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TRENDS OF POPULATION REPRODUCTION IN JAPAN

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FOREWORD

The Institute of Population Problems, as a part of its activities, has been processing the primary data or raw materials on population and vital statistics to prepare them into what may be called the secondary data of various kinds required for demographic researches, the results of which have been published in different materials from time to time. Since the Documentation Section was established in the Institute in 1960, such works have been handled in the Section as revealed in past publications of the Section. In this report, from among the results of such calculations, various kinds concerning the population reproduction had been collected and summed up into an English pamphlet with some explanatory remarks.

The data presented in this pamphlet cover mainly the calculation results of standardized vital rates, population reproduction rates and the stable population indices (vital rates and age distribution) of total Japan, for the period of past several decades. These data are valuable as the basic indices for the analysis of the historical trends of vital statistics by means of demographic techniques.

One purpose of this publication is to demonstrate the

calculated values to serve as the basic materials for the analysis of population phenomena and the other purpose is to present a general view of the changes in population reproductivity of Japan's population (female), particularly through international comparison of its present status.

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Trends of Population Reproduction in Japan

1. Preface

The population is composed of the people who follow the life which begin with birth and end with death. This is not limited to the human population but the same is true with the other animal populations. The population, accordingly, continuously adds its components by births on one hand and loses them by deaths on the other.

Human beings, unlike other animals, perform a social life. Although the order pertaining to births and deaths which regulates the reproductive performances of the population is inevitably the subject to the natural biological law, many parts of it are moderated by the state of social and economic living. Thus the population as the congregation of human beings, through the replacement of its individual component by the immutable order of births and deaths, goes through the changes in its size and structure. Such performances are the basic characteristics of the population phenomena.

For one individual person, death occurs only once, and it is decisively the final and conclusive event. Whereas for one birth to take place, it requires the presence of a man and a woman as a concerned party. For this same concerned

party of two persons, birth is effected not necessarily just once, and also the party is not capacitated to repeat births for ever. Moreover, in the present civilized society, birth is artificially regulated in various ways. Comparing with deaths, therefore, births have far more complicated effects upon the reproductive activities of the population.

Under this cognition given so far, a general view on the reproductive capacity of the Japanese population mainly based on the results of recent calculations will be given. Importance is naturally admitted to take detailed examination of internal structure of births and deaths into consideration in analysing the activities of population reproduction, but the space did not allow such examination to be included in the present report.

2. Population Increase as the Difference between Births and Deaths

According to the latest 1964 edition of Vital Statistics (Annual Report on Final Numbers) published by the Division of Health and Welfare Statistics of the Japanese Ministry of Health and Welfare, the number of births is 1,717 thousand, or a baby being born in every 18 seconds. The birth rate per

one thousand population is 17.7, showing a slight upwarding trend since the lowest rate of 16.9 in 1961. The number of deaths is 673 thousand, or a person dying in every 47 seconds. The death rate per one thousand population is 6.9, indicating the lowest rate ever recorded in modern vital statistics of Japan. The number of natural increase (excess of births over deaths), or the net volume of self reproduction of this country is 1,044 thousand, showing the increase at the rate of one person in every 30 seconds. The natural increase rate per one thousand population is 10.7.

Vital statistics of Japan started to follow the trace of modernization in early 1920's, showing the trend change from high birth and death rates to low birth and death rates. After the termination of the World War II, the speed of modernization was accelerated by the sudden decline both in birth rate and death rate. Since 1955 the decline became dull to fall into the stagnancy and in very recent years, birth rate started an upward trend and death rate to come down. The natural increase rate obtained by deducing death rate from birth rate reflects the trend in both rates by its increase.

The remarkable improvement in mortality coincided with the emergence of "baby boom" is one of the major characteristics

after the World War II not only in Japan but in the world population as well. In 1947, the year of the "baby boom", the net volume of self-reproduction of Japan's population reached as high as 1.54 million. In following 1948 and 1949, the annual volume of increase exceeded 1.7 million every year, that is, the population of the present Yokohama City was reproduced annually. During the years immediatly following the termination of the War, voluminous repatriation of overseas Japanese joined in the scene and such enormous population increase at the time of post-war confusion rendered unmeasurable difficulties for the struggling society.

Passing the peak in the "baby boom", birth rate started to decline in 1950, converting into the trend of declining natural increase. The natural increase which once exceeded 1.7 million now became 1.4 million in 1950, followed the annual decrease to less than 1 million in 1956, and in 1957, the smallest post-war number of natural increase of over 800 thousand was recorded. This remarkable drop in natural increase was caused entirely by the conspicuous birth decline. Since that time, the decline both in fertility and mortality slowed down almost in stagnancy and the natural increase thereby followed around the 900 thousand level. In very recent years, the gradual upwarding in fertility effected the

Table 1. Population, Number of Live Births, Deaths, and Natural Increase : 1920-1965

