



Title	Medical and Occupational Radiation Exposure Reported by Self-Administered Questionnaire
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Citation	日本医学放射線学会雑誌. 1977, 37(12), p. 1144-1152
Version Type	VoR
URL	https://hdl.handle.net/11094/18553
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MEDICAL AND OCCUPATIONAL RADIATION EXPOSURE REPORTED BY SELF-ADMINISTERED QUESTIONNAIRE

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ATOMIC BOMB CASUALTY COMMISSION

Hiroshima and Nagasaki, Japan

A Cooperative Research Agency of

U.S.A. NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL

and

JAPANESE NATIONAL INSTITUTE OF HEALTH OF THE MINISTRY OF
HEALTH AND WELFARE

with funds provided by

U.S.A. ATOMIC ENERGY COMMISSION

JAPANESE NATIONAL INSTITUTE OF HEALTH

U.S.A. PUBLIC HEALTH SERVICE

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Research Field Code: 302

Key Words: Medical radiation, A-bomb survivors, Adult
health study

質問票調査で判明した医療及び職業による放射線被曝

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広島、長崎両市の ABCC—予研成人健康調査対象者の調査から、診断、治療ならびに職業による電離放射線の被曝体験率を求めた。前回 ABCCを

訪れて以後に診断用放射線を受けたという回答は50%、又面接3カ月以内に受けたという回答は20%であつた。原爆非被曝群よりも原爆被曝群に高

い医用X線被曝率が得られた。このことは原爆被曝群が、非被曝群に比べてX線検査を必要とする罹病率が高いのか、あるいは原爆被曝群の原爆被曝者健康手帳の所有が医療診断を受けやすくし、高い頻度をもたらしただのかも知れない。原爆被曝群間では、X線被曝率の差は認められなかった。

放射線治療を受けたという回答率は広島で2.6%、長崎で1.6%、又職業上被曝については広島で0.5%、長崎で0.2%であつた。放射線治療及び職業上被曝については、いずれも原爆被曝線量による差は認められなかった。

ABSTRACT

Affirmative response rates for diagnostic, therapeutic, and occupational ionizing radiation exposure were ascertained by surveying Hiroshima and Nagasaki ABCC-JNIH Adult Health Study subjects. Half reported diagnostic exposure since last visiting ABCC; 20%, within 3 months of interview. Rates were higher for A-bomb exposed than those not-in-city; possibly because of a higher disease rate or concern therefor among the A-bomb exposed group and/or A-bomb Survivors Medical Treatment Law handbooks' facilitating more examinations of the exposed. The rates did not differ among the A-bomb exposed groups. The respective Hiroshima and Nagasaki rates were 2.6%, and 1.6% for radiation therapy; and 0.5% and 0.2% for occupational exposure. Neither radiation therapy nor occupational exposure rates differed by A-bomb dose.

BACKGROUND

Medical X-ray is being studied as a contaminant in evaluations of atomic bomb (A-bomb) survivors for late-radiation effects.¹⁾ Subjects in the Atomic Bomb Casualty Commission (ABCC) and the Japanese National Institute of Health (JNIH) Adult Health Study (AHS)²⁾ are surveyed periodically for exposure they reported receiving at other hospitals and clinics.^{3,5)} The present survey using a self-administered questionnaire spanned an interval during which no trained personnel were available to interview subjects. Affirmative responses will be used in subsequent estimates of individual doses from radiation therapy, and in supplementary estimates of AHS subjects' exposure trends over the years since World War II.

Exposure data reported for diagnostic roentgenology, radiation therapy and occupational hazards were analyzed for affirmative response rates by age and A-bomb (T65) dose,⁶⁾ and results were compared with those previously obtained.

METHOD

From 1 April 1965 to 31 December 1967, during their routine visits to the ABCC medical clinic, all AHS subjects completed a medical history questionnaire, assisted occasionally by nurses. The following questions concerning exposure to medical and occupational ionizing radiation were included:

1. Have you had any diagnostic X-ray examination:
 - a. At any time since last examination at ABCC? Yes No
 - b. Within the past 3 months? Yes No
2. Have you ever in the past had any radiation therapy?
Yes No Hospital Date
3. Have you ever had any exposure to X-ray or other radiation during any of your past or present occupations?
Yes No Occupation Date

Recorded data were coded and analyzed. There were negligible differences by age adjustment.

