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SURVIVAL EXPERIENCE OF ATOMIC BOMB SURVIVORS, HIROSHIMA AND NAGASAKI, 1951-76

原爆被爆者の生存率，広島・長崎，1951—76年

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原爆被爆者の生存率，広島・長崎，1951－76年

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SUMMARY

This report is a review of the experience of persons in the Life Span Study sample exposed to the atomic bombs in 1945 as reflected by survival rates for the period 1951-76. The greatest effect is on the population less than 10 years of age at the time of the bombs (ATB) exposed to 100 rad or more. The survival rates for both sexes in the two cities declined significantly below those for the controls. This change occurred after a latent period.

There has been an unusual acceleration in the decline in survival rates for the group aged 25-44 years ATB but this does not appear to be radiation related inasmuch as both the exposed and nonexposed populations in the two cities are similarly affected.

INTRODUCTION

The Atomic Bomb Casualty Commission (ABCC) was established in 1948 to study the effects of the atomic bomb explosions on the health of the surviving populations of Hiroshima and Nagasaki. The various studies conducted by ABCC and by its successor organization, the Radiation Effects Research Foundation (RERF), have focussed mainly upon the problem of the delayed radiation effects of the A-bombs on the surviving population and their offspring. Although the genetic effects of the A-bombs have yet to be demonstrated, there is a good deal of evidence relating to the somatic effects of ionizing radiation. These epidemiologic studies based upon death certificate information and on tumor registry data have made clear the carcinogenic effect of ionizing radiation with respect to leukemia and solid tumors of several sites.[1-9]

要 約

本研究では，1945年に原子爆弾に被爆した寿命調査集団を対象に1951－76年間における生存率を検討した．放射線の影響は，原爆時に10歳以下で100rad以上の放射線に被曝した者に最も大きく現われている．両市の男女共に生存率は，対照者のそれよりも有意に下降した．この下降現象は潜伏期間後に観察された．

原爆時年齢が25－44歳の者の生存率が異常に下降したが，両市の被爆群及び非被爆群に共にこの現象が見られたので，この急下降は放射線と関係がないようである．

緒 言

原爆傷害調査委員会（ABCC）は，1948年，広島及び長崎における被爆生存者集団の健康に及ぼす原子爆弾の影響を調査するために，創立されたものである．ABCC及びその継続機関である財団法人放射線影響研究所（放影研）は，主として原爆放射線が被爆集団及びその子孫に及ぼす遅発性影響の問題に焦点を当てて調査している．原爆の遺伝的影響はまだ立証されていないが，電離放射線の身体的影響については多くの証拠が得られている．死亡診断書及び腫瘍登録資料に基づくこれらの疫学的調査によって，白血病及び幾つかの部位の充実性腫瘍に関する電離放射線の発癌性影響が明らかになっている．[1-9]

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They have also suggested the possibility that other cancer sites are dose related. For diseases other than neoplasia, the results have been essentially negative.

In these epidemiologic studies, the general method of approach is to compare the experience of the population exposed to ionizing radiation with that of the nonexposed or those receiving minimal radiation exposure. Such comparisons show significant differences in a statistical sense. For example, the relative risk of leukemia mortality may be as high as 20:1 for certain groups by age ATB. This is a large difference and provides convincing support for the hypothesis of radiation effect. However, in an absolute sense, the excess number of deaths involved is relatively small.

The most recent Life Span Study (LSS) report shows that in the period 1950-74, the excess deaths per million person-years per rad of exposure is 3.89. This yields some 181 excess deaths among the 82,242 A-bomb survivors in the LSS in the 25-year period.[10] For the 285,000 registrants in the 1950 A-bomb survey, it may be estimated that there were from 337-492 radiation-induced cancer deaths in the period 1950-74. These estimates may be compared with possibly 70,000 deaths from other causes in the same population. It seems clear that radiation-induced cancer deaths form only a relatively small part of the total mortality in the surviving population.

Another way of viewing the experience of A-bomb survivors is to examine the survival rates for this population. The survival rate is the complement of the mortality rate, and has a readily understandable social significance. In this report, the survivorship experience of the A-bomb exposed population will be compared with that of the control group.

MATERIALS AND METHODS

The LSS extended sample is comprised of about 109,000 A-bomb survivors and controls. The control group (or the comparison group) consists of those located between 2,500m and 10,000m from the hypocenter ATB matched by age, sex, and city with survivors within 2,000m from the hypocenter. An additional comparison group of those not in the city ATB was also selected, but this group has not been included in the present report.

これらは，その他の癌部位も線量と関係のある可能性を示唆している．新生物以外の疾患については，実質的に放射線の影響は観察されなかった．

これらの疫学的調査では，アプローチの一般的方法は，電離放射線に被曝した集団と，非被爆者又は低線量被爆者の死亡率を比較する方法がとられる．そのような比較によって，統計的にみて有意な差が示される．例えば，白血病死亡の相対危険度は，特定の被爆時年齢群で20：1ほどの高さになることもある．これは大きい差異であり，放射線の影響に関する仮説の信頼できる支持となる．しかし，絶対的な意味では，これによる過剰死亡数は比較的少ない．

最近の寿命調査報告書によれば，1950－74年の期間における1rad当たり100万人年当たりの過剰死亡数が3.89である．これは，25年間で寿命調査集団中の原爆被爆者82,242人のうち約181人の過剰死亡をもたらすことになる．[10] これを1950年の原爆被爆者調査による登録者285,000人に当てはめた場合は，1950－74年の期間に放射線誘発癌による死亡は337－492例であったことが推定される．この推定値に対して，同一集団内に他の死因によって70,000名が死亡したと推定される．放射線誘発性癌による死亡数は，被爆集団における総死亡数の比較的小部分のみを占めることは明らかである．

原爆被爆者への影響を調べるその他の方法は，この集団の生存率を調べることである．生存率は（1－死亡率）であり，容易に理解できる社会的意義をもつものである．本報では，原爆被爆集団の生存率と対照群の生存率との比較を行う．

材料と方法

寿命調査拡大集団は，原爆被爆者及び対照者の合計約109,000人からなる．対照群すなわち比較群は，原爆時爆心地から2,500－10,000mの位置にいた者で，爆心地から2,000m未満にいた被爆者と年齢，性及び都市別構成を対応させた集団である．原爆時広島又は長崎市にいなかった者が別の比較群として選定されているが，この群は本報告に含めていない．

The study sample was established in connection with the National Census conducted 1 October 1950. Therefore, this study will not include the survivorship experience of those who died before the 1950 Census.

The deaths in the LSS extended sample are determined routinely from death certificates. In addition, use is made of the family registration system which makes it possible to ascertain the survival status of any individual in the family register maintained at the city office. Any vital event is posted in these registers regardless of the place where these events occur. Therefore, deaths occurring in the LSS extended sample are known with virtual certainty.

Dose estimates are available for each individual in the LSS extended sample. These estimates were based on available information on physical location of the individual with respect to the hypocenter and the shielding configuration. The T65D estimates were calculated from the dosimetry equation provided by the Oak Ridge National Laboratory.

The quality of ionizing radiation differs in the two cities. In Hiroshima the neutron component is appreciable, whereas in Nagasaki the radiation is predominantly from gamma rays.

Because the cohorts were established a little over 5 years after the A-bombs, the survivorship patterns differ significantly from the survivorship of the actual population exposed. However, the survivorship experience in this study corresponds to the mortality experience as observed in the LSS extended sample.

RESULTS

The survival rates (Appendix 1) are measures of the probability of survival over the specified number of years for the various cohorts alive 1 October 1950 who were exposed to different doses some 5 years previously. They also indicate the proportion of the population still alive at a particular point in time.