Year	Population	Live births	Deaths	Natural increase
1920	55,963,053	2,025,564	1,422,096	603,468
1925	59,736,822	2,086,091	1,210,706	875,385
1930	64,450,005	2,085,101	1,170,867	914,234
1935	69,254,148	2,190,704	1,161,936	1,028,768
1940	71,933,000	2,115,867	1,186,595	929,272
1947	78,101,473	2,678,792	1,138,238	1,540,554
1948	80,002,500	2,681,624	950,610	1,731,014
1949	81,772,600	2,696,638	945,444	1,751,194
1950	83,199,637	2,337,507	904,876	1,432,631
1951	84,541,000	2,137,689	838,998	1,298,691
1952	85,808,000	2,005,162	765,068	1,240,094
1953	86,981,000	1,868,040	772,547	1,095,493
1954	88,239,000	1,769,580	721,491	1,048,089
1955	89,275,529	1,730,692	693,523	1,037,169
1956	90,172,000	1,665,278	724,460	940,818
1957	90,928,000	1,566,713	752,445	814,268
1958	91,767,000	1,653,469	684,189	969,280
1959	92,641,000	1,626,088	689,959	936,129
1960	93,418,501	1,606,041	706,599	899,442
1961	94,285,000	1,589,372	695,644	893,728
1962	95,178,000	1,618,616	710,265	908,351
1963	96,156,000	1,659,521	670,770	988,751
1964	97,186,000	1,716,761	673,067	1,043,694
* 1965	98,274,961	1,821,841	700,237	1,121,604

Prior to 1945, includes former Okinawa Prefecture.
* Provisional (vital statistics).
Sources : Bureau of Statistics, Office of the Prime Minister, Population Census Reports, and Population Estimates Series.
Health and Welfare Statistics Division, Minister's Secretariat, Ministry of Health and Welfare, Vital Statistics Reports.

Table 2. Crude Vital Rates : 1920-1965
(per 1,000 population)

Year	Crude vital rates			Index (1930=100)		
	Birth rate	Death rate	Natural inc.rate	Birth rate	Death rate	Natural inc. rate
1920	36.19	25.41	10.78	111.9	139.8	76.0
1925	34.92	20.27	14.65	107.9	111.6	103.2
1930	32.35	18.17	14.19	100.0	100.0	100.0
1935	31.63	16.78	14.85	97.8	92.4	104.7
1940	29.41	16.50	12.92	90.9	90.8	91.1
1947	34.30	14.57	19.73	106.0	80.2	139.0
1948	33.52	11.88	21.64	103.6	65.4	152.5
1949	32.98	11.56	21.42	101.9	63.6	151.0
1950	28.10	10.88	17.22	86.9	59.9	121.4
1951	25.29	9.92	15.36	78.2	54.6	108.2
1952	23.37	8.92	14.45	72.2	49.1	101.8
1953	21.48	8.88	12.59	66.4	48.9	88.7
1954	20.05	8.18	11.88	62.0	45.0	83.7
1955	19.39	7.77	11.62	59.9	42.8	81.9
1956	18.47	8.03	10.43	57.1	44.2	73.5
1957	17.23	8.28	8.96	53.3	45.6	63.1
1958	18.02	7.46	10.56	55.7	41.1	74.4
1959	17.55	7.45	10.10	54.3	41.0	71.2
1960	17.19	7.56	9.63	53.1	41.6	67.9
1961	16.86	7.38	9.48	52.1	40.6	66.8
1962	17.01	7.46	9.54	52.6	41.1	67.2
1963	17.26	6.98	10.28	53.4	38.4	72.4
1964	17.66	6.93	10.74	54.6	38.1	75.7
* 1965	18.54	7.13	11.41	57.3	39.2	80.4

See footnote of Table 1.

Chart 1. Crude Vital Rates : 1920-1965
(per 1,000 population)

rise in natural increase to reach in 1964 the level again of 1 million, or the level of 1954 and 1955.

The pre-war level (since 1920) of natural increase rate was between 10 and 15 per thousand population, but in the baby boom period it recorded 20 to 22 ‰, which was the highest rate ever recorded in her history of modern vital statistics. Since 1950, however, due to the decrease in natural increase, natural increase rate declined in faster speed to break through by far the pre-war level. 1957 showed the lowest post-war record of below 9‰ and since then the rate was between 9.5 and 10.5‰ in stagnant or slight upwarding trend to reach 10.7‰ in 1964 (see Table 1 and 2, and Chart 1).

In international comparison, 1964 natural increase rate of Japan is considerably lower than the average of the countries compared, being a little lower than the rate of U.S.A., Australia and Italy and a little higher than that of Switzerland and Finland. The remarkably high natural increase rate of Latin American countries is the indication of the rapid improvement in mortality where fertility is not controlled. This is also a common phenomenon seen in backward areas of Africa or Asia (see Table 3).

Table 3. Crude Vital Rates, Selected Countries : 1964 and 1955 (per 1,000 population)

Country and administrative status	1964			1955
	Birth rate	Death rate	Natural inc.rate	Natural inc.rate
El Salvador	46.8	10.4	36.4	33.7
Mexico	45.4	10.3	35.1	32.7
Costa Rica	40.8	8.8	32.0	37.7
China (Taiwan)	34.5	5.7	28.8	36.7
Guatemala	44.4	15.8	28.6	28.2
Malaya	33.2	8.1	25.1	31.5
Puerto Rico	30.2	7.1	23.1	27.2
Chile	32.8	11.2	21.6	22.2
Canada	23.5	7.6	15.9	20.0
New Zealand	24.1	8.8	15.3	15.9
Argentina	21.7	8.1	13.6	15.4
Spain	22.2	8.7	13.5	11.2
Portugal	23.8	10.6	13.2	12.6
Netherlands	20.7	7.7	13.0	13.8
Soviet Union	19.6	6.9	12.7	17.4
United States	21.0	9.4	11.6	15.3
Australia	20.6	9.0	11.6	13.7
Yugoslavia	20.8	9.4	11.4	15.4
Italy	19.9	8.8	11.1	8.8
Ireland	22.5	11.5	11.0	8.6
Japan	17.7	6.9	10.7	11.6
Poland	18.1	7.6	10.5	19.5
Switzerland	19.2	9.4	9.8	7.0
Finland	17.6	9.3	8.3	11.9
Bulgaria	16.1	7.9	8.2	11.0
Norway	17.7	9.5	8.2	10.0
Denmark	17.6	9.9	7.7	8.6
Germany, Fed.Rep. of	18.5	10.8	7.7	5.0
Czechoslovakia	17.1	9.6	7.5	10.7
United Kingdom	18.8	11.3	7.5	3.8
France	18.1	10.8	7.3	6.4
Austria	18.6	12.3	6.3	3.4
Sweden	16.0	10.0	6.0	5.3
Belgium	17.1	12.1	5.0	4.5
German Demo. Rep.	17.2	13.5	3.7	5.0
Hungary	13.1	10.0	3.1	11.5

Source : United Nations, Demographic Yearbook.