RESULTS

From 1 April 1965 to 31 December 1967, 11,960 Hiroshima and 4,985 Nagasaki subjects completed the questionnaire. Some subjects were surveyed more than once because the study spanned more than 2 years. Only the responses of 9,157 Hiroshima and 3,991 Nagasaki subjects surveyed during a prescribed 2-year examination

cycle were statistically analyzed.

Distribution of subjects by age groups is shown in Table 1, and by T65 dose groups in Table 2. These subjects comprised the basic population for statistical analysis. The numbers and percentages of subjects affirmatively responding for diagnostic X-ray are shown in Tables 3—6. Numbers and percentages for diagnostic exposure since previous ABCC visits are shown by age in Table 3, and by T65 dose in Table 4. The male affirmative response rate was higher than that for females in both cities. This rate decreased with increasing age as shown in Table 3. Table 4 shows higher response rates for 0—9, 10—99 and >100 rad A-bomb exposed groups

Table 1. Subjects surveyed, by age, sex and city

City	Sex	Age						Total
		0-29	30-39	40-49	50-59	60-69	>70	
Hiroshima	Male	246	835	429	660	728	347	3245
	Female	374	1240	1406	1225	1199	468	5912
	Total	620	2075	1835	1885	1927	815	9157
Nagasaki	Male	200	512	253	323	276	64	1633
	Female	223	875	621	314	239	86	2358
	Total	423	1387	874	642	515	150	3991

Table 2. Subjects surveyed, by A-bomb dose, sex and city

City	Sex	T65 Dose (rad)					Total
		Not-in-city	0-9	10-99	>100	Unknown	
Hiroshima	Male	812	1077	723	539	94	3245
	Female	1454	1942	1598	780	138	5912
	Total	2266	3019	2321	1319	232	9157
Nagasaki	Male	361	445	249	448	130	1633
	Female	534	631	350	712	131	2358
	Total	895	1076	599	1160	261	3991

Table 3. Affirmative responses for diagnostic X-ray exposure since previous ABCC visit, by age, sex and city

City	Sex	Age						Total	Regression Test †
		0-29	30-39	40-49	50-59	60-69	>70		
Hiroshima	Male	177(72.0)	569(68.1)	276(64.3)	395(59.8)	413(56.7)	169(48.7)	1999(61.6)	***
	Female	184(49.2)	616(49.7)	661(47.0)	640(52.2)	609(50.8)	210(44.9)	2920(49.4)	N.S.
	Total	361(58.2)	1185(57.1)	937(51.1)	1035(54.9)	1022(53.0)	379(46.5)	4919(53.7)	
Nagasaki	Male	128(64.0)	359(70.1)	180(71.1)	221(67.4)	135(48.9)	28(43.8)	1051(64.4)	***
	Female	112(50.2)	390(44.6)	261(42.0)	120(38.2)	85(35.6)	38(44.2)	1006(42.7)	**
	Total	240(56.7)	749(54.0)	441(50.5)	341(53.1)	220(42.7)	66(44.0)	2057(51.5)	

() Percent of number of subjects surveyed.

† This test is that the slope of regression line of the affirmative response rate on age is zero or not.

N.S. Not significant.

** 0.001 < P < 0.01

*** P < 0.001

than the not-in-city group in Hiroshima for recall since the last cycle visit, with no significant difference between the exposed groups themselves. The regression of the rate by A-bomb dose was not significant in either city.

Table 5 also shows a tendency for decrease in rate with increasing age and a higher affirmative response rate for males than that for females. Table 6 shows higher rates for the 3-month recall period for the A-bomb exposed groups than the not-in-city groups, without significant differences between exposed groups.

Affirmative radiation therapy responses by age and T65 dose groups are shown in Tables 7 and 8. For therapy responses, there was no difference by sex, but the Hiroshima rate was higher than that of Nagasaki. No significant difference by age (Table 7) or T65 dose range (Table 8) was found, but the difference between the >100 rad group and the not-in-city group was suggestively higher for Hiroshima females and Nagasaki males. The affirmative radiation therapy responses by institution type are shown in Table 9. Excluding unspecified institutions, these responses mainly involved large hospitals.⁷⁾

Affirmative occupational exposure responses by age and T65 dose groups are shown in Tables 10 and 11. There was no significant difference by either category.