By the end of 1976, 74% of the LSS extended sample was still alive. The survival rate for the Nagasaki sample (0.77) is considerably higher than that for Hiroshima (0.73). Also, as may be

この調査集団は，1950年10月１日に実施された国勢調査に関連して行った被爆者調査に基づくものである．したがって，本研究では，1950年国勢調査以前に死亡した者の生存率は含まれていない．

寿命調査拡大集団に起こる死亡は，死亡診断書によって確認される．更に，戸籍制度を利用し，市役所で保管中の戸籍を照合して対象者の生死が確認できる．生死など異動が生じたときは，それがいずれの場所で起ころうとも戸籍にその変化が記載される．したがって，寿命調査拡大集団対象者に生じた死亡はほとんど確実に分かる．

寿命調査拡大集団の各対象者については線量推定値が得られている．これらの推定値は，爆心地からの距離や遮蔽条件など，対象者の位置に関する入手資料に基づいて計算されたものである．Oak Ridge National Laboratory が提供した線量推定方程式によりT65D推定値が算出された．

電離放射線の線質は，広島と長崎とでは異なる．広島では中性子線が相当認められ，長崎では主としてガンマー線であった．

対象集団は原爆後５年余りして設けられたので，その生存率は実際の被爆集団の生存率とは有意に異なる．ただし，本調査での生存率は寿命調査拡大集団に認められた死亡率に相当するものである．

結　果

ここに示す生存率（付録１）は，1945年に異なる線量に被曝し，1950年10月１日に生存していた各コホート群についてみたその後の生存確率の尺度である．また，この生存率は，その集団がある特定の時点まで生存した割合を示す．

1976年の末には，寿命調査拡大集団の74％がまだ生存していた．長崎集団の生存率（0.77）は，広島（0.73）よりもかなり高い．また，表１から分かる

TABLE 1 PERCENT SURVIVORS AS OF 31 DECEMBER 1976, HIROSHIMA AND NAGASAKI

表1　生存者の百分率；1976年12月31日現在，広島・長崎

Age ATB •	Male	Female	Total
Total	68.3%	77.9%	73.9%
<10	96.4	97.9	97.1
10-14	92.4	95.0	93.7
15-24	89.6	94.1	92.8
25-44	70.6	82.9	78.5
45-64	23.6	37.4	30.8
65+	0.2	1.7	1.1

seen from Table 2, the survival rate for females is significantly greater than for males, especially in the older ages ATB. As expected, the percentage alive varied inversely with increasing age ATB. By 1976, of those who were 65 years of age and over ATB, less than 2% remained in Hiroshima and there were virtually none in Nagasaki.

In comparing the survival rates by dose, sex, and age (Figures 1-5) no radiation effect can yet be detected for the group exposed to 1-99 rad. Among Hiroshima males under age 10 ATB, the survival rate seems to be somewhat below that for the 0 rad group starting around 1970. The difference is not yet statistically significant, but because these men are reaching the age of rapidly diminishing survival, the effect of low radiation dose may soon become more evident.

The most prominent feature of the survival curves is the apparent radiation effect for the population under age 10 ATB. In both cities and in both sex groups, the survival rates for those exposed to 100 rad or more have, after a latent period, dropped below those for the control groups. The number of deaths in this age group is still small, and consequently the survival rates are high. However, the differences in proportion of the original cohort alive at the end of 1976 between the 100 rad or more group and the control group are statistically significant.

For the other age groups, the differences in survival rates for both cities and both sexes are not as consistent as for the younger age groups. For example, in the 10-14 year age ATB group, the survival rates for Hiroshima males exposed to 100 rad or more were consistently lower than those for the control groups over the 26-year period, while no such difference was observed

ように，女の生存率は，特に原爆時高齢であった者では，男よりも有意に高い．生存率は，予想どおり，原爆時年齢と反比例した．1976年には，原爆時65歳以上であった者のうち，生存した者は広島では2％未満であり，長崎ではほとんどいなかった．

線量，性及び年齢別による生存率の比較（図1－5）では，1－99rad に被曝した群の放射線影響はまだ探知されない．原爆時10歳未満であった広島の男では，0 rad 群の生存率に比べ1970年頃から幾らか低くなったように思われる．その差はまだ統計学的に有意ではないが，それらの男は急速に生存率が低下する年齢に達しつつあるので，低線量の影響は間もなくより明白になるかもしれない．

生存曲線の最も顕著な特徴は，原爆時年齢10歳未満の群に放射線の影響と思われる傾向がみられることである．広島・長崎両市，男女両群とも，100 rad 以上の者の生存率は，潜伏期間の後では対照群の者よりも低下した．この年齢群の死亡者数はまだ少ないので，その生存率は高い．しかし，100rad 以上の群と対照群との間には1976年末における生存率に有意な差が認められる．

その他の年齢群では，生存率の差は広島・長崎両市，男女両群において若年群ほどは終始一貫していない．例えば，原爆時年齢10－14歳群においては，100 rad 以上に被曝した広島の男の生存率は，対照群よりも26年間にわたって終始低かったが，長崎の男ではその

in Nagasaki. For Hiroshima females, a drop in the survival rate for the 100 rad or more group may be observed about 1970. It is not clear whether this divergence will continue.

For the 15-24 year age ATB group, the survival rates for females only seem to show the tendency to diverge starting towards the end of the 1960s. However, the differences between the heavily exposed and the control populations are not yet statistically significant.

The striking feature of the survival rates for the 25-44 year age ATB group is that they are essentially curvilinear whereas the rates for the other age groups are linear. This suggests that the mortality rates for this age group have been increasing more rapidly in recent years. The reason for this is not clear, but it seems to be uniformly true for both cities and both sexes. Also, the different exposure groups appear to be affected in the same way. In other words, it would seem that the same nonradiation-related phenomenon is affecting the survival pattern for this age group.

In the 45-64 year age ATB group, only the survival rates for Hiroshima males appear to be adversely affected by radiation exposure. The age of members of this group is presently at least 75 years, and the future lifetime is relatively short. It does not seem likely that substantial radiation effects on survival will be demonstrated by those in this age group.

DISCUSSION

Relatively large differences in mortality can be demonstrated between the population exposed to ionizing radiation and the controls. Studies on carcinogenesis using such measures constitute convincing evidence of a radiation effect. On the other hand, the absolute number of excess deaths is invariably small, and does not alter substantially the survival pattern of A-bomb survivors.

The acceleration in the decline of the survival rates in the 25-44 year age ATB group appears unusual, but it does not seem to be radiation related. Both the exposed and nonexposed in the two cities appear to be similarly affected.

From the standpoint of radiation effects, the most significant finding relates to the survival

ような差は認められなかった．広島の女では，100 rad 以上群の生存率の低下は，1970年頃に認められる．この差が続くかどうかは明らかでない．

原爆時15—24歳であった群では，女のみの生存率には，1960年代の末から差が始まる傾向があるように思われる．しかし，高線量被曝群と対照集団との差は依然として統計的に有意ではない．

原爆時年齢25—44歳群の生存率における特徴は，他の年齢群の率は線形であるのに，それがほとんど曲線を呈することである．これは，この年齢群の死亡率が近年一層急上昇していることを示唆する．この理由は明白でないが，両市の男女共そのことがいえるように思われる．また，異なる被爆群にも同様の傾向がみられるように思われる．換言すれば，放射線被曝と関係のない同様の現象がこの年齢群の生存率に影響しているように思われる．

原爆時年齢45—64歳群では，広島の男の生存率のみに，放射線被曝の影響がみられるように思われる．この群の対象者の年齢は現在少なくとも75歳であり，余命は比較的短い．この年齢群の者では，生存率に及ぼす有意な放射線影響が認められることはないと考える．

考　察

電離放射線を受けた集団とその対照群との間には，死亡率に比較的大きい差が認められる．このような尺度を用いて発癌について研究すれば，放射線の影響が明らかに確認できる．反面，過剰死亡例の絶対数は常に小さく，それによって原爆被爆者の生存率が本質的に変更されることはない．

原爆時年齢25—44歳群における生存率の急激な下降は異常のように思われるが，それは放射線と関係がないように思われる．両市における被爆者も非被爆者も，同様に影響を受けているように思われる．

放射線影響の観点からすれば，最も有意な所見は，原爆時10歳未満であった者の生存率に関するもので

experience of those who were less than 10 years of age ATB. After a latent period, the survival rate for those exposed to 100 rad or more is beginning to decline. This is true of survivors of both sexes in the two cities. The changes in the survival rates are still small (although statistically significant), and it is not certain at this time what the pattern will be in the future. However, it would seem worthwhile to follow this group and study in greater detail possible radiation effects.