3. Standardized Vital Rates

The vital rates referred in preceeding section, that is, the number of births and the number of deaths as against the population were simply called birth rate and death rate respectively, but more correctly they are "crude birth rate" and "crude death rate" and their difference is called "crude natural increase rate".

In the denominator population, people of both sexes in all age groups are included. The difference in age distribution only has much bearing upon the difference in birth rate and death rate as the high ratio of young married couples in the population means the possible high fertility and the high ratio of aged people means high mortality. Accordingly, when the comparison is made in fertility and mortality among populations of different age distribution in accurate terms, it is necessary to use the rates which are independent from the effect of differences in age distribution. For this purpose, the general practice is to obtain birth rate or death rate by applying age-specific birth rates or age-specific death rates to the age distribution of a particular population (as standard population) and the rates acquired in this manner are respectively called "standardized birth rate" and "standardized death rate" and further the difference in the two "standardized

natural increase rate". For example, in the comparative study of prefectural birth or death rates in Japan, the age distribution of the total population of Japan as a whole may be used as the standard for such standardization.

To study birth and death rates on comparative basis among populations with different age distribution, the use of standardized rates is theoretically more desirable, although crude vital rates demonstrate as they are the actual facts and have their own meaning.

For reference, standardized vital rates calculated for total Japan are shown in Table 4. Even taking the population of one country of Japan into consideration, the composition varies in different years. For example, in pre-war 1930 and in 30 years later of 1960, the population compositions are considerably different as shown in Chart 2, thus naturally requires the process of standardization. As a methodological choice, the direct standardization method or selection of voluntary standard population can be used.[1] As the standard population, the total population of 1930 is applied here from the understanding of appropriateness of its basic composition as the standard population.[2] Only the outline of the results of recent years mainly around 1964 will be commented here.

Table 4. Standardized Vital Rates : 1925-1964
(per 1,000 population)

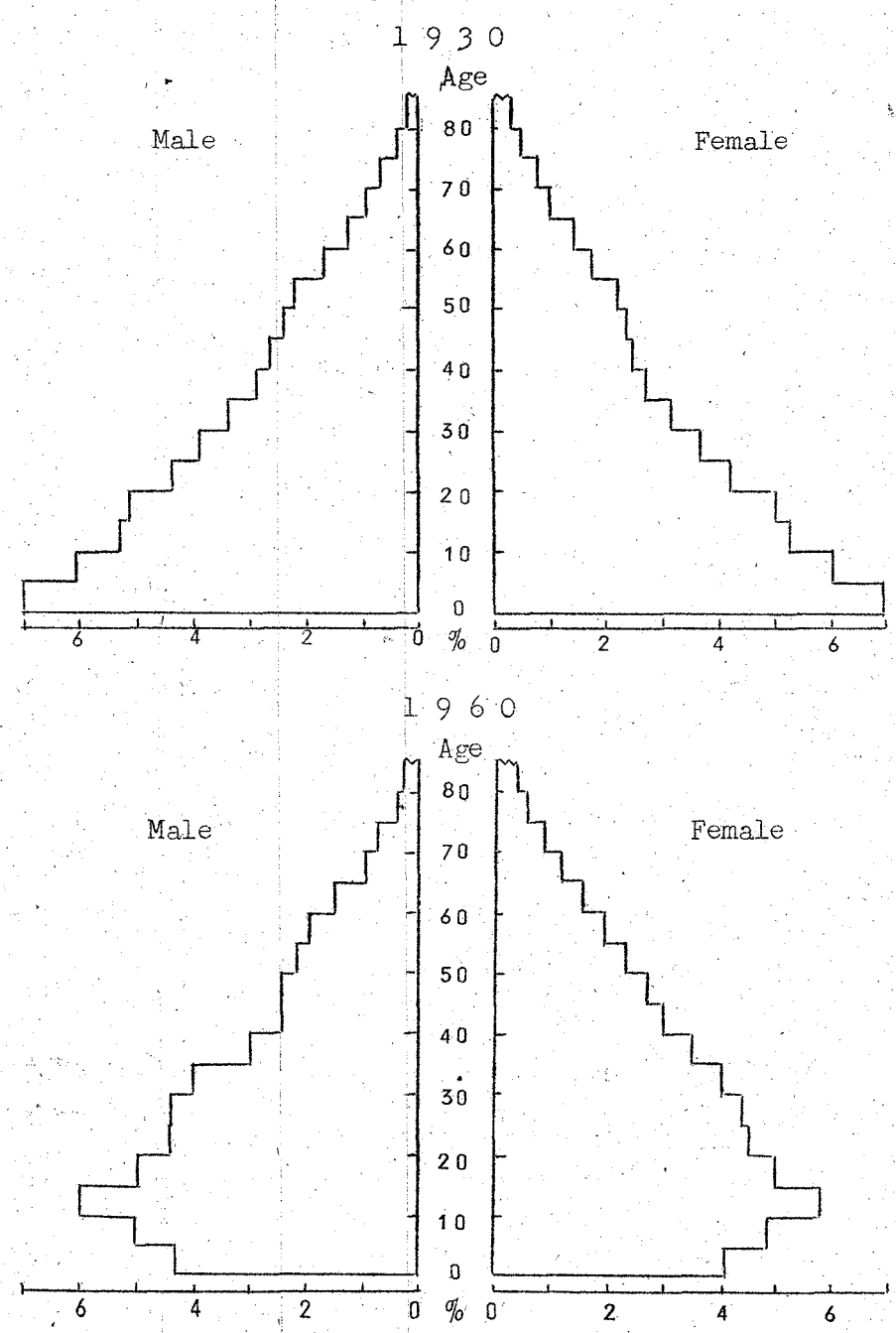
Year	Stand. vital rates			Index (1930=100)		
	Birth rate	Death rate	Natural inc.rate	Birth rate	Death rate	Natural inc.rate
1925	35.27	20.24	15.03	109.0	111.4	106.0
1930	32.35	18.17	14.18	100.0	100.0	100.0
1937	29.77	17.35	12.42	92.0	95.5	87.6
1940	27.74	16.97	10.77	85.7	93.4	76.0
1947	30.69	15.32	15.37	94.9	84.3	108.4
1948	30.03	12.31	17.72	92.8	67.7	125.0
1949	29.66	11.88	17.78	91.7	65.4	125.4
1950	25.33	10.97	14.36	78.3	60.4	101.3
1951	22.63	9.88	12.75	70.0	54.4	89.9
1952	20.75	8.86	11.89	64.1	48.8	83.9
1953	18.86	8.85	10.01	58.3	48.7	70.6
1954	17.44	8.16	9.28	53.9	44.9	65.4
1955	16.79	7.67	9.12	51.9	42.2	64.3
1956	15.83	7.86	7.97	48.9	43.3	56.2
1957	14.61	8.01	6.60	45.2	44.1	46.5
1958	15.19	7.14	8.05	47.0	39.3	56.8
1959	14.82	7.02	7.80	45.8	38.6	55.0
1960	14.46	6.97	7.49	44.7	38.4	52.8
1961	14.07	6.68	7.39	43.5	36.8	52.1
1962	14.09	6.66	7.43	43.6	36.7	52.4
1963	14.26	6.13	8.13	44.1	33.7	57.3
1964	14.62	5.96	8.66	45.2	32.8	61.1

