

## A Statistical Survey of Malignant Neoplasm Mortality among Atomic Bomb Survivors in Nagasaki

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A statistical survey was conducted on 1,347 reported deaths due to malignant neoplasm in Nagasaki City, among whom 629 cases had history of exposure to the atomic bomb explosion on August 9, 1945. The following findings were resulted from this survey. 1. Neoplasm of the digestive organs has the highest incidence of 72.8 per cent in male and 53.8 per cent in female, followed by that of the respiratory system in male and the reproductive system in female. Neoplasm of the lymphatic and hematopoietic system, which is supposed to be related closely to radiation, is 6.2 per cent in male and 4.1 per cent in female, significantly higher than the average incidence in Japan. 2. Higher neoplastic mortality was found in the younger generation as compared to the national rate, and majority of the cases in this age group belong to categories No. 200 to 205, namely malignant neoplasm of the lymphatic and hematopoietic system. If one exclude this 200-205 disease group, there is found no difference of incidence between the local, or the exposed, and the national neoplastic mortality in age distribution. 3. Control study of neoplastic mortality in Nagasaki Prefecture disclosed the incidence lower than the rate either of the nation or of the exposed, while the last two are almost identical.

Nearly one third of inhabitants in Hiroshima and Nagasaki were killed instantly or within a few months as the consequence of atomic bomb explosions on the 6th and 9th of August, 1945. Death was caused mainly by direct explosive pressure, heat burn, mechanical injury and radiation sickness. It is only natural to assume that such an enormous radiation must have left the survivor with some kind of physical after-effect. FOLLEY, BORGES and YAMAWAKI<sup>1,3)</sup> have reported of high incidence of leukemia and aplastic anemia among the survivors, and OH<sup>7)</sup> gave evidence of high mortality of malignant neoplasm among them. The author has carried out a statistical survey on the reported deaths due to malignant neoplasm in Nagasaki City in the five year period from 1953 to 1957.

### MATERIALS AND METHOD

The survey is based on the 1,347 fatal cases of malignant neoplasm selected from 11,424 death certificates submitted to Nagasaki City Health Department between January 1, 1953 and December 31, 1957. These 1,347 cases were sorted according to the year, sex, age, and district, and then comparisons were made among the exposed, the non-exposed and the unclassified.

On the exposed group the exposed circumstances (indoor or outdoor, with or

without sheltering) and symptoms of acute radiation sickness such as injury, burn, sore throat, epilation hemorrhage, from the skin and mucous membrane, fever, diarrhea and others were investigated.

To calculate mortality of the malignant neoplasm the total population of Nagasaki Prefecture and of Japan are to be estimated in addition to the total number of the survivors in Nagasaki City. The statistics used for this purpose are 1958 ABCC estimation of the survivors of the atomic explosion, and 1955 census populations of Nagasaki Prefecture and of Japan.

### STATISTICAL FINDINGS

Year, sex and district distribution of deaths due to malignant neoplasm are shown in the Table 1. Mortality of malignant neoplasm has increased gradually year after year, while it has not changed in the exposed group.

TABLE 1.  
Year, Sex and District Distribution of Deaths due to Malignant Neoplasm

	Inside City						Outside City						Total
	Exposed		Non-exposed		Unclassified		Exposed		Non-exposed		Unclassified		
	M	F	M	F	M	F	M	F	M	F	M	F	
1953	61	61	28	40	9	5	3	2	3	1	13	18	244
1954	63	65	38	33	4	5	2	3	2	1	22	7	245
1955	56	67	42	45	12	2	1	4	4	2	17	12	264
1956	55	72	59	43	8	7	3	1	5	3	19	11	286
1957	73	56	39	54	8	13	5	2	10	3	31	14	308
Total	308	321	206	215	41	32	14	12	24	10	102	62	1,347

M : Male. F : Female.

Acute symptoms of radiation sickness following exposure are, according to URABE and MENJYU<sup>11)</sup> and KAJITANI and HATANO<sup>12)</sup>, burn, injury, stomatitis, epilation, fever, nausea and vomiting, anorexia, petechiae and diarrhea. On the 445 exposed cases the above symptoms were investigated in relation to the exposed environment, as shown in the Table 2, as well as to the exposed distance, as shown in the Table 3. Distance was measured from the hypocenter where the explosion took place 600 meters above.