ある．100rad 以上に被曝した者の生存率は，潜伏期後下降しはじめている．これは両市の男女いずれの被爆者にもいえることである．生存率の変化は(統計的には有意であるが)依然として小さく，現時点では，将来どんなパターンになるか不明である．しかし，この対象群を追跡し，放射線の影響をより詳細に調査する価値はあると思われる．

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FIGURE 1 PERCENT SURVIVORS IN THE LSS EXTENDED SAMPLE BY AGE, CITY, SEX, & EXPOSURE, 1951-76
AGE LESS THAN 10

図1　寿命調査拡大集団中の生存者の百分率；年齢，都市，性及び被曝線量別；1951－76年；原爆時年齢10歳未満

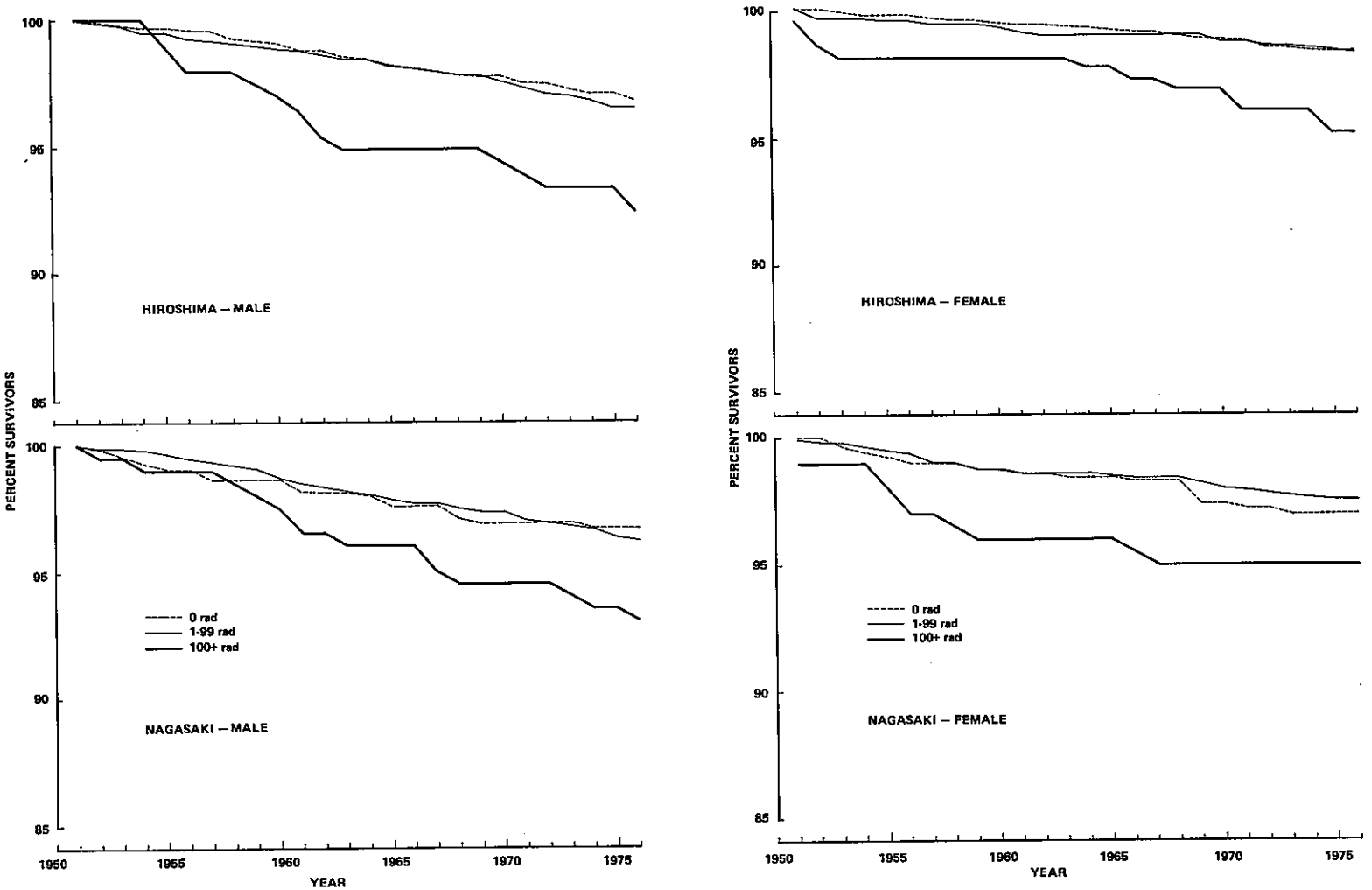


FIGURE 2 PERCENT SURVIVORS IN THE LSS EXTENDED SAMPLE BY AGE, CITY, SEX, & EXPOSURE, 1951-76
AGE 10 – 14

図 2　寿命調査拡大集団中の生存者の百分率；年齢，都市，性及び被曝線量別；1951－76年；原爆時年齢10－14歳

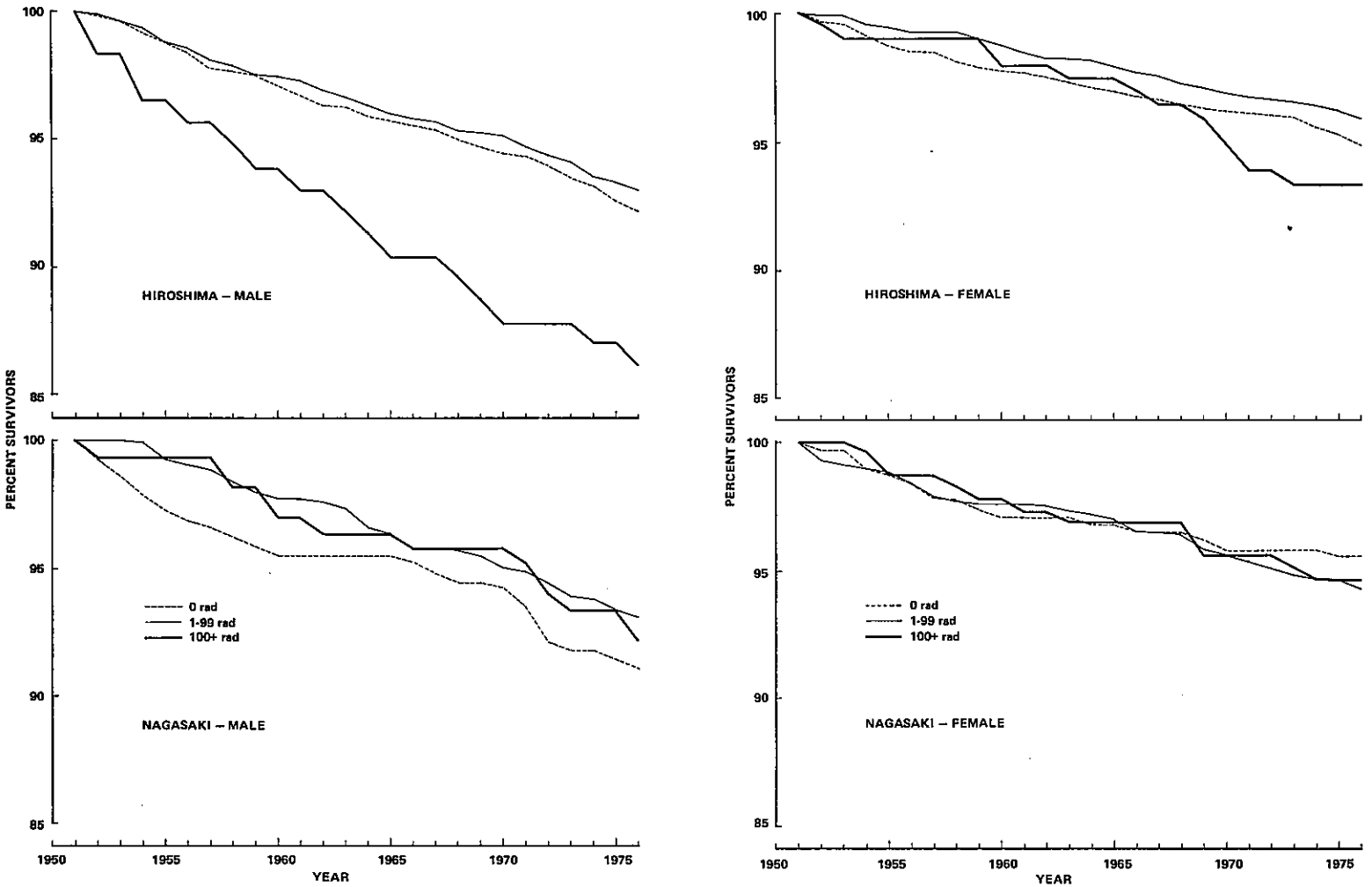


FIGURE 3 PERCENT SURVIVORS IN THE LSS EXTENDED SAMPLE BY AGE, CITY, SEX, & EXPOSURE, 1951-76
AGE 15 – 24

図3　寿命調査拡大集団中の生存者の百分率；年齢，都市，性及び被曝線量別；1951－76年；原爆時年齢15－24歳

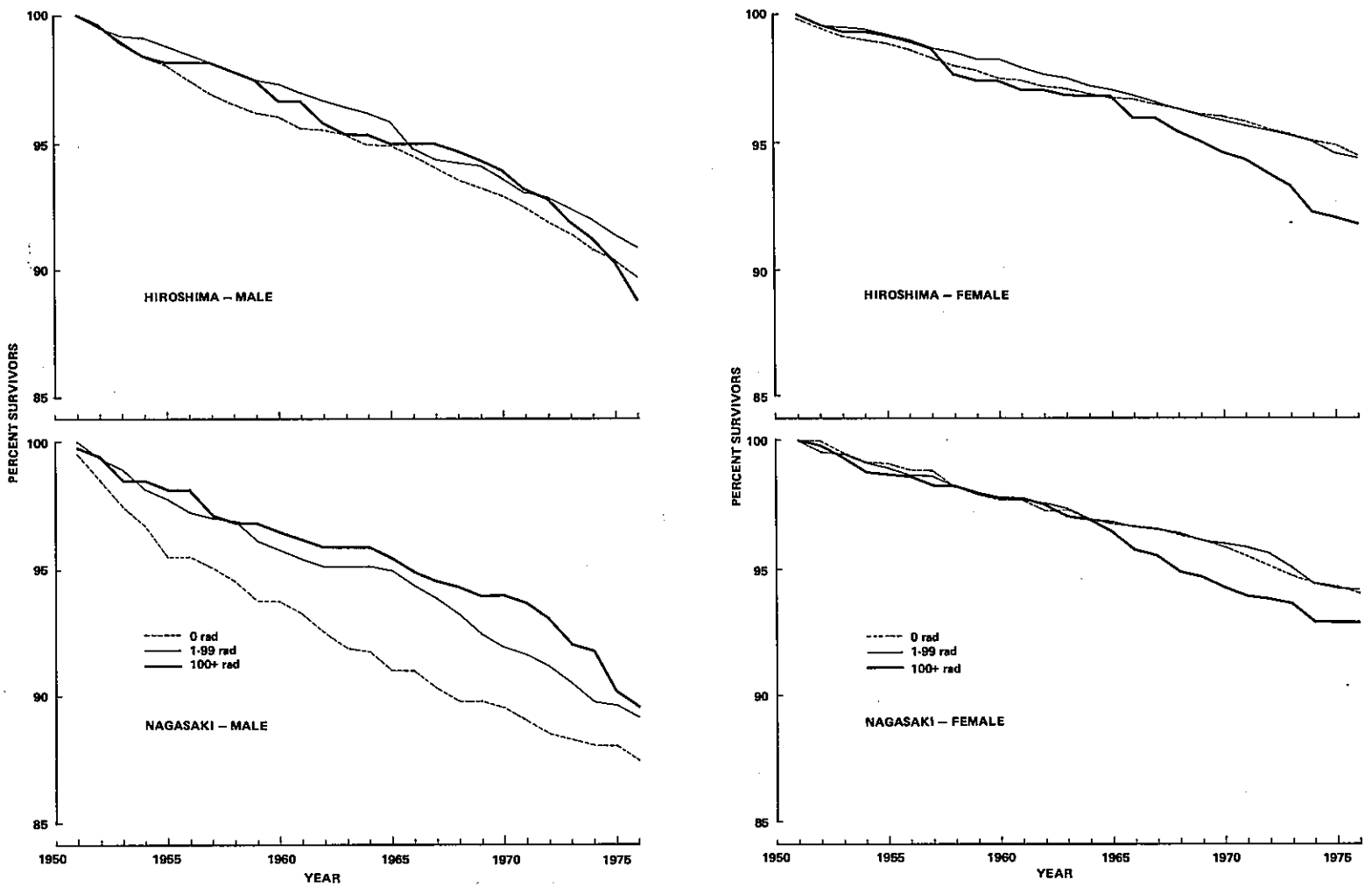


FIGURE 4 PERCENT SURVIVORS IN THE LSS EXTENDED SAMPLE BY AGE, CITY, SEX, & EXPOSURE, 1951-76
AGE 25 – 44

図 4　寿命調査拡大集団中の生存者の百分率；年齢，都市，性及び被曝線量別；1951－76年；原爆時年齢25－44歳

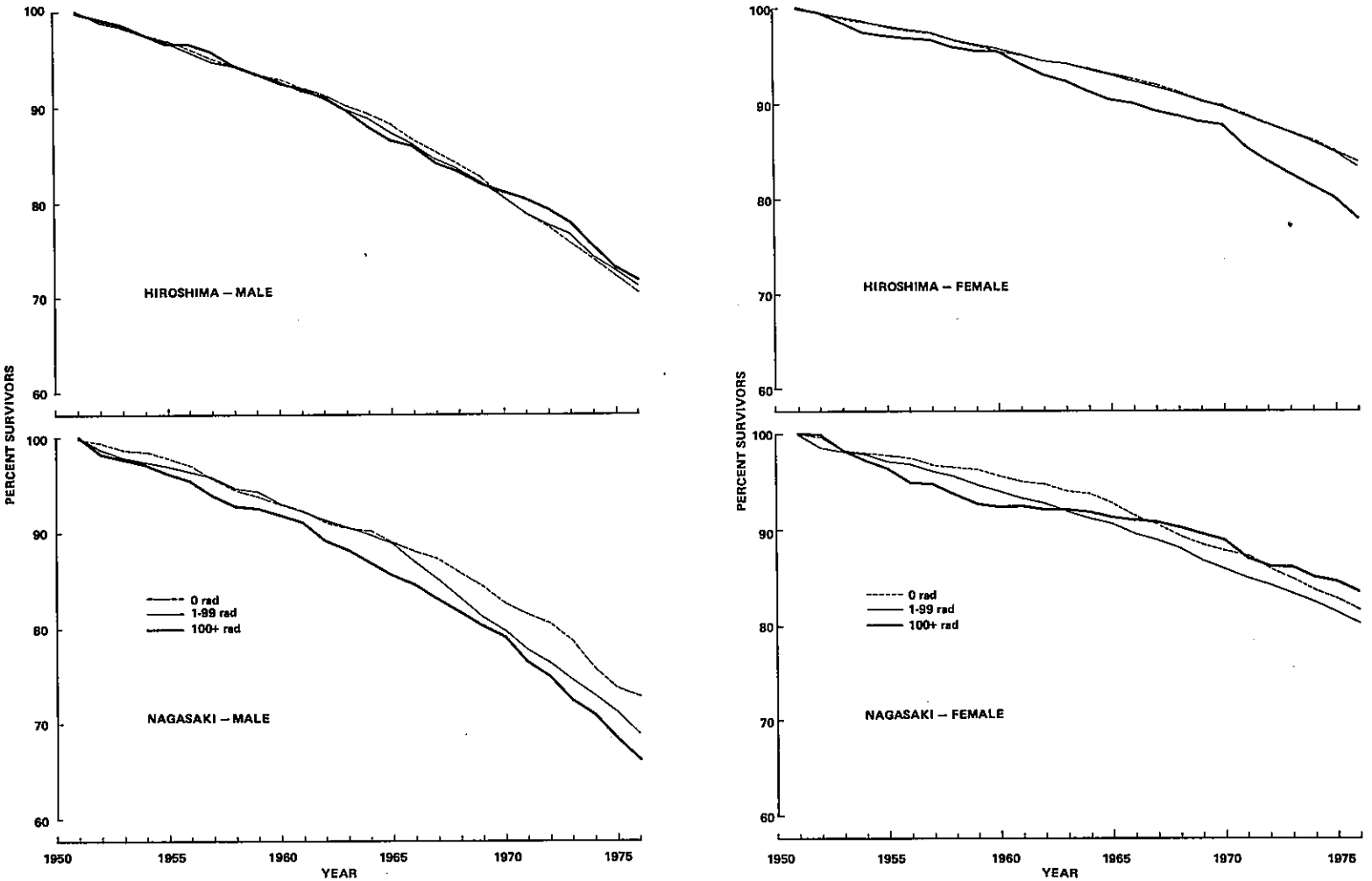
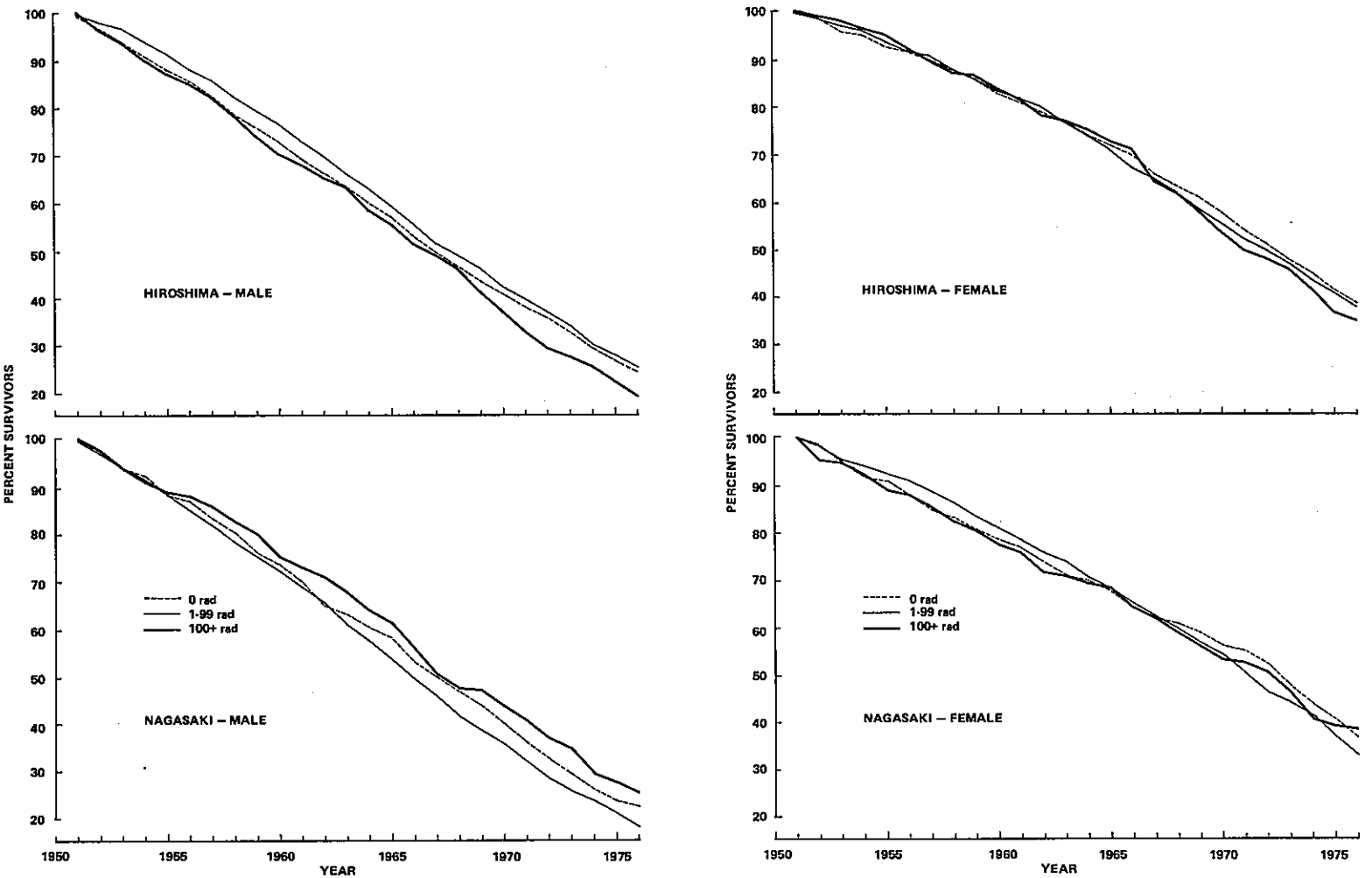


FIGURE 5 PERCENT SURVIVORS IN THE LSS EXTENDED SAMPLE BY AGE, CITY, SEX, & EXPOSURE, 1951-76
AGE 45 – 64

図5　寿命調査拡大集団中の生存者の百分率，年齢，都市，性及び被曝線量別；1951－76年；原爆時年齢45－64歳