Computed by the direct method of standardization (The 1930 all Japan population taken as the standard population). Based on the number of births and deaths from the Vital Statistics Reports, enumerated and estimated populations by ages.

Prior to 1945, includes former Okinawa Prefecture.

Source : Computed by the Institute of Population Problems, Ministry of Health and Welfare (The Journal of Population Problems and Research Series).

Chart 2. Comparison of Population Pyramids: 1930 and 1960



If one compares 1963 and 1964, the standardized birth rates rose by 0.3‰ from 14.3‰ to 14.6‰, and increase rate by 2.5%. The increase in the corresponding one-year period in crude birth rates was 2.4% which was greater increase than in the period 1962-63. The standardized rates showed similar continuous increase. The fact that the increase rate of standardized birth rates is somewhat higher signifies that the change in population composition during this one-year period worked in way of lowering the seeming birth rate. However, these almost identical rates of 2.4 and 2.5% can also be considered as statistically not meaningful. If one compares 1930 (standard year) and 1964, the decline was 45.5% in crude birth rate and 54.2% in standardized birth rate, indicating that when the factors of changes in population composition are deleted, the rate of increase of birth rate has been sharper than actually observed. However, the recent fertility trend of Japan is definitely that of upwarding one in both observations of standardized and crude rates.

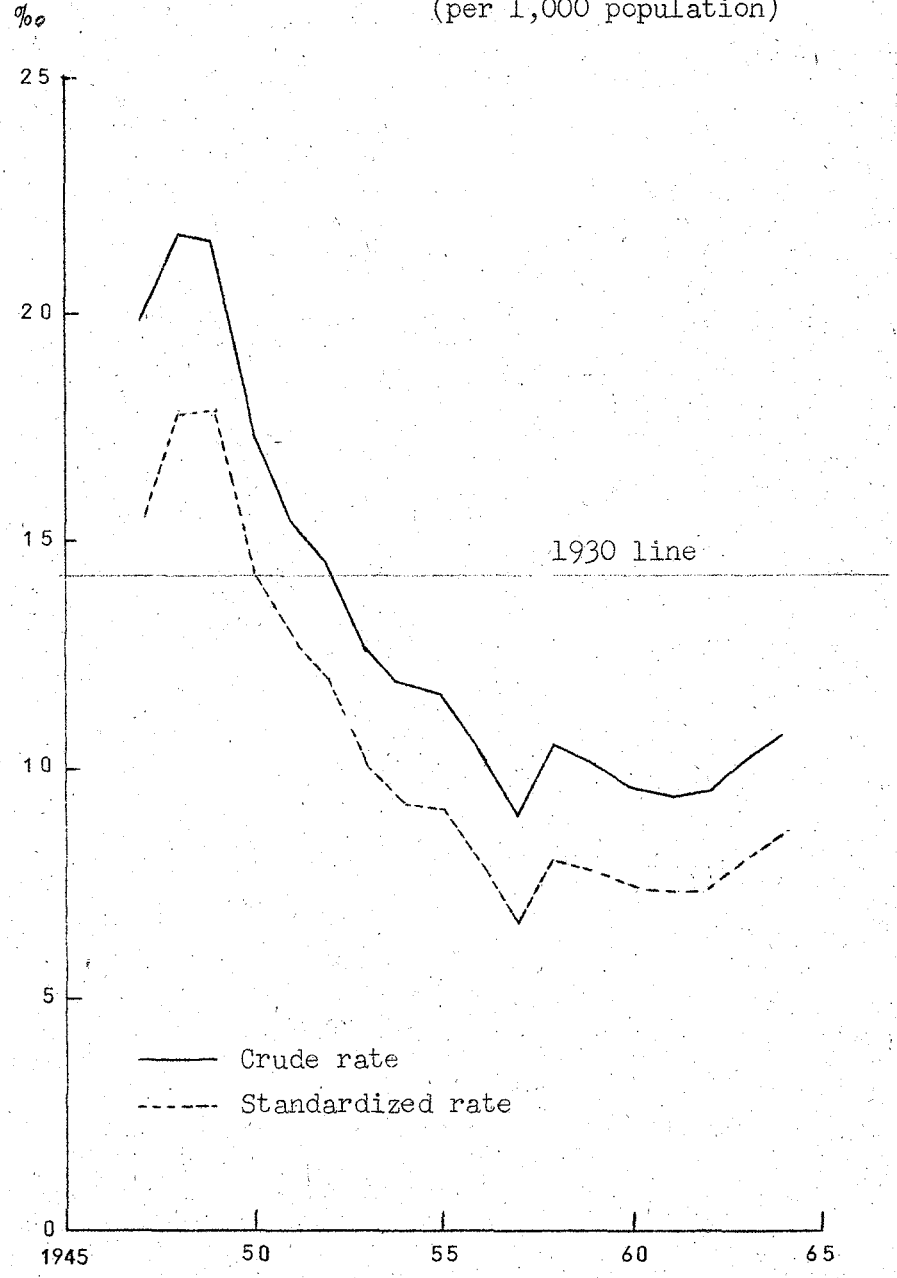
As regards the death rate trend, it declined 0.6‰ during a year 1963-64 in crude death rate but 2.8% from 6.1‰ to 6.0‰ in the same year in standardized death rate. Crude rates, after slight increase in 1961-62, fell down considerably by 6.5% in 1962-63 and in 1963-64, the decline continued though

not as sharp as in the previous year. Standardized death rates showed the remarkable decrease of 8% in 1962-63 after the continuous decline over the past several years. The decrease in 1963-64 was not as sharp as it was in the previous year but was more obvious than the decline of crude death rate. In comparison with the standard year, the degree of decline was higher than birth rate both in crude and standardized rates and the difference between the two rates is smaller than in the case of birth rates. However, the rate decline is clearer when standardized than in crude death rates. This leads to the fact that the changes in population composition during this period withheld the seeming death rate decline in minor degree. Excluding the change factors in population composition, the death rate itself dropped more rapidly than seemingly factual.

Standardized natural increase rate also increased considerably in 1963-64, though somewhat less rapid than in the preceding one year. Same thing was true with crude rates and both continued upwarding trend due to the rise in birth rate and drop in death rate. Standardized rates are approximately 2% lower than crude natural increase rates as birth rate is fairly lower than the crude rate. Compared with the standard year, recent natural increase rates show the decline