TABLE 2.  
Exposed Circumstances of Malignant Neoplasm Cases

Acute Radiation Symptom	Indoor Exposure				Outdoor Exposure				Unknown		Total
	Concrete Building		Wooden Building		With Shelter		Without Shelter		M	F	
	M	F	M	F	M	F	M	F			
Positive	8	4	24	29	8	11	19	15	8	2	128
Negative	15	4	85	112	13	20	26	20	10	11	317

TABLE 3.  
Acute Radiation Symptoms and Exposed Distance

Acute Symptoms	Exposed Distance (km)											Total
	0   0.5	0.6   1.0	1.1   1.5	1.6   2.0	2.1   2.5	2.6   3.0	3.1   3.5	3.6   4.0	4.1   4.5	4.6   5.0	Over 5.1	
Injury			1	2	6	4	3	3	5	5	3	32
Burn				2	1	1	2					6
Sore throat							1				1	2
Epilation				1		2			3	1	1	8
Petechiae						1						1
Fever						1		1	1	2		5
Diarrhea			1		4	2	4	3	2	1	2	19
Others						2	2	1		1		4
Many symptoms	2	2	12	5	8	5	7	6	1	1	2	51
Total	2	2	14	10	19	16	19	14	12	11	9	128

TABLE 4.  
Classification in International Classification of Diseases and Exposed Distance

	Distance (km)													Un- known
	Within 0.5	0.6	1.1	1.6	2.1	2.6	3.1	3.6	4.1	4.6	5.1	5.6	Over 6.1	
Mouth and pharynx No. 140-148	M. F.				1						2			
Digestive system and peritoneum No. 150-159	M. F.	1 2	2 4	4 8	8 15	15 18	18 35	35 43	28 19	19 23	9 17	9 15	32 15	1 2
Respiratory system No. 160-165	M. F.			1 1	1 1	2	8 3	7 4	5 2	2	1 3	2	4 3	
Breast No. 170	M. F.			2		1	2		4	1				1
Reproductive system No. 171-179	M. F.						1 16			1 10	1 6		1 7	1
Urinary system No. 180-181	M. F.						1 1		1 1	1		1 2		
Unknown location No. 190-199	M. F.		1 1	1		1	1 1	5 4	3 4	1 4			2 2	
Hematopoietic and lymphatic system excluding leukemia No. 200-203, 205	M. F.					1	2	1			1			
Leukemia No. 204	M. F.		1 1	1	1	1	2 3	4	2 1			1	1 1	
Total	M. F.	1 1	3 10	6 8	10 28	19 33	23 47	50 46	60 37	39 28	26 29	12 20	13 28	40 4
Neoplasm of unknown etiology No. 230-239	M. F.					1	1			1			2	

Relation between the exposed distance and malignant neoplasm is illustrated in the Table 4, which reveals that only a few survived the exposure in a close distance.

Year, sex and age distributions of the 629 exposed malignant neoplasm cases who died in the 5-year investigation period were shown in the Table 5. The average number of death per year was calculated from the total cases of five years. Total number of deaths due to malignant neoplasm in Nagasaki Prefecture in 4 years from 1954 to 1957 were sorted likewise as shown in the Table 6. Figures of 1954—1956 period are based on the unpublished data of Prefectural Health Department, and the figures of 1957 are based on statistics of Statistics Bureau, Ministry of Welfare. The Table 7 shows 629 exposed malignant tumor cases in age and cause of death distributions. The exposed malignant tumor cases were then classified after their location and organs to find percentage of each system and organ to all cases, comparing with national rates based on 1955 vital statistics published by Statistics Bureau, Ministry of Welfare, as shown in the Table 8. Mortality of malignant tumor in the exposed per 100,000 population was compared with prefectural and national rates in different age groups. As shown in the Table 9, mortality of malignant neoplasm in the exposed cases was calculated from the estimated age group population of December 1956 and average annual death in 5 consecutive years from 1953 to 1957, and mortality of malignant neoplasm in Nagasaki Prefecture was based on average annual deaths from 1954 to 1957 and prefectural population at 1955 census. National mortality of malignant neoplasm was based on 5 year vital statistics of Statistics Bureau from 1953 to 1957 (Table 10). This national mortality was used as control indicated by index 100, and the rate among the exposed and the prefectural population were expressed respectively. The Table 11 shows these ratio and the Figure 1 is its graphic illustration.