Table 4. Affirmative responses for diagnostic X-ray exposure since previous ABCC visit, by T65 dose, sex and city

City	Sex	T65 Dose (rad)					Total
		Not-in-city	0-9	10-99	> 100	Unknown	
Hiroshima	Male	467(57.5)	664(61.7) Sugg.	448(62.0) Sugg.	352(65.3) **	68(72.3)	1999(61.6)
	Female	593(40.8)	978(50.4) ***	862(53.9) ***	414(53.1) ***	73(52.9)	2920(49.4)
	Total	1060(46.8)	1642(54.4)	1310(56.4)	766(58.1)	141(60.8)	4919(53.7)
Nagasaki	Male	236(65.4)	276(62.0) N.S.	160(64.3) N.S.	295(65.8) N.S.	84(64.6)	1051(64.4)
	Female	206(38.6)	271(42.9) N.S.	151(43.1) N.S.	318(44.7) *	60(45.8)	1006(42.7)
	Total	442(49.4)	547(50.8)	311(51.9)	613(52.8)	144(55.2)	2057(51.5)

() Percent of number of subjects surveyed.

Significance test by percentages of not-in-city group compared with each dose range.

N.S. Not significant.

Sugg. $0.05 < P < 0.1$

* $0.01 < P < 0.05$

** $0.001 < P < 0.01$

*** $P < 0.001$

Table 5. Affirmative responses for diagnostic X-ray exposure within 3 months of interview, by age, sex and city

City	Sex	Age						Total	Regression Test †
		0-29	30-39	40-49	50-59	60-69	> 70		
Hiroshima	Male	76(30.9)	244(29.2)	130(30.3)	147(22.3)	160(22.0)	62(17.9)	819(25.5)	***
	Female	70(18.7)	219(17.7)	216(15.4)	228(18.6)	215(17.9)	74(15.8)	1022(17.3)	N.S.
	Total	146(23.5)	463(22.3)	346(18.9)	375(19.9)	375(19.5)	136(16.7)	1841(20.1)	
Nagasaki	Male	54(27.0)	181(35.4)	86(34.0)	104(31.7)	54(19.6)	10(15.6)	489(29.9)	***
	Female	46(20.6)	153(17.5)	77(12.4)	42(13.4)	34(14.2)	12(14.0)	364(15.4)	*
	Total	100(23.6)	334(24.1)	163(18.6)	146(22.7)	88(17.1)	22(14.7)	853(21.4)	

() Percent of number of subjects surveyed.

† This test is that the slope of regression line of the affirmative response rate on age is zero or not.

N.S. Not significant.

* $0.01 < P < 0.05$

*** $P < 0.001$

Table 6. Affirmative responses for diagnostic X-ray exposure within 3 months of interview, by T65 dose, sex and city

City	Sex	T65 Dose (rad)					Total
		Not-in-city	0-9	10-99	> 100	Unknown	
Hiroshima	Male	168(20.7)	279(25.9) **	191(26.4) **	151(28.0) **	30(31.9)	819(25.2)
	Female	223(15.3)	336(17.3) N.S.	293(18.3) *	145(18.6) *	25(18.1)	1022(17.3)
	Total	391(17.3)	615(20.4)	484(20.9)	296(22.4)	55(23.7)	1841(20.1)
Nagasaki	Male	92(25.5)	132(29.7) N.S.	82(32.9) *	144(32.1) *	39(30.0)	489(29.9)
	Female	56(10.5)	102(16.2) **	62(17.7) **	110(15.4) **	34(26.0)	364(15.4)
	Total	148(16.5)	234(21.7)	144(24.0)	254(21.9)	73(28.0)	853(21.4)

() Percent of number of subjects surveyed.

Significance test by percentages of not-in-city group compared with each dose range.

N.S. Not significant.