Chart 3. Comparison of Crude and Standardized Natural Increase Rates : 1947-1964

(per 1,000 population)



of about 40% in standardized rates and about 30% in crude rates (see Chart 3).

4. Population Reproduction

The natural increase rate previously mentioned is the rate of annual net volume of population reproduction as against the total number of population and does not necessarily indicate the reproductive capacity of the population. In this section, the trend of the reproductive capacity of the population, which is the main point of the present paper, will be outlooked by means of indices which are often used in such observation.

The demographic studies concerning the interrelationship between birth rate, death rate and age distribution led to the development of the measurement method of the reproduction capacity of population, or in other words, the capacity of population maintenance as to how the population is maintained, whether it expands or decreases when the present generation is replaced by the next generation. If all the married couples give birth of one child each, it is obvious that the number of the children becomes smaller than that of the parents when they reach the parent generation, and if two children are born to each couple, possible deaths before

reaching adulthood do not assure the shere maintenance of the population. If, then, a couple has three children, it is still a question depending on the conditions of mortality. Furthermore, how many births are given by a couple is related also to the length of life of the parents, to complicate the question even more.

The birth rate referred in Sections 2 and 3 is the crude birth rate and it does not as it is express the fertility, because many numbers of people who are not immediately envolved in child-bearing are included in the denominator population. Among the varied determinant factors of fertility, it is basically important to calculate and examine "the age-specific fertility rate of women" of the female population of reproductive ages who are immediately responsible for child births in order to clarify the fertility trends. In fact, the age-specific fertility rate of women indicates the fertility free from the effect arising from the difference in age distribution. This does not express the fertility of the population in a single figure, and in that way inconvenient, as the fertility here is expressed in 35 different figures (the number of ages of child-bearing). To express the fertility in a single figure in avoiding the inconvenience is the method of obtaining the sum of the age-specific fertility

rates of women at each year.[3]

The total sum of the female age-specific fertility rates of a certain year signifies the degree of reproduction as regards how many males and females the present female cohort will reproduce to replace the present cohort during the reproductive period, on the assumption that the female age-specific fertility rates of the year will remain constant. This indicator is called "the total fertility rate" and since the death factor is entirely excluded from the replacing cohort, it means the fertility from the standpoint of population reproduction.