TABLE 5.  
Age, Sex, Year Distribution of Exposed Malignant Neoplasm Cases

Age	1953		1954		1955		1956		1957		Total		Average	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
0~4														
5~9														
10~14	1		1		1				1		3	1	0.6	0.2
15~19						1					1			0.2
20~24			1						1		1	1	0.2	0.2
25~29	1	2			1	1	1	3	3		6	6	1.2	1.2
30~34		1		1		3			2			7		1.4
35~39	2	4	1	1		4	1	3	3		4	15	0.8	3.0
40~44	5	6	1	2	2	5		5	3		8	21	1.6	4.2
45~49	2	4	3	6	4	3	2	8	2	2	13	23	2.6	4.6
50~54	4	5	5	11	8	5	4	4	8	5	29	30	5.8	6.0
55~59	10	11	8	12	10	10	10	9	6	8	44	50	8.8	10.0
60~64	12	5	14	12	10	5	15	14	20	7	71	43	14.2	8.6
65~69	8	6	19	11	6	12	9	10	16	9	58	48	11.6	9.6
70~74	8	6	2	8	10	8	6	7	10	8	36	37	7.2	7.4
75~79	4	8	6	1	2	7	6	5	8	4	26	25	5.2	5.0
Over 80	4	3	2		1	3	1	4	1	3	9	13	1.8	2.6
Total	61	61	63	65	55	67	55	72	74	56	308	321	61.6	64.2

TABLE 6.  
Age, Sex and Year Distribution of Malignant Neoplasm in Nagasaki Prefecture

Age	1954		1955		1956		1957		Total		Average	
	M	F	M	F	M	F	M	F	M	F	M	F
0~4	8		5	3	6	6	4	7	23	16	5.7	4.0
5~9		1	1	3	3	3	3	5	7	12	1.7	3.0
10~14	2	2	3	3	3	1	4	4	12	10	3.0	2.5
15~19	3	3	1	2	2		2	4	8	9	2.0	1.2
20~24	5	1	4	7	2	3	4	6	15	17	3.7	4.2
25~29	4	8	5	9	9	9	7	9	25	35	6.2	8.7
30~34	9	10	6	15	10	19	18	26	43	70	10.7	17.5
35~39	16	20	10	25	11	31	14	36	51	112	10.2	28.0
40~44	34	53	30	37	26	37	27	42	117	169	29.2	42.2
45~49	51	55	50	52	40	68	45	69	186	244	46.5	61.0
50~54	81	79	65	76	75	72	86	82	307	309	76.7	77.2
55~59	106	73	100	72	92	86	104	84	402	315	100.5	78.7
60~64	108	87	121	74	129	78	127	100	485	339	121.2	84.7
65~69	112	65	94	75	109	84	131	86	446	310	111.5	77.5
70~74	66	70	88	82	81	71	100	73	335	296	83.7	74.0
75~79	42	42	40	42	74	64	46	61	202	209	50.5	52.2
Over 80	27	20	17	26	20	30	19	30	83	106	10.7	26.5
Total	674	589	640	603	692	662	741	724	2747	2578	686.6	644.5

TABLE 7.  
Classification of Exposed Malignant Neoplasm Cases in International  
Classification Code Number and Age