APPENDIX 1 PERCENT SURVIVORS IN LSS EXTENDED SAMPLE BY CITY, AGE ATB, SEX, AND EXPOSURE, 1951-76

付録1　寿命調査拡大集団中の生存者の百分率；都市，原爆時年齢，性及び被曝線量別；1951－76年

Year	Hiroshima								Nagasaki							
	Male				Female				Male				Female			
	Total	T65 Dose in Rad			Total	T65 Dose in Rad			Total	T65 Dose in Rad			Total	T65 Dose in Rad		
		0	1-99	100+		0	1-99	100+		0	1-99	100+		0	1-99	100+
Age Less than 10 ATB																
1951	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.6	100.0	100.0	100.0	100.0	99.9	100.0	99.9	99.0
1952	99.9	99.9	99.8	100.0	99.8	100.0	99.7	98.7	99.9	99.8	99.9	99.5	99.8	100.0	99.8	99.0
1953	99.8	99.8	99.8	100.0	99.7	99.9	99.7	98.2	99.8	99.6	99.9	99.5	99.7	99.6	99.8	99.0
1954	99.6	99.7	99.5	100.0	99.7	99.8	99.7	98.2	99.6	99.3	99.8	99.0	99.5	99.4	99.6	99.0
1955	99.6	99.7	99.5	99.0	99.7	99.8	99.6	98.2	99.4	99.1	99.6	99.0	99.3	99.2	99.5	98.0
1956	99.4	99.6	99.3	98.0	99.6	99.8	99.6	98.2	99.3	99.1	99.4	99.0	99.0	99.0	99.3	97.0
1957	99.4	99.6	99.2	98.0	99.5	99.7	99.4	98.2	99.1	98.7	99.3	99.0	98.8	99.0	99.0	97.0
1958	99.2	99.3	99.1	98.0	99.5	99.6	99.4	98.2	99.0	98.7	99.2	98.5	98.7	99.0	98.9	96.5
1959	99.0	99.2	98.9	97.5	99.5	99.6	99.4	98.2	98.9	98.7	99.1	98.0	98.5	98.8	98.8	96.0
1960	98.9	99.1	98.8	97.0	99.4	99.5	99.3	98.2	98.6	98.7	98.8	97.5	98.5	98.8	98.7	96.0
1961	98.7	98.8	98.7	96.4	99.2	99.4	99.1	98.2	98.2	98.2	98.5	96.5	98.4	98.6	98.6	96.0