Table 5 and Chart 4 indicate the trend of the total fertility rates of Japan. In 1920, it is estimated that one woman had the fertility to reproduce over five male and female children during her reproductive period, and the pre-war fertility followed the linear trend of decline to come down to a little over 4 persons in 1940. The baby boom elevated the total fertility rate up to 4.5 in 1947, the level being the midway between the levels of 1930 and 1937 by not reaching the level of 1920's of over 5 children. Since 1950, the trend line departed the pre-war linear trend due to the accelerated speed of decline. Since around 1955, the decline was somewhat moderated (temporary increase in 1957-58) and after making

Table 5. Reproduction Rates for Female : 1920-1964

Year	Total fertility rate (1)	Gross reproduction rate (2)	Net reproduction rate (3)	(3)/(2) (4)	(1)/(3) (5)	(1)-(5) (6)
*1920	5.24	2.56	1.59	0.62	3.30	1.94
1925	5.11	2.51	1.56	0.62	3.28	1.83
1930	4.71	2.30	1.52	0.66	3.10	1.61
1937	4.36	2.13	1.49	0.70	2.93	1.43
1940	4.11	2.01	1.44	0.72	2.85	1.26
1947	4.52	2.20	1.67	0.76	2.71	1.81
1948	4.37	2.13	1.75	0.82	2.50	1.87
1949	4.29	2.09	1.74	0.83	2.47	1.82
1950	3.63	1.76	1.53	0.87	2.37	1.26
1951	3.24	1.58	1.38	0.87	2.35	0.89
1952	2.96	1.45	1.28	0.88	2.31	0.65
1953	2.68	1.31	1.17	0.89	2.29	0.39
1954	2.47	1.20	1.09	0.91	2.27	0.20
1955	2.36	1.15	1.05	0.91	2.25	0.11
1956	2.21	1.07	0.99	0.93	2.23	-0.02
1957	2.03	0.99	0.91	0.92	2.23	-0.20
1958	2.10	1.02	0.96	0.94	2.19	-0.09
1959	2.03	0.99	0.92	0.93	2.21	-0.18
1960	1.97	0.96	0.91	0.95	2.16	-0.19
1961	1.93	0.94	0.89	0.95	2.17	-0.24
1962	1.94	0.94	0.90	0.96	2.16	-0.22
1963	1.97	0.96	0.92	0.96	2.14	-0.17
1964	2.01	0.98	0.94	0.96	2.14	-0.13

Computed based on the number of births from the Vital Statistics Reports, enumerated and estimated populations by ages and life table L(x).

Prior to 1945, includes former Okinawa Prefecture.

Column (4): Reproduction survival rate, Column (5): Total fertility rate necessary to keep the stationary population.

* Estimation.

Source : Computed by the Institute of Population Problems, Ministry of Health and Welfare (The Journal of Population Problems and Research Series).

Table 6. Index of Reproduction Rates for Female :1920-1964
(1930=100)

Year	Total fertility rate (1)	Gross reproduction rate (2)	Net reproduction rate (3)	(3)/(2) (4)	(1)/(3) (5)
*1920	111.3	111.3	104.6	93.9	106.5
1925	108.5	109.1	102.6	93.9	105.8
1930	100.0	100.0	100.0	100.0	100.0
1937	92.6	92.6	98.0	106.1	94.5
1940	87.3	87.4	94.7	109.1	91.9
1947	96.0	95.7	109.9	115.2	87.4
1948	92.8	92.6	115.1	124.2	80.6
1949	91.1	90.9	114.5	125.8	79.7
1950	77.1	76.5	100.7	131.8	76.5
1951	68.8	68.7	90.8	131.8	75.8
1952	62.8	63.0	84.2	133.3	74.5
1953	56.9	57.0	77.0	134.8	73.9
1954	52.4	52.2	71.7	137.9	73.2
1955	50.1	50.0	69.1	137.9	72.6
1956	46.9	46.5	65.1	140.9	71.9
1957	43.1	43.0	59.9	139.4	71.9
1958	44.6	44.3	63.2	142.4	70.6
1959	43.1	43.0	60.5	140.9	71.3
1960	41.8	41.7	59.9	143.9	69.7
1961	41.0	40.9	58.6	143.9	70.0
1962	41.2	40.9	59.2	145.5	69.7
1963	41.8	41.7	60.5	145.5	69.0
1964	42.7	42.6	61.8	145.5	69.0

See footnote of Table 5.

Chart 4. Reproduction Rates for Female : 1920-1964

the lowest figure of 1.93 in 1961, it turned to the upwarding trend to nearly restore the 1959 level in 1964 when the rate became 2.

Considering the fact that the reproduction of population is nothing but the replacement by the following cohort, it is generally assumed or is theoretically sound to consider in discussing the process of reproduction that the female population reproduces females and the male population reproduces males. As the total fertility rate includes both males and females, female births must be isolated to examine the female fertility. Such indicator of the total fertility rate for female births only is the "gross reproduction rate" and it indicates the fertility of female population from the standpoint of how many female children will be reproduced as the replacing cohort by each of the present female cohort during her reproductive period or her life-time, on the assumption that the female age-specific fertility rates will remain constant. It is commonly understood that the ratio at birth of males and females is almost always constant. The sex ratio at birth being constant, gross reproduction rate is approximately equal to total fertility rate multiplied by the sex ratio at birth, and the changes in total fertility rate is in proportionate to the changes in gross reproduction rate.