Age	Code number												Total									
	140~148		150~159		160~165		170		171~179		180~181			190~199		200, 201 202, 203 205		204		230~239		
	M	F	M	F	M	F	M	F	M	F	M	F		M	F	M	F	M	F	M	F	
0~4																						
5~9																						
10~14																		3	1		3	1
15~19								1													1	
20~24								1										1			1	1
25~29			1	1		1						1	1				3	3	1		5	6
30~34				3				3											1			7
35~39			2	7				7						1			1	1			4	15
40~44			7	11			1	7							1		1	1			8	21
45~49			7	11	3	2	3	6	1			1			1		1	1			13	23
50~54			44	15	4	3	1	7					2		1		1	1			29	30
55~59			35	29	4	1	1	17		1		2	1	1					2		42	50
60~64	2		56	29	8	1	2	9	1			2	2	1		1					71	43
65~69	1		37	23	8	6		2	14		1	7	4	1		1			1		57	48
70~74			27	22	3	1	2	1	6	2	1	2	2	1	1					2	36	35
75~79			23	13	1		1	1	5	2				3			1	1			26	25
Over 80			5	8	2	1		2		1		1	1						1		8	13
Total	3		224	172	33	16	11	4	85	4	6	16	16	5	4	14	9	5	2	303	319	

TABLE 8.  
Classification of Exposed Malignant Neoplasm Cases in Affected  
Organs and Their Incidence

	Exposed Cases				Nation (1955)	
	No. of Death		%		%	
	M	F	M	F	M	F
Total	308	321	100.0	100.0	100.0	100.0
Mouth and pharynx	3		1.0		1.0	0.6
Digestive system	224	172	72.8	53.8	80.2	60.9
Esophagus	9	7	2.9	2.2	5.0	2.4
Stomach	138	92	44.6	28.4	55.7	39.5
Small intestine	2		0.5		0.2	0.2
Rectum	8	14	2.6	4.4	3.3	3.4
Liver and choledochus	48	45	15.7	14.1	11.8	10.1
Pancreas	9	1	2.9	0.3	1.5	1.3
Peritoneum	3	5	1.0	1.6	0.9	1.4
Others	4	6	1.3	1.9		
Respiratory system	33	16	11.1	5.0	7.1	3.6
Nose, ear, and sinus	4	4	1.0	1.3	0.9	0.7
Larynx	4	1	1.3	0.3	1.3	0.5
Lung, trachea and bronchus	24	9	7.9	2.8	4.5	2.2
Mediastinum	1		0.3		0.2	0.1
Others and unclassified		2		0.6		
Breast		11		3.4		
Reproductive system	4	85	1.3	26.9	1.1	23.6
Uterine cervix		18		5.6		2.3
Uterine body						0.4
Chorioepithelioma		3		0.9		0.7
Other regions of the uterus						
Unknown part of the uterus		59		18.4		16.6
Ovary		4		1.3		1.3
Ovarian tube and fimbria						
Other female genitalia		1		0.3		
Prostate	2		0.5		0.7	
Testis					0.1	
Other male genitalia	2		0.5		0.3	
Urinary system	4	6	1.3	1.9	1.6	1.2
Kidney	1	1	0.3	0.3	0.4	0.3
Bladder and others	3	5	1.0	1.6	1.2	0.9
Others	16	16	5.2	5.0	4.1	4.2
Skin		1		0.3	0.7	0.7
Eye	1	1	0.3	0.3	0.1	0.1
Brain and other central nervous system					0.2	0.1
Thyroid gland		2		0.6	0.1	0.3
Other endocrine glands		1		0.3		
Bone	8	3	2.6	0.9	1.1	0.9
Connective tissues						
Lymph nodes	1	1	0.3	0.3	0.3	0.3
Other unknown regions	6	7	2.0	2.2	1.6	1.8
Lymphatic and hematopoietic system	19	13	6.2	4.1	4.6	3.5
Lymphsarcoma and reticulosarcoma	5	4	1.6	1.3	1.0	0.8
Hodgkin's disease					0.6	0.3
Other lymphoma					0.1	0.1
Multiple myeloma						
Leukemia and aleukemia	14	9	4.6	2.8	2.9	2.3