* $0.01 < P < 0.05$ ** $0.001 < P < 0.01$

Table 7. Affirmative responses for radiation therapy, by age, sex and city

City	Sex	Age						Total	Regression Test †
		0-29	30-39	40-49	50-59	60-69	> 70		
Hiroshima	Male	5(2.0)	19(2.3)	13(3.0)	19(2.9)	17(2.3)	9(2.6)	82(2.5)	N.S.
	Female	4(1.1)	25(2.0)	35(2.5)	38(3.1)	39(3.3)	11(2.4)	152(2.6)	N.S.
	Total	9(1.5)	44(2.1)	48(2.6)	57(3.0)	56(2.9)	20(2.5)	234(2.6)	
Nagasaki	Male	3(1.5)	3(0.6)	3(1.2)	9(2.7)	7(2.5)	1(1.6)	26(1.6)	Sugg.
	Female	1(0.4)	14(1.6)	9(1.4)	7(2.2)	4(1.7)	3(3.5)	38(1.6)	Sugg.
	Total	4(0.9)	17(1.2)	12(1.4)	16(2.5)	11(2.1)	4(2.7)	64(1.6)	

() Percent of number of subjects surveyed.

† This test is that the slope of regression line of the affirmative response rate on age is zero or not.

N.S. Not significant.

Sugg. $0.05 < P < 0.1$

Table 8. Affirmative responses for radiation therapy, by T65 dose, sex and city

City	Sex	T65 Dose (rad)				Total
		Not-in-city	0-9	10-99	> 100	
Hiroshima	Male	23(2.8)	24(2.2) N.S.	17(2.4) N.S.	16(3.0) N.S.	82(2.5)
	Female	36(2.5)	38(2.0) N.S.	44(2.8) N.S.	29(3.7) Sugg.	152(2.6)
	Total	59(2.6)	62(2.1)	61(2.6)	45(3.4)	234(2.6)
Nagasaki	Male	3(0.8)	7(1.6) N.S.	3(1.2) N.S.	12(2.7) Sugg.	26(1.6)
	Female	8(1.5)	13(2.1) N.S.	3(0.9) N.S.	13(1.8) N.S.	38(1.6)
	Total	11(1.2)	20(1.9)	6(1.0)	25(2.2)	64(1.6)

() Percent of number of subjects surveyed.

Significance test by percentages of not-in-city group compared with each dose range.

N.S. Not significant.

Sugg. $0.05 < P < 0.1$

Table 9. Distribution of affirmative responses for radiation therapy, by type of institution, sex and city

City and sex	Large Hospital	Hospital	Clinic	Institution not Specified	Total
Hiroshima Male	41(50.0)	11(13.4)	14(17.1)	16(19.5)	82(100.0)
Female	91(59.9)	22(14.5)	21(13.8)	18(11.8)	152(100.0)
Total	132(56.4)	33(14.1)	35(15.0)	34(14.5)	234(100.0)
Nagasaki Male	7(26.9)	0(0.0)	8(30.8)	11(42.3)	26(100.0)
Female	19(50.0)	1(2.6)	6(15.8)	12(31.6)	38(100.0)
Total	26(40.6)	1(1.6)	14(21.8)	23(35.9)	64(100.0)

Numbers in parentheses are percentages.

Table 10. Affirmative responses for occupational exposure, by age, sex and city

City	Sex	Age						Total
		0-29	30-39	40-49	50-59	60-69	>70	
Hiroshima	Male	1(0.4)	6(0.7)	5(1.2)	6(0.9)	5(0.7)	2(0.6)	25(0.8)
	Female	2(0.5)	2(0.2)	6(0.4)	2(0.2)	6(0.5)	1(0.2)	19(0.3)
	Total	3(0.5)	8(0.4)	11(0.6)	8(0.4)	11(0.6)	3(0.4)	44(0.5)
Nagasaki	Male	2(1.0)	10(2.0)	2(0.8)	3(0.9)	5(1.8)	0(0.0)	22(1.3)
	Female	0(0.0)	3(0.3)	4(0.6)	4(1.3)	3(1.3)	1(1.2)	15(0.6)
	Total	2(0.5)	13(0.9)	6(0.7)	7(1.1)	8(1.6)	1(0.7)	37(0.9)

() Percent of number of subjects surveyed.