According to the estimate of 1920, on the assumption that the age-specific fertility rate of women of that year would remain constant in the future, the fertility of a woman was of 2.6 persons of female reproduction during her life span. As it is evident in Table 5, this gradually decreased similarly with total fertility rate during pre-war years and reached 2.0 persons in 1940. The decline trend of gross reproduction rate during this period was approximately linear. During the baby boom of 1947, gross reproduction rate went up to 2.2. This elevated level stands halfway in between the rates of 1930 and 1937. The process followed thereafter was similar to that of previously mentioned total fertility rate and in 1957, it fell below the level of 1 to 0.99. In the recent year of 1964, the rate is 0.98, restoring the level of 1957 (see Chart 4).

Since the above-mentioned gross reproduction rate takes into consideration only the female births of the present cohort, neglecting totally the death factor of the born females, this represents only the female fertility but not the intrinsic reproductivity. So here, in assuning that female births of mothers of 15 years of age will reach 15 years old in 15 years to replace the present female population and that female births of mothers of 16 years of age will become 16

years old in 16 years to replace the present female population ....., the probability of survival during the replacement period of the born females is taken into consideration. Then the reproductivity can be represented in the balance of births and deaths. Such reproduction rate obtained from calculation adding the factor of probability of survival of female births to gross reproduction rate is called "net reproduction rate" and the net reproduction rate indicates the extent to which the present cohort eventually replaces itself per head during an average length of generation and the extent to which the births survive eventually to replace the present cohort, according to a fixed schedule of births and deaths of a certain year. Net reproduction rate at 1, accordingly, represents the population with no increase or decrease, in other words, the stationary population under the assumption of constant continuance into the future of the present schedule of births and deaths and indicates the simple reproduction. The net reproduction rate over 1 means the above-unit reproduction and the rate below 1 means the below-unit reproduction or the decreasing population. Further, the ratio of net reproduction rate and gross reproduction rate, as it represents the survivors during the process of reproductive performances, in called "reproduction survival rate".

The changes of net reproduction rate of Japan will be at this point outlined with reference to Table 5 and Chart 4. From 1920's throughout the normal pre-war period, net reproduction rate followed a very gradual linear decline. Comparing with the trend of gross reproduction rate, that of net reproduction rate was extremely gradual. This implies the fact that the decline of reproductive capacity was more gradual than that of fertility, reflecting the counter balancing feature to the fertility decline by the improvement of mortality. To prove this process, reproduction survival rate having been only 62% in 1920's, rose to 66% in 1930 and over 70% after 1937 (see column(4) of Table 5). In the baby boom period, with the fertility represented in gross reproduction rate coming up to halfway in between the levels of 1930 and 1937 as previously mentioned, the remarkable improvement in mortality in post-war years elevated the net reproduction rate of 1947 up to 1.67, exceeding the record of 1.59 in 1920. The accelerated fall of mortality since then effected the recent reproduction survival rate at over 90% and after 1960 the rate became over 95%. Because of the decline in fertility, however, the net reproduction rate fell below the stationary limit at 1 in 1956 and thenafter the population is in below-unit reproduction state every year. In very recent years,

some restoration can be seen along with the rise in fertility, and together with the improvement in mortality, the net reproduction rate is approaching the level of 1958.

Total fertility rate divided by net reproduction rate is termed "total fertility rate necessary to keep the stationary population (ratio of total fertility to net reproduction rate)" and represents a total fertility rate corresponding to a net reproduction rate of 1.00 on the assumption of constant mortality schedule; in other words, the extent to which the present female population should give births of males and females during its life span in order to make the population stationary after one average length of generation under the assumption of constant mortality schedule. This is what may be called the total fertility rate at the stop line of population increase (Table 5 column(5)). In 1920's when the mortality level was high, the population increase was ceased if a woman gave births of 3.3 males and females in average during her lifetime. Recently, however, due to the extreme fall of mortality, the population increase stops when 2.14 children in average are born to each woman of the present generation. It is so calculated, therefore, that the average two children will stop the population increase after one average length of generation, that is, approximately 28 years.

The value of the total fertility rate deducing the ratio of total fertility to net reproduction rate represents the excessive number of children as against the total fertility rate required to cease the population increase (Table 5 column (6)). This value of 1960 was - 0.19 and the actual total fertility rate was 1.97, being lower than the ratio of total fertility to net reproduction rate of the year at 2.16. Although the 1964 value was elevated somewhat to - 0.13, it does not fail at any rate to conform with other indices to show the decline of recent fertility to such an extent as indicating the possibility of population decrease after one generation from now.

In spite of some signs of slight upwarding in recent years, the fact that Japan's net reproduction rate has been below 1 annually since 1956 and that her population continues below-unit reproduction is a peculiar phenomenon even in the world. As shown in Table 7 which compares recent net reproduction rates of selected countries, the only country which shows below-unit reproduction outside of Japan is Hungary. As the countries whose net reproduction rates are not known (because of insufficiency of data) are generally those of high fertility with rapid improvement of mortality of late, it can be assumed that the reproduction capacity in any of these

countries will be high. It is said that the rate of Hungary reflects the consequence of the 1956 tragedy.

Before the war in 1930's, many countries in Europe and Americas showed below-unit reproduction like Austria at 0.74. This has been explained to have been caused by the decrease of marriages and strengthened birth control during the then economic depression. As the economic conditions being normalized, the red figures of reproduction came to be eliminated. In Japan, however, in spite of the surprisingly rapid economic growth of recent years, population reproductive capacity fell below the stationary limit and has not recovered its status for the past 10 years. This is where Japan's characteristics stand.