TABLE 9.  
Mortality of Malignant Neoplasm per 100,000 Population

Age	Exposed				Nagasaki Prefecture			
	Average Annual Deaths in 5 years		Mortality		Average Annual Deaths in 4 years		Mortality	
	M	F	M	F	M	F	M	F
0~4					5.7	4.0	4.9	3.6
5~9					1.7	3.0	1.4	2.6
10~14	0.6	0.2	10.5	3.5	3.0	2.5	3.2	1.4
15~19		0.2		3.8	2.0	1.2	1.5	1.6
20~24	0.2	0.2	3.3	3.2	3.7	4.2	1.9	5.6
25~29	1.2	1.2	28.2	20.5	6.2	8.7	8.9	12.1
30~34		1.4		30.4	10.7	17.5	19.7	18.5
35~39	0.8	3.0	57.3	40.3	10.2	28.0	23.6	54.1
40~44	1.6	4.2	100.3	128.8	29.2	42.2	70.4	90.4
45~49	2.6	4.6	143.3	138.8	46.5	61.0	118.5	148.2
50~54	5.8	6.0	228.5	169.9	76.7	77.2	218.9	218.9
55~59	8.8	10.0	317.6	341.7	100.5	78.7	329.9	252.6
60~64	14.2	8.6	637.3	354.6	121.2	84.7	518.5	335.4
65~69	11.6	9.6	776.8	545.1	111.5	77.5	680.3	397.5
70~74	7.2	7.4	750.0	606.0	83.7	74.0	755.7	488.5
75~79	5.2	5.0	1019.6	602.0	50.5	52.2	771.7	490.0
Over 80	1.8	2.6	534.1	429.8	10.7	26.5	276.6	337.8

TABLE 10.  
National Mortality of Malignant Neoplasm per 100,000 Population

Age	1953		1954		1955		1956		1957		Average	
	M	F	M	F	M	F	M	F	M	F	M	F
0~4	5.8	4.3	6.5	4.9	6.8	5.3	7.7	5.3	7.4	5.3	6.8	5.0
5~9	3.0	2.7	4.2	2.5	4.4	3.0	4.2	2.8	4.1	3.3	3.9	2.8
10~14	3.2	2.9	3.5	2.8	3.9	3.3	4.3	3.2	3.4	3.1	3.6	3.1
15~19	4.6	4.3	5.1	4.0	5.4	3.5	5.5	3.9	4.8	4.4	5.1	4.0
20~24	6.2	5.7	6.1	5.3	5.8	5.3	6.6	6.1	6.8	6.3	6.3	5.7
25~29	8.9	11.8	9.4	11.9	9.1	11.8	9.9	12.0	10.0	13.0	9.4	12.1
30~34	16.6	25.7	16.6	27.2	17.3	23.5	17.4	27.9	18.0	27.4	17.2	26.3
35~39	32.6	53.5	33.6	55.4	33.3	49.6	36.7	50.3	31.4	50.2	33.5	51.8
40~44	62.0	93.9	65.5	91.0	65.1	91.6	64.5	91.9	59.6	87.4	51.4	91.2
45~49	119.9	146.0	119.6	142.7	127.0	139.1	125.0	139.3	123.4	137.3	121.9	140.9
50~54	220.0	202.7	221.1	209.1	218.2	201.6	229.5	201.9	227.9	196.2	223.3	202.3
55~59	362.8	275.4	371.7	278.1	354.5	275.2	367.1	274.5	387.1	271.4	368.6	274.9
60~64	547.4	355.1	561.2	374.8	573.4	368.3	579.3	377.9	595.7	367.8	571.4	368.7
65~69	745.4	481.4	775.6	487.3	800.9	492.0	807.8	509.2	804.8	486.0	786.3	491.2
70~74	876.7	555.5	922.8	555.7	971.8	573.7	1014.6	603.8	1043.2	606.0	965.8	579.1
75~79	853.5	543.5	884.6	552.5	904.7	596.7	998.6	616.1	993.8	614.4	927.0	584.6
Over 80	609.3	377.3	852.8	421.0	606.7	495.8	753.4	512.9	719.3	494.1	680.3	460.2

TABLE 11.  
Age Distribution of Mortality Index,  
When National Rate is Set as 100