Table 11. Affirmative responses for occupational exposure, by T65 dose, sex and city

City	Sex	T65 Dose (rad)					Total
		Not-in-city	0-9	10-99	>100	Unknown	
Hiroshima	Male	6(0.7)	8(0.7)	5(0.7)	4(0.7)	2(2.1)	25(0.8)
	Female	6(0.4)	4(0.2)	7(0.4)	2(0.3)	0(0.0)	19(0.3)
	Total	12(0.5)	12(0.4)	12(0.5)	6(0.5)	2(0.9)	44(0.5)
Nagasaki	Male	5(1.4)	7(1.6)	2(0.8)	7(1.6)	1(0.8)	22(1.3)
	Female	6(1.1)	1(0.2)	0(0.0)	6(0.8)	2(1.5)	15(0.6)
	Total	11(1.2)	8(0.7)	2(0.3)	13(1.1)	3(1.1)	37(0.9)

() Percent of number of subjects surveyed

Table 12. Distribution of affirmative responses for occupational exposure, by type of occupation, sex and city

City and Sex	Physician	Medical Technician	Industrial Technician	Nurse	Others	Unidentified	Total
Hiroshima Male	2(8.0)	5(20.0)	7(28.0)	- -	2(8.0)	9(36.0)	25(100.0)
Female	1(5.3)	1(5.3)	0(0.0)	4(21.1)	3(15.8)	10(52.6)	19(100.0)
Total	3(6.8)	6(13.6)	7(15.9)	4(9.1)	5(11.4)	19(43.2)	44(100.0)
Nagasaki Male	9(40.9)	2(9.1)	8(36.4)	- -	0(0.0)	3(13.1)	22(100.0)
Female	2(13.3)	1(6.7)	0(0.0)	1(6.7)	3(20.0)	8(53.3)	15(100.0)
Total	11(29.7)	3(8.1)	8(21.6)	1(2.7)	3(8.1)	11(29.7)	37(100.0)

Numbers in parentheses are percentages.

In both cities the male affirmative response rates for occupational exposure were higher than those of females. By city there was no difference in the response rate for males, but it was higher for females in Nagasaki. Affirmative response distributions for occupational exposure by type are shown in Table 12. Salesmen contributed half of the response rate for the "industrial technician" category. The "others, male" group included one researcher and one high school teacher assistant; the "others, female," included research assistants, and wives and maids of clinic physicians. The affirmative response rate for occupational exposure was very low. Many of the affirmative responses were in the "unidentified" category. Some of these may have been those who received no assistance in completing their questionnaires. The affirmative responses of "industrial technicians" were more numerous in Hiroshima; whereas, physicians led all others in Nagasaki.

DISCUSSION

Table 13 compares present and earlier survey results⁵⁾. The latter study consisted of interviews by trained personnel. In both cities 50% of subjects reportedly experienced diagnostic exposures at some time since the last ABCC examination; 20%, within 3 months of interview. For diagnostic X-ray within 3 months of interview, the present rates exceeded those of the previous study in Nagasaki, but they were nearly similar in Hiroshima for both studies. There was a statistically higher affirmative rate for males than females within 3 months in both the previous and present studies and even for the one-cycle recall in the present study. This trend is similar to the sex ratio of bone marrow doses; namely, 60% for males and 40% for females reported for Japan as a whole⁸⁾.

Tables 3 and 5 show a lower affirmative response rate with increasing age, possibly reflecting an ease for younger people to obtain medical examinations during employment. The higher affirmative rate for the A-bomb exposed than the not-in-city groups (Table 6) suggests their use of A-bomb Survivors Medical Treatment Law handbooks provides them more frequent medical care, a trend similar to that in the previous investigation⁵⁾. There is also a possibility that the A-bomb exposed group had a higher disease rate or was concerned about having disease than that of the not-in-city group.

The affirmative response rates for radiation therapy were 2.6% in Hiroshima; 1.6% in Nagasaki, and corresponding rates in the previous study⁵⁾, were 2.8% and 0.1%, respectively (Table 13). The lower rates for

Table 13. Affirmative responses for radiation exposure in the present and earlier study