1962	98.6	98.8	98.6	95.4	99.2	99.4	99.0	98.2	98.2	98.2	98.4	96.5	98.4	98.6	98.6	96.0
1963	98.5	98.6	98.5	94.9	99.2	99.3	99.0	98.2	98.1	98.2	98.3	96.0	98.3	98.4	98.6	96.0
1964	98.4	98.5	98.5	94.9	99.1	99.3	99.0	97.8	97.9	98.0	98.1	96.0	98.3	98.4	98.6	96.0
1965	98.1	98.3	98.2	94.9	99.1	99.2	99.0	97.8	97.7	97.6	97.9	96.0	98.3	98.4	98.5	96.0
1966	98.0	98.1	98.1	94.9	99.0	99.1	99.0	97.4	97.5	97.6	97.7	96.0	98.0	98.2	98.3	95.5
1967	97.9	98.0	98.0	94.9	99.0	99.1	99.0	97.4	97.4	97.6	97.7	95.0	97.9	98.2	98.3	95.0
1968	97.8	97.9	97.9	94.9	98.9	99.0	99.0	96.9	97.1	97.1	97.5	94.5	97.9	98.2	98.3	95.0
1969	97.8	97.8	97.9	94.9	98.9	98.9	99.0	96.9	97.0	96.9	97.4	94.5	97.7	97.4	98.1	95.0
1970	97.6	97.8	97.6	94.4	98.8	98.9	98.8	96.9	97.0	96.9	97.4	94.5	97.6	97.4	98.0	95.0
1971	97.3	97.5	97.3	93.9	98.7	98.9	98.8	96.1	96.7	96.9	97.0	94.5	97.5	97.2	97.9	95.0
1972	97.1	97.5	97.1	93.4	98.6	98.6	98.7	96.1	96.7	96.9	96.9	94.5	97.4	97.2	97.8	95.0
1973	97.0	97.3	97.0	93.4	98.5	98.6	98.7	96.1	96.5	96.9	96.7	94.0	97.3	97.0	97.7	95.0
1974	96.8	97.1	96.8	93.4	98.5	98.5	98.6	96.1	96.3	96.7	96.6	93.5	97.2	97.0	97.6	95.0
1975	96.7	97.1	96.5	93.4	98.3	98.4	98.4	95.2	96.1	96.7	96.3	93.5	97.1	97.0	97.4	95.0
1976	96.5	96.8	96.5	92.4	98.2	98.4	98.3	95.2	96.0	96.7	96.2	93.0	97.1	97.0	97.4	95.0