Age	Exposed		Nagasaki Prefecture	
	M	F	M	F
0~4			72.1	72.0
5~9			35.9	92.8
10~14	291.6	112.9	88.8	45.1
15~19		85.0	29.4	40.0
20~24	52.3	56.1	30.2	98.2
25~29	300.0	169.4	94.7	100.0
30~34		115.6	114.5	70.3
35~39	171.0	166.6	70.4	144.4
40~44	195.1	141.2	136.9	99.1
45~49	117.5	98.5	97.2	105.1
50~54	102.3	84.0	98.0	108.2
55~59	86.2	124.3	89.5	91.8
60~64	111.5	96.2	90.7	90.9
65~66	98.8	111.0	86.5	80.9
70~74	77.7	104.6	78.2	84.3
75~79	109.9	103.0	83.2	83.8
Over 80	78.5	93.4	40.8	73.4

The mortality peak in the younger age group was found to be consisted mainly of malignant tumors of the lymphatic and hematopoietic systems (International Classification of Diseases Code No. 200 to 205). The Figure 2 illustrates graphic representation of the mortality after excluding these tumors of the lymphatic and hematopoietic systems which are believed to be closely related to radiation. Then the corrected malignant tumor mortalities of the exposed and of Nagasaki Prefecture were compared with that of the nation. The mortality of the exposed cases was corrected by comparing with above-mentioned age distribution of average annual mortality rate and the census population of October 1955. Same correcting method was applied to mortality of Nagasaki Prefecture. As mentioned before, the national mortality compared was the average annual mortality in 5-year period from 1953 to 1957 (Table 12). The corrected

malignant tumor mortality of the exposed was calculated in disease groups and compared with national rates (Table 13).

TABLE 12.  
Comparison of Corrected Mortality (per 100,000 Population)

	Nation 1953-1957		Nagasaki Prefecture 1954-1957		Exposed 1953-1957	
	M	F	M	F	M	F
Corrected Mortality	94.3	80.6	81.7	72.3	95.0	84.3

TABLE 13.  
Comparison of Corrected Mortality in Affected Organs (per 100,000 Population)

	Mouth & Pharynx		Digest. System & Peritoneum		Respiratory System		Breast	Uterus & Female Genitalia	Male Genitalia	Urinary System		Lymphatic & Hematopoietic System		Others & Unclassified	
	M	F	M	F	M	F				F	M	M	F	M	F
Nation (1955)	0.9		75.4	48.9	6.6	3.0	3.5	17.3	1.0	1.5	0.9	4.4	2.8	4.0	3.5
Exposed (1953-1957)	0.8		69.3	49.4	8.4	5.6	3.1	21.2	1.0	1.3	1.8	7.7	4.0	1.4	0.6



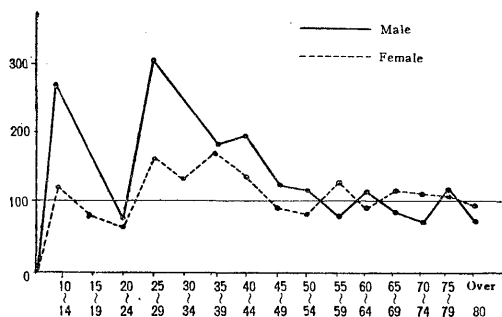


FIG. 1. Mortality index of exposed malignant neoplasm to national mortality (100).

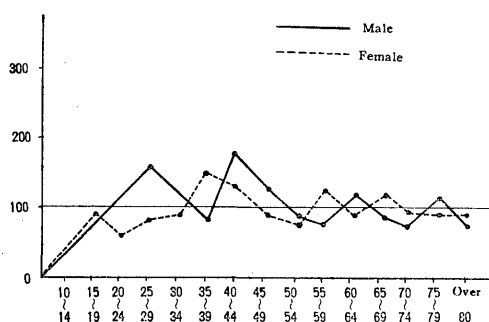


FIG. 2. Same after excluding No. 200-205 lesions.

### SUMMARY AND DISCUSSION

There have been reported 1,347 deaths due to malignant neoplasm in Nagasaki City in 5 years from 1953 to 1957. 629 of them were survivors of the atomic bomb radiation, while 421 were not exposed and 73 were of unknown status concerning exposure.