	1965-1967, Present Study						1964-1965 Survey					
	Hiroshima			Nagasaki			Hiroshima			Nagasaki		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
Subject surveyed	3245	5912	9157	1633	2358	3991	1970	3323	5293	942	1279	2221
All diagnostic X-ray since previous ABCC visit	1999 (61.6)	2920 (49.4)	4919 (53.7)	1051 (64.4)	1006 (42.7)	2057 (51.5)						
Diagnostic X-ray within past 3 months	819 (25.2)	1022 (17.3)	1841 (20.1)	489 (29.9)	364 (15.4)	853 (21.4)	562 (28.5)	745 (22.4)	1307 (24.7)	118 (12.5)	107 (8.4)	225 (10.1)
All past radiation therapy	82 (2.5)	152 (2.6)	234 (2.6)	26 (1.6)	38 (1.6)	64 (1.6)			150 (2.8)			2 (0.1)
All past occupational exposure	25 (0.8)	19 (0.3)	44 (0.5)	22 (1.3)	15 (0.6)	37 (0.9)	10 (0.5)	23 (0.7)	33 (0.6)	3 (0.3)	2 (0.2)	5 (0.2)

Numbers in parentheses are percentages.

Nagasaki might be due to less radiation therapy equipment in that city. But affirmative radiation therapy response rates increased in Nagasaki since the previous survey⁵⁾. The rate did not correlate with age groups or T65 doses, but a suggestively higher rate was observed in Hiroshima females and Nagasaki males in the >100 rad group as compared to the not-in-city group. Radiation therapy is administered mainly in large hospitals⁹⁾, where most therapy units are located (Table 9).

As previously reported⁴⁾⁵⁾, affirmative response rates for occupational exposure were low (Table 13). The present Hiroshima rate (0.5%) approximated those of previous studies (0.8%⁴⁾ and 0.6%⁵⁾), but the present Nagasaki rate (0.9%) increased from 0.1%⁴⁾ and 0.2%⁵⁾ of that previously recorded. The large numbers of affirmatively reported but "unexplained" occupational exposures underscore the need for subject assistance during such surveys.

Comparison of results of the present and previous studies⁵⁾, showed nearly identical affirmative response rates in Hiroshima. But all Nagasaki rates increased. Though the present survey's self-administered questionnaire methodology differed from interviewing of previous surveys, the increase in reported diagnostic and therapeutic exposures in Nagasaki as compared to lack of change in Hiroshima rates may have been due to greater disease and correspondingly greater use of X-ray apparatus.

Reliability of reporting is hampered by subjects' limited abilities in recalling X-ray examinations they received more than 3 months before interview⁹⁾¹⁰⁾. Because of large numbers of examinations and the relative unavailability of many of the pertinent medical records⁹⁾, it is impossible to routinely confirm diagnostic exposures reportedly occurring at other hospitals. However, the relatively low doses from these types of examinations make their routine confirmation less urgent than radiation therapy exposures.

On the other hand, because of the relatively high doses incurred, it is mandatory to search hospital records to confirm reported radiation therapy and to estimate doses therefrom. Therapy exposures are relatively easy to confirm because few subjects are involved, and the pertinent records are more readily available. The affirmative therapy reporting rates were greater for larger hospitals, and medical records were more readily available in those institutions.

AHS subjects are continually interviewed for radiation therapy they have received. This information is pooled with similar data from other studies³⁻⁵⁾¹¹⁾, and updated by searches of hospital and clinic records to confirm the exposures and ascertain doses.

Occupational exposures may be relatively easy to confirm, but any corresponding dose estimates are difficult or impossible to determine. Doses to some individuals engaged in the manufacture of medical and industrial radiological equipment and in the radiological profession may be relatively high, but their exposure doses have not so far been estimated. To obtain total doses for individuals, some estimation of their occupational exposure doses should be performed, referring to any recorded data such as those of film badges.

ACKNOWLEDGMENT

The authors sincerely appreciate the assistance to subjects by the Nursing Department, ABCC in completing the questionnaires. Mr. Kokichi Omae and other members of the Department of Epidemiology and Statistics, ABCC, Mrs. Sakae Kuwabara and Mrs. Kiyoko Nishioki of the Department of Radiology, ABCC greatly assisted in tabulating results. The criticisms and helpful suggestions of Drs. Walter J. Russell, Haruma Yoshinaga, Kenji Takeshita, Shigetoshi Antoku, Shozo Sawada and Iwao M. Moriyama during the study are greatly appreciated. We are indebted to Mrs. Sachie Masumoto and Miss Masako Shimooka for their assistance in the preparation of the report.

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