (2,170)	11,133 (0)	311,386 (23,698)	282,805 (111,662)	34,158 (8,561)	4,768 (416)	29,388 (14,760)	14,007 (434)	27,430 (434)	7,948 (0)	6,378 (0)	18,014 (434)	5,788 (0)	0 (0)	3,204 (0)	0 (0)	2,255 (0)	0 (0)	44,058 (416)	7,193 (0)	0 (0)	899,6 (162,9
50—54	45,011 (434)	35,819 (2,586)	11,334 (416)	238,760 (24,771)	264,196 (101,805)	49,156 (7,823)	5,750 (0)	35,056 (16,500)	13,259 (0)	23,577 (0)	15,976 (0)	8,597 (0)	16 890 (0)	1,944 (0)	0 (0)	677 (0)	0 (0)	6,296 (0)	1,545 (0)	39,571 (1,284)	6,490 (0)	2,708 (0)	822,6 (155,6
55—	64,207 (0)	102,831 (4,472)	21,406 (0)	639,199 (59,911)	634,803 (252,317)	51,275 (8,953)	21,695 (811)	63,104 (32,367)	30,141 (0)	58,385 (0)	27,119 (801)	19,666 (0)	24,135 (0)	1,820 (0)	678 (0)	868 (0)	0 (0)	28,813 (1,354)	10,389 (0)	137,760 (416)	4,723 (0)	6,106 (434)	1,949,1 (361,8
Total	614,998 (1,143)	717,081 (41,295)	132,067 (3,343)	5,853,668 (489,867)	2,943,978 (1,165,199)	346,158 (56,168)	107,043 (4,589)	401,810 (200,477)	225,924 (1,546)	326,232 (434)	148,166 (801)	137,151 (1,961)	229,929 (3,318)	29,557 (0)	13,952 (0)	83,788 (2,688)	97,038 (434)	542,673 (5,558)	42,085 (868)	904,761 (19,303)	141,462 (0)	50,736 (3,334)	14,090,28 (2,002,42

Figure indicated in this table include both radiography and flouroscopy.
The parenthesized figures stand only for flouroscopy.

医学診療用放射線による遺伝有意線量に関する研究

文部省科学研究費による綜合研究班

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この報告は文部省科学研究費による「医学診療用放射線による遺伝有意線量に関する研究」班の研究成果で，1959年4月から1961年3月までの2年間にわたつて研究費計 280万円でおこなわれたものである．

研究の目的は日本での医療用放射線による遺伝有意線量を求めることにあり，その考え方並びに求め方は国連科学委員会報告書（1958年）に記載された式に従つたものである．

$$D=\frac{\sum_{jk}\left(N_{jk}^{(F)}\,d_{jk}^{(F)}\,W_{jk}^{(F)}+N_{jk}^{(M)}\,d_{jk}^{(M)}\,W_{jk}^{(M)}\right)}{\sum_{k}\left(N_{k}^{(F)}\,W_{k}^{(F)}+N_{k}^{(M)}\,W_{k}^{(M)}\right)}$$

1)　N_{jk} は j種のX線診断をうける年令Kの患者の年間の数であるが，全数調査は望めないので，我々は医療施設を一定の約束で抽出して部分調査をおこない，この結果を年間に拡大して計算した．

2)　d_{jk} は j種のX線診断によつて年令Kの患者がうける生殖腺線量である．この値は種々の要因によつてかなり広い範囲に変異するので，代表的な値を求めるのは至難であるが，我々は，後述のように実際の調査から得た撮影，透視の条件を再現して d_{jk} の平均値を求めた．

3)　W_k は年令Kの人の子供期待値であつて，人口統計から求めた．調査の対象は，一般病院及び一般診療所のX線診断のみに限つた．これら以外の医療施設におけるX線診断，健康診断のための間接撮影，歯科診療所における歯科X線診断，放射線治療並びに放射性同位元素の医学的利用は除外された．以下に結果の概要をのべる．

1．　調査　1959年は北海道（札幌市，室蘭市），新潟市，東京都，名古屋市，広島市，徳島市，長崎市の一般病院につき，連続した1週間にわたつてX線診断に関する調査をおこなつた．総計79,756枚の調査票を集計した上，X線診断の頻度の地方差，病床区分による差，経営主体による差を統計学的に検討した．結果として全国値を求めるにはかゝる有意選出法では不充分であることが判明した．1960年は調査規模を拡大し，全国の一般病院から $1/10$ の抽出をおこない 479施設を選び，X線施設を有する一般診療所から $1/5$ 抽出をおこない6,213施設を選んだ．この抽出は乱数を用いて確率抽出で，郵送による依頼によつてX線診断に関するデータを得た．総計61,378件のX線診断を集計し，年令別，部位別の頻度を求めた．この数値を遺伝有意線量の計算に用いた．

2．　生殖腺線量の測定　生殖腺線量に及ぼす因子として管電圧，濾過板，管電流，照射時間等のほかに，患者の体位，方向，照射野の大きさ，生殖腺からの距離等が考えられるが，これらの因子を調査表のデータに基いて検討した結果，生殖腺線量はこれらの因子によつて同一部位の撮影や透

視でも最高 10^4 程度までの変異の巾があることが分つた．従つて，モデル実験から直ちに有用な生殖腺線量の平均を求めるのは至難である．我々は，1959年の調査票から，男女別に年令を4階級に別け，各撮影，透視別に約60件を抽出し，記載された条件を実験室で再現してファントームを用いて生殖腺線量を測定し，この平均値を求めて d_{jk} とし，遺伝有意線量の計算に用いた．

3．遺伝有意線量の計算　全国値を求めるには調査に対して回答のなかつた施設でのX線診断の内容を推定する材料を得る必要あがり，全未回答施設に1週間の総診断件数に関する再調査をおこなつた．この結果を検討した後，遺伝有意線量を求めた．この際，調査時期により偏りは殆んどないと仮定して年間に拡大した．一方，d_{jk} の標準偏差がかなり大きいので，d_{jk} の標準偏差のみを用いて遺伝有意線量の標準偏差を計算した．

（結果）1960年に一般病院，一般診療所でおこなわれたX線診断による遺伝有意線量は，38.6±4.2mrem となつた．