Year	Hiroshima								Nagasaki							
	Male				Female				Male				Female			
	Total	T65 Dose in Rad			Total	T65 Dose in Rad			Total	T65 Dose in Rad			Total	T65 Dose in Rad		
		0	1-99	100+		0	1-99	100+		0	1-99	100+		0	1-99	100+
Age 10-14 ATB																
1951	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1952	99.8	99.8	99.9	98.3	99.7	99.6	99.9	99.5	99.7	99.3	100.0	99.4	99.6	99.7	99.4	100.0
1953	99.5	99.6	99.6	98.3	99.6	99.5	99.9	99.0	99.6	98.6	100.0	99.4	99.4	99.7	99.2	100.0
1954	99.2	99.2	99.4	96.5	99.3	99.1	99.5	99.0	99.3	97.9	99.9	99.4	99.1	99.0	99.0	99.6
1955	98.7	98.8	98.8	96.5	99.0	98.8	99.4	99.0	98.8	97.3	99.3	99.4	98.8	98.7	98.8	98.7
1956	98.3	98.3	98.6	95.7	98.8	98.5	99.2	99.0	98.6	96.9	99.1	99.4	98.4	98.4	98.4	98.7
1957	97.9	97.8	98.1	95.7	98.8	98.5	99.2	99.0	98.4	96.6	98.9	99.4	98.0	97.8	97.9	98.7
1958	97.7	97.7	97.9	94.8	98.6	98.1	99.2	99.0	97.8	96.2	98.4	98.2	97.8	97.8	97.7	98.2
1959	97.4	97.5	97.6	93.9	98.4	97.9	99.0	99.0	97.5	95.9	98.0	98.2	97.6	97.4	97.6	97.8
1960	97.2	97.1	97.5	93.9	98.2	97.8	98.8	98.0	97.2	95.5	97.8	97.0	97.5	97.1	97.6	97.8
1961	96.8	96.6	97.3	93.0	98.0	97.7	98.4	98.0	97.2	95.5	97.8	97.0	97.4	97.1	97.6	97.3
1962	96.5	96.3	96.9	93.0	97.9	97.5	98.2	98.0	96.9	95.5	97.6	96.4	97.4	97.1	97.5	97.3
1963	96.2	96.2	96.6	92.2	97.7	97.3	98.2	97.5	96.7	95.5	97.3	96.4	97.2	97.1	97.3	96.9
1964	95.9	95.9	96.3	91.3	97.5	97.1	98.1	97.5	96.3	95.5	96.6	96.4	97.1	96.8	97.2	96.9
1965	95.6	95.7	96.0	90.4	97.4	97.0	97.9	97.5	96.2	95.5	96.5	96.4	97.0	96.8	97.0	96.9
1966	95.4	95.5	95.8	90.4	97.2	96.8	97.7	97.0	95.7	95.2	95.8	95.8	96.6	96.5	96.5	96.9
1967	95.3	95.3	95.7	90.4	97.0	96.7	97.5	96.4	95.6	94.8	95.8	95.8	96.6	96.5	96.5	96.9
1968	95.0	95.0	95.4	89.6	96.8	96.4	97.2	96.4	95.4	94.5	95.7	95.8	96.5	96.5	96.4	96.9
1969	94.7	94.7	95.2	88.7	96.6	96.3	97.1	95.9	95.2	94.5	95.4	95.8	95.9	96.2	95.8	95.6
1970	94.5	94.5	95.1	87.8	96.4	96.2	96.9	94.9	94.9	94.2	95.0	95.8	95.6	95.8	95.6	95.6
1971	94.3	94.4	94.7	87.8	96.2	96.1	96.8	93.9	94.6	93.5	94.9	95.2	95.5	95.8	95.4	95.6
1972	94.0	94.0	94.4	87.8	96.1	96.0	96.7	93.9	93.8	92.1	94.4	94.0	95.4	95.8	95.1	95.6
1973	93.6	93.5	94.1	87.8	96.0	95.9	96.5	93.4	93.3	91.8	93.9	93.4	95.1	95.8	94.8	95.1
1974	93.2	93.2	93.6	87.0	95.8	95.6	96.4	93.4	93.2	91.8	93.8	93.4	94.9	95.8	94.7	94.7
1975	92.7	92.6	93.3	87.0	95.6	95.3	96.2	93.4	92.9	91.4	93.4	93.4	94.9	95.5	94.7	94.7
1976	92.4	92.2	93.0	86.1	95.2	94.9	95.9	93.4	92.5	91.1	93.1	92.2	94.7	95.5	94.3	94.7