In spite of crucial importance of reliable vital statistics to be compared with, as SEGI<sup>9)</sup> pointed out, no exact population of survivors is recorded and the author was forced to use the estimated population of December 1956.

Exposed circumstances of the exposed cases were investigated, revealing that 132 of the exposed 413 were outdoor at the time of explosion and 281 were in the buildings most of which were of wood. Only 21 of 629 exposed cases were exposed in the distance within 1.5 km from the center and the rest beyond the radius, indicating that those who were exposed in close distance either died instantly or died of radiation sickness within a few months following exposure. Explosion at the periphery of the city and geographical situation of the city are possible explanation for these findings. Of 445 investigated exposed cases, 128 have noticed one or more symptoms of acute radiation sickness; injury, burn, sore throat, epilation, hemorrhage of the skin and mucous membrane, fever and diarrhea. All four who were exposed within 1 km radius have had many of the symptoms.

URABE and MENJYU<sup>11)</sup> have reported in their paper on symptoms of acute radiation sickness that considerable effect is inflicted upon the vascular system and other organs not mentioning the vulnerable hematopoietic system. Mortality of malignant neoplasm among the exposed was evaluated in sex and disease groups and it was found that neoplasm of the alimentary system shows the highest incidence above others, reaching 72.8 per cent in male and 53.8 per cent in female. This high incidence of neoplasm in the alimentary tracts is supported by SEGI's<sup>8)</sup> report and by 1955 vital statistics of the nation. SEGI also states that malignant neoplasm of the respiratory system is increasing in Japan. Among females neoplasm of the reproductive organs has the second highest incidence of 26.9 per cent only slightly lower than 28.4 per cent of gastric cancer. Neoplasm of the lymphatic and hematopoietic systems are the ones that are closely related to the atomic bomb radiation, and their rates among the exposed are 6.2 per cent in male and 4.1 per cent in female, both higher than the national rates of 4.6 per cent in male and 3.5 per cent in female.

Among the exposed there is no age group under nine which consists a large number of general population. This necessitates comparison in age levels rather than

simple comparison of mortality when any comparative study of malignant tumor is contemplated. Geographical and racial differences also influence incidence of malignant neoplasm, as SEGI *et al*<sup>10)</sup> have pointed out. Therefore, mortality in Nagasaki Prefecture, which has a similar environment, was compared with that of the exposed. Mortality of neoplasm in Nagasaki Prefecture is lower than either the national rate or the rate among the exposed. There is a certain disease group of younger age among the exposed which shows higher mortality than in the nation. This disease group is consisted of neoplasms of the lymphatic and hematopoietic systems, *i. e.* code No. 200 to 205. Exclusion of this disease group results in lower peak which is moderately high in 25 — 29 and 40 — 44 age groups of male, and slightly high in 25 — 29 female group.

Then the corrected mortalities of Nagasaki Prefecture and of the exposed were compared with national rate, revealing the same mortality of the exposed male and higher mortality of the exposed female, and lower mortality of both male and female residents of Nagasaki Prefecture as compared with national mortality. Mortality of the exposed is significantly higher than that of Nagasaki Prefecture. The incidence of malignant neoplasm of the respiratory, lymphatic and hematopoietic systems is higher among the exposed males than in the nation. Similarly incidence of neoplasm of the reproductive, lymphatic, hematopoietic, urinary and respiratory organs among the exposed females is higher than in the nation. The age group older than 40, who are susceptible to cancer, has increased only 0.02 per cent in male and 0.04 per cent in female in the exposed population in 7 years from 1949 to 1954. This increase is statistically insignificant.

### CONCLUSION

Five-year survey of deaths in Nagasaki City due to malignant neoplasm in 5-year period from 1953 to 1957 with respect to the relation of atomic bomb radiation to the incidence of malignant neoplasm has resulted in the following findings:

1. The exposed younger age group has had higher incidence of malignant neoplasm with predominance of the lymphatic and hematopoietic system, as compared with national mortality of the same age group.
2. Comparison of corrected mortality between the exposed and the nation shows same death rate with slightly higher rate of the exposed female, while mortality in Nagasaki Prefecture is significantly lower than the national rate.

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