Year	Hiroshima								Nagasaki							
	Male				Female				Male				Female			
	Total	T65 Dose in Rad			Total	T65 Dose in Rad			Total	T65 Dose in Rad			Total	T65 Dose in Rad		
		0	1-99	100+		0	1-99	100+		0	1-99	100+		0	1-99	100+
Age 15-24 ATB																
1951	100.0	100.0	99.9	100.0	99.9	99.8	100.0	100.0	99.7	99.5	99.9	99.7	100.0	100.0	100.0	100.0
1952	99.5	99.5	99.5	99.6	99.5	99.5	99.6	99.6	99.1	98.5	99.3	99.4	99.8	100.0	99.6	99.8
1953	99.0	98.9	99.1	98.8	99.3	99.2	99.5	99.3	98.4	97.5	98.9	98.4	99.5	99.5	99.5	99.3
1954	98.7	98.4	99.0	98.4	99.2	99.0	99.4	99.3	97.8	96.7	98.1	98.4	99.0	99.1	99.1	98.8
1955	98.3	98.0	98.7	98.1	99.0	98.9	99.2	99.1	97.2	95.5	97.7	98.1	98.9	99.1	98.9	98.7
1956	97.9	97.4	98.4	98.1	98.8	98.6	99.0	98.9	97.0	95.5	97.3	98.1	98.6	98.8	98.6	98.5
1957	97.5	96.8	98.1	98.1	98.5	98.3	98.7	98.7	96.5	95.0	97.0	97.1	98.5	98.8	98.6	98.2
1958	97.1	96.4	97.7	97.7	98.2	98.0	98.5	97.6	96.2	94.5	96.9	96.8	98.2	98.2	98.1	98.2
1959	96.8	96.1	97.4	97.3	98.0	97.8	98.2	97.4	95.6	93.7	96.1	96.8	97.8	97.8	97.8	97.9
1960	96.6	96.0	97.2	96.5	97.8	97.5	98.2	97.4	95.4	93.7	95.8	96.5	97.7	97.6	97.7	97.7
1961	96.2	95.6	96.8	96.5	97.6	97.4	97.9	97.0	95.0	93.2	95.4	96.2	97.6	97.6	97.6	97.7
1962	96.0	95.5	96.5	95.7	97.3	97.1	97.6	97.0	94.5	92.4	95.1	95.9	97.4	97.2	97.5	97.4
1963	95.7	95.3	96.3	95.3	97.1	97.0	97.4	96.7	94.4	91.9	95.1	95.9	97.2	97.2	97.3	97.0
1964	95.4	94.9	96.0	95.3	97.0	96.8	97.1	96.7	94.3	91.7	95.1	95.9	96.9	96.9	96.9	96.9
1965	95.2	94.8	95.7	94.9	96.8	96.7	97.0	96.7	93.9	90.9	94.9	95.5	96.7	96.7	96.8	96.4
1966	94.6	94.4	94.7	94.9	96.6	96.6	96.8	95.9	93.5	90.9	94.3	94.9	96.3	96.6	96.5	95.7
1967	94.2	93.9	94.3	94.9	96.4	96.4	96.5	95.9	93.0	90.2	93.8	94.6	96.2	96.5	96.4	95.4
1968	93.8	93.4	94.1	94.6	96.2	96.2	96.2	95.4	92.5	89.7	93.2	94.3	95.9	96.2	96.3	94.9
1969	93.6	93.1	93.9	94.2	96.0	96.1	96.0	95.0	91.9	89.7	92.3	93.9	95.8	96.1	96.0	94.7
1970	93.2	92.8	93.5	93.8	95.8	96.0	95.8	94.6	91.6	89.4	91.9	93.9	95.5	95.8	95.9	94.2
1971	92.6	92.3	92.9	93.0	95.6	95.8	95.6	94.3	91.2	88.9	91.5	93.6	95.3	95.5	95.8	93.9
1972	92.3	91.8	92.7	92.6	95.3	95.5	95.4	93.7	90.8	88.4	91.1	93.0	95.0	95.1	95.5	93.8
1973	91.7	91.3	92.2	91.8	95.1	95.3	95.2	93.3	90.1	88.2	90.4	92.0	94.6	94.7	95.0	93.6
1974	91.3	90.7	91.9	91.1	94.9	95.1	95.0	92.2	89.6	87.9	89.7	91.7	94.1	94.4	94.4	92.9
1975	90.8	90.4	91.3	90.3	94.6	94.9	94.6	92.0	89.2	87.9	89.6	90.1	94.0	94.3	94.2	92.9
1976	90.1	89.7	90.8	88.7	94.3	94.5	94.4	91.7	88.7	87.4	89.0	89.5	93.8	94.0	94.1	92.8

Year	Hiroshima								Nagasaki							
	Male				Female				Male				Female			
	Total	T65 Dose in Rad			Total	T65 Dose in Rad			Total	T65 Dose in Rad			Total	T65 Dose in Rad		
		0	1-99	100+		0	1-99	100+		0	1-99	100+		0	1-99	100+
								Age 25-44 ATB								
1951	99.8	99.8	99.9	99.8	99.8	99.8	99.9	99.8	99.8	99.6	99.9	100.0	99.9	100.0	99.8	100.0
1952	99.0	99.0	99.0	99.3	99.4	99.3	99.4	99.5	98.8	99.3	98.8	98.2	99.1	99.7	98.9	99.0
1953	98.4	98.4	98.4	98.6	98.9	98.9	99.0	98.4	98.0	98.6	97.8	97.7	98.4	98.4	98.4	98.4
1954	97.6	97.5	97.6	97.6	98.5	98.6	98.6	97.4	97.6	98.4	97.4	97.1	97.9	98.1	98.0	97.4
1955	96.8	96.8	96.8	96.7	98.1	98.2	98.2	97.1	97.0	97.9	96.9	96.1	97.3	97.9	97.3	96.4
1956	96.0	96.1	95.9	96.7	97.7	97.6	97.8	96.8	96.4	97.0	96.4	95.3	96.9	97.6	96.9	95.0
1957	95.0	95.1	94.8	95.7	97.3	97.2	97.4	96.7	95.3	95.7	95.7	93.8	96.1	96.8	96.1	95.0
1958	94.2	94.3	94.2	94.3	96.7	96.7	96.7	95.9	94.3	94.5	94.8	92.7	95.6	96.5	95.6	93.7
1959	93.5	93.6	93.3	93.6	96.2	96.2	96.3	95.5	93.8	93.8	94.4	92.5	94.8	96.4	94.7	92.7
1960	92.7	92.8	92.5	92.4	95.7	95.6	95.8	95.5	92.8	93.1	93.1	91.7	94.3	95.7	94.1	92.4
1961	91.9	92.0	91.7	91.9	95.1	95.2	95.2	94.1	92.0	92.4	92.2	90.9	93.6	95.1	93.3	92.4
1962	91.1	91.2	91.0	90.9	94.6	94.7	94.7	93.0	90.8	90.9	91.4	89.1	93.0	94.8	92.5	92.1
1963	90.0	90.2	89.7	89.7	94.1	94.2	94.2	92.3	90.0	90.4	90.6	88.1	92.3	94.0	91.8	92.1
1964	89.0	89.3	88.8	87.8	93.5	93.7	93.5	91.2	89.3	90.1	89.8	86.8	91.8	93.8	91.1	91.7
1965	87.8	88.3	87.4	86.6	93.0	93.2	93.0	90.4	88.1	88.8	88.7	85.5	91.0	92.7	90.4	91.1
1966	86.3	86.6	86.0	85.9	92.4	92.7	92.4	90.0	86.7	87.9	86.9	84.4	90.1	91.3	89.6	90.8
1967	85.0	85.4	84.6	84.2	91.7	92.0	91.7	89.2	85.3	87.2	85.2	82.9	89.3	90.5	88.8	90.4
1968	83.8	84.1	83.6	83.3	91.0	91.2	91.0	88.7	83.5	85.8	83.1	81.3	88.5	89.1	88.0	90.1
1969	82.3	82.6	82.0	81.9	90.3	90.5	90.3	87.9	81.9	84.4	81.1	80.3	87.4	88.4	86.8	89.4
1970	80.7	80.7	80.7	81.1	89.6	89.9	89.6	87.6	80.4	82.6	79.7	79.0	86.6	87.8	85.8	88.8
1971	79.0	78.9	78.9	80.4	88.6	88.9	88.7	85.3	78.4	81.2	77.7	76.4	85.7	87.2	84.9	87.1
1972	77.7	77.5	77.7	79.2	87.7	87.9	87.8	83.9	77.3	80.5	76.4	74.8	84.8	85.9	84.2	86.1
1973	76.3	75.8	76.5	77.8	86.8	87.1	86.9	82.6	75.3	78.7	74.5	72.2	83.9	84.8	83.2	86.1
1974	74.3	74.1	74.3	75.4	85.7	86.1	85.9	81.2	73.3	75.8	72.8	70.9	83.0	83.8	82.4	85.1
1975	72.7	72.4	72.9	73.0	84.7	85.0	84.9	79.9	71.3	73.7	71.1	68.3	82.0	82.7	81.3	84.5
1976	71.0	70.6	71.3	71.8	83.4	83.9	83.4	77.8	69.4	72.5	68.9	66.0	80.9	81.6	80.2	83.5

Year	Hiroshima								Nagasaki							
	Male				Female				Male				Female			
	Total	T65 Dose in Rad			Total	T65 Dose in Rad			Total	T65 Dose in Rad			Total	T65 Dose in Rad		
		0	1-99	100+		0	1-99	100+		0	1-99	100+		0	1-99	100+
							Age 45-64 ATB									
1951	99.4	99.1	99.6	99.8	99.7	99.7	99.7	100.0	99.6	99.8	99.5	100.0	99.4	99.3	99.4	99.4
1952	97.1	96.6	97.7	96.0	98.2	97.9	98.4	99.3	97.2	96.7	97.4	97.5	97.4	98.0	97.6	95.5
1953	95.1	94.0	96.4	93.8	96.6	96.2	96.9	98.0	94.2	94.3	94.1	94.0	95.3	95.3	95.4	94.8
1954	92.4	91.1	94.0	90.8	95.2	94.7	95.7	96.6	91.7	92.2	91.7	91.0	93.6	91.9	94.2	92.3
1955	89.6	88.1	91.5	87.3	93.8	93.3	94.2	95.3	89.0	88.6	89.1	89.4	91.7	90.6	92.4	89.0
1956	86.9	85.6	88.5	85.0	91.9	91.6	92.2	92.5	85.8	86.7	84.9	87.9	89.9	87.9	90.8	87.7
1957	83.8	82.3	85.6	81.8	90.1	89.7	90.6	89.8	82.8	83.4	82.1	85.4	87.4	84.8	88.4	85.2
1958	80.2	78.7	82.1	77.8	87.9	87.5	88.4	87.5	79.7	80.3	78.8	82.9	85.1	83.2	86.1	81.9
1959	77.2	75.8	79.2	73.5	86.0	85.7	86.3	87.1	76.1	76.2	75.3	79.9	82.5	80.5	83.3	80.0
1960	74.1	72.6	76.3	70.8	83.7	83.4	84.0	84.1	73.4	73.9	72.8	75.4	79.8	78.8	80.4	77.4
1961	71.1	69.5	73.2	68.0	81.6	81.2	81.9	81.7	69.5	70.1	68.7	72.9	77.7	76.8	78.3	75.5
1962	67.6	66.2	69.5	65.0	79.3	78.8	79.8	78.3	65.9	65.1	65.2	70.9	75.2	74.1	76.0	71.6
1963	64.4	63.1	66.1	62.5	76.8	76.8	76.8	76.9	62.3	63.2	60.8	67.8	73.0	71.0	73.7	71.0
1964	61.1	59.9	62.8	58.5	74.2	74.4	74.0	74.9	59.1	60.8	57.4	63.8	70.1	69.7	70.3	69.0
1965	57.8	56.8	59.2	55.3	71.6	72.1	70.9	73.2	55.7	58.4	53.4	61.3	67.7	67.0	67.8	67.7
1966	54.1	53.1	55.5	51.5	68.6	69.6	67.2	71.2	51.5	53.2	49.9	55.8	64.5	64.0	64.8	63.9
1967	50.7	49.8	51.9	48.8	65.6	66.6	64.6	64.4	47.7	50.4	46.0	50.8	62.1	62.3	62.0	61.9
1968	47.7	46.6	49.2	46.0	62.8	64.0	61.6	62.0	44.1	47.3	41.9	48.2	59.8	60.9	59.7	58.7
1969	44.7	43.7	46.2	40.8	60.1	61.4	58.9	58.0	41.2	43.9	38.7	47.7	57.1	58.9	56.8	55.5
1970	41.4	40.9	42.6	36.5	56.7	58.0	55.5	54.2	37.9	39.9	35.7	44.2	54.3	56.6	53.9	52.9
1971	38.5	38.0	39.8	32.5	53.5	54.6	52.6	50.2	34.1	35.9	32.0	40.7	51.4	55.2	50.3	52.3
1972	35.7	35.3	37.1	29.3	50.5	51.2	49.9	48.5	30.6	32.5	28.4	37.2	48.0	51.9	46.6	50.3
1973	32.9	32.6	34.1	27.5	47.8	48.4	47.2	46.1	27.9	29.9	25.7	34.7	44.9	47.5	44.1	45.8
1974	29.8	29.5	30.7	25.3	44.6	45.3	44.1	42.0	25.1	25.9	23.9	29.6	41.3	43.8	40.8	40.0
1975	27.2	27.2	28.1	21.8	41.4	42.1	41.1	36.9	22.8	24.0	21.3	27.6	37.8	40.4	37.0	38.7
1976	24.5	24.4	25.4	19.0	38.0	38.6	37.7	34.9	20.3	23.0	18.1	25.1	34.6	36.7	33.5	38.7

Year	Hiroshima								Nagasaki							
	Male				Female				Male				Female			
	Total	T65 Dose in Rad			Total	T65 Dose in Rad			Total	T65 Dose in Rad			Total	T65 Dose in Rad		
		0	1-99	100+		0	1-99	100+		0	1-99	100+		0	1-99	100+
								Age 65 or More ATB								
1951	96.8	95.8	98.2	91.7	97.9	98.3	97.5	97.1	97.3	97.1	98.1	83.3	96.8	94.8	97.0	100.0
1952	88.0	86.2	90.2	83.3	93.3	94.0	92.3	94.3	90.5	91.4	90.7	83.3	88.2	84.5	88.9	91.7
1953	81.1	79.2	83.3	79.2	87.9	88.4	87.5	82.9	82.4	80.0	83.2	83.3	80.0	74.1	82.3	75.0
1954	74.0	72.7	75.8	66.7	82.4	83.3	81.6	77.1	74.3	71.4	74,8	83.3	70.7	62.1	74.2	62.5
1955	66.8	66.1	67.9	62.5	76.4	78.1	74.7	71.4	62.8	65.7	61.7	66.7	66.4	58.6	69.2	62.5
1956	60.9	60.5	61.7	54.2	69.6	71.4	68.2	60.0	57.4	57.1	57.0	66.7	59.3	53.4	61.6	54.2
1957	52.9	51.2	55.3	45.8	61.9	64.2	60.0	48.6	51.4	51.4	50.5	66.7	48.6	43.1	50.0	50.0
1958	45.3	44.9	46.0	41.7	55.2	56.8	54.0	45.7	43.2	40.0	43.9	50.0	42.1	32.8	43.9	50.0
1959	38.5	38.1	39.1	37.5	48.1	49.8	46.2	45.7	35.1	37.1	34.6	33.3	36.1	27.6	36.9	50.0
1960	33.3	31.5	35.2	33.3	42.9	44.7	41.2	37.1	31.8	31.4	31.8	33.3	31.8	27.6	31.8	41.7
1961	28.9	27.6	30.3	29.2	36.6	38.2	34.9	34.3	25.0	25.7	24.3	33.3	28.6	25.9	28.8	33.3
1962	24.0	23.4	24.7	25.0	30.8	31.6	29.5	34.3	22.3	22.9	22.4	16.7	22.1	19.0	23.2	20.8
1963	18.9	17.5	20.3	20.8	26.1	27.2	24.5	31.4	17.6	17.1	17.8	16.7	17.1	13.8	18.7	12.5
1964	15.2	13.8	17.0	12.5	21.8	22.3	20.5	31.4	12.2	8.6	13.1	16.7	13.9	12.1	15.7	4.2
1965	12.6	12.2	13.6	4.2	19.1	19.6	18.0	25.7	9.5	5.7	10.3	16.7	10.0	8.6	11.1	4.2
1966	10.9	10.3	12.1	4.2	15.6	15.4	15.5	20.0	6.1	5.7	5.6	16.7	8.9	6.9	10.1	4.2
1967	9.2	7.9	10.8	4.2	12.3	12.4	12.1	14.3	4.1	2.9	4.7	.0	8.2	6.9	9.1	4.2
1968	7.6	7.5	8.0	4.2	10.9	11.4	10.2	11.4	2.7	2.9	2.8	.0	6.4	5.2	7.6	.0
1969	5.1	5.1	5.1	4.2	9.6	10.3	8.6	11.4	2.0	2.9	1.9	.0	2.5	3.4	2.5	.0
1970	3.6	3.5	3.6	4.2	8.3	8.7	7.7	11.4	1.4	2.9	0.9	.0	1.4	1.7	1.5	.0
1971	2.6	2.8	2.3	4.2	6.4	6.5	6.3	5.7	0.7	.0	0.9	.0	1.1	.0	1.5	.0
1972	1.7	2.3	1.0	.0	5.3	5.1	5.7	2.9	0.7	.0	0.9	.0	1.1	.0	1.5	.0
1973	0.8	1.4	0.3	.0	4.1	4.1	4.2	2.9	0.7	.0	0.9	.0	0.7	.0	1.0	.0
1974	0.7	1.2	0.3	.0	3.0	2.5	3.6	2.9	0.7	.0	0.9	.0	0.7	.0	1.0	.0
1975	0.6	0.9	0.3	.0	2.2	1.7	2.7	2.9	0.7	.0	0.9	.0	0.7	.0	1.0	.0
1976	0.1	0.2	.0	.0	2.0	1.6	2.5	2.9	0.7	.0	0.9	.0	0.4	.0	0.5	.0