5. Intrinsic Vital Rates and Stable Age Composition

As another important index to represent the reproduction capacity of the population, we have "intrinsic (natural) increase rate",which is logically far more complicated than the net reproduction rate. To explain this briefly, the stable population represents the permanent structure with the stable age composition that a hypothetical population closed against migration will ultimately have after sufficient period of time, if the present age-specific birth rates and death

Table 7. Reproduction Rates for Female, Selected Countries: latest available year

Country and administrative status	Date	Gross reproduction rate	Net reproduction rate	Reproduction survival rate
Costa Rica	1964	3.34	...	...
Venezuela	1963	3.04	...	...
Panama	1960-64	2.78	...	...
Honduras	1957	2.77	...	...
Hong Kong	1962	2.46	...	...
Chile	1960-64	2.25	...	...
Israel, Total pop.	1963	2.08	...	...
Jews	1963	1.63	1.57	0.96
Ireland	1963	1.90	...	...
Canada	1962	1.84	1.77	0.96
New Zealand	1964	1.83	1.77	0.97
Cyprus	1962	1.69	1.52	0.90
Australia	1963	1.62	1.57	0.97
U.S., Continental	1963	1.62	1.56	0.96
Whites	1963	1.56	1.51	0.97
Non whites	1963	2.10	1.97	0.94
Netherlands	1963	1.55	1.51	0.97
Portugal	1960	1.52	1.33	0.88
Scotland	1964	1.49	1.43	0.96
France	1964	1.42	1.37	0.96
Norway	1961	1.40	1.36	0.97
England and Wales	1963	1.39	1.34	0.96
Poland	1961	1.36	1.28	0.94
Austria	1960-64	1.35	...	...
Finland	1960	1.32	1.26	0.95
Yugoslavia	1962	1.30	1.16	0.89
Belgium	1961	1.28	1.24	0.97
Denmark	1963	1.28	1.24	0.97
Italy	1963	1.23	1.18	0.96
Sweden	1964	1.21	1.18	0.98
Switzerland	1962	1.20	1.16	0.97
Germany, Fed. Rep.	1962	...	1.13	...
Czechoslovakia	1962	1.14	1.09	0.96
Bulgaria	1960-64	1.09	...	...
Japan	1964	0.98	0.94	0.96
Hungary	1961	0.94	0.88	0.94

Source : Office of Population Research, Princeton University; and Population Association of America, Inc., Population Index, Vol.32 No.2, April, 1966.

rates persist without change. In that ultimate stage, the increase rate will also become constant. This increase rate is called the intrinsic (natural) increase rate and the determinant birth rate, that is, "intrinsic birth rate" and accordingly the death rate, that is, "intrinsic death rate" can be obtained.[4)5)]

The net reproduction rate referred before is a compound increase rate between average length of generation (average ages of births) under the assumption of constant schedule of births and deaths. Accordingly, the following relation is established, where r is the intrinsic increase rate, $\bar{T}$ is the average length of generation and r_n is the net reproduction rate.

$$r \fallingdotseq \frac{1}{\bar{T}} \sqrt{r_n} - 1$$

The intrinsic vital rates represent not the result of the following one generation as the net reproduction rate does but the picture of over a hundred years ahead. However, the time factor here is not important by its nature and what is significant is the fact that the rates indicate the potential of the basic population maintenance capacity, undisguised from the superficial appearance of the natural increase rate caused either in positive or negative figures by birth rate and death rate of the present population.

Referring to the results of calculation of intrinsic vital rates of Japan's female population given in Table 8 and Chart 5, the following paragraphs will outline the trend of intrinsic rates by years in comparison with crude vital rates and reproduction rates of the female population.

Both intrinsic birth and death rates were on decline in the pre-war period of 1925-1940, and as the decline of death rate could not counter-balance the decline of birth rate, the intrinsic increase rate also showed a downward trend, coinciding roughly with other reproduction indices.

At the peak of the post-war baby boom of 1947, very extraordinary situation was encountered. In spite of the level of the intrinsic birth rate at around halfway in between the levels of pre-war 1930 and 1937, the intrinsic increase rate remarkably increased due to the very low rate of the intrinsic death rate which had never been seen in pre-war years. In 1948 and 1949, the decline of birth rate was not so noticeable and the baby boom continued. The intrinsic death rate was further lowered, resulting thus in unprecedented high level of the growth rate.

In 1950, another unprecedented change took place; the intrinsic birth rate started an acceleratedly rapid declining, breaking down the pre-war levels. The intrinsic death rate

remained almost stagnant for several years following 1948, with a sign of slight upwarding, but the intrinsic increase rate very suddenly dropped mainly due to the fall of birth rate.

Since then, the intrinsic birth rate followed the annual decrease, while the intrinsic death rate on the contrary was on gradual rise, resulting in the conversion to the decreasing population in 1956 with the minus rate of the intrinsic increase rate. Such sudden fall of the intrinsic birth rate and the rise of the death rate are considered to have been effected by the ageing in the age distribution of stable population. In other words, when the age-specific fertility is low, the stable population composition becomes to be aged and this ageing in the age-distribution causes high intrinsic mortality. Therefore, the low intrinsic birth rate and the high intrinsic death rate as their interaction results in the intrinsic (natural) increase rate of negative value. The stable population of Japan passed through the stationary phase and came into the phase of decreasing population during the period 1955-56, endorcing the afore-mentioned trend of net reproduction rate which fell below the level of one in the same year to turn into the below-unit reproduction.

Table 8. Intrinsic and Crude Vital Rates for Female : 1925-1964 (per 1,000 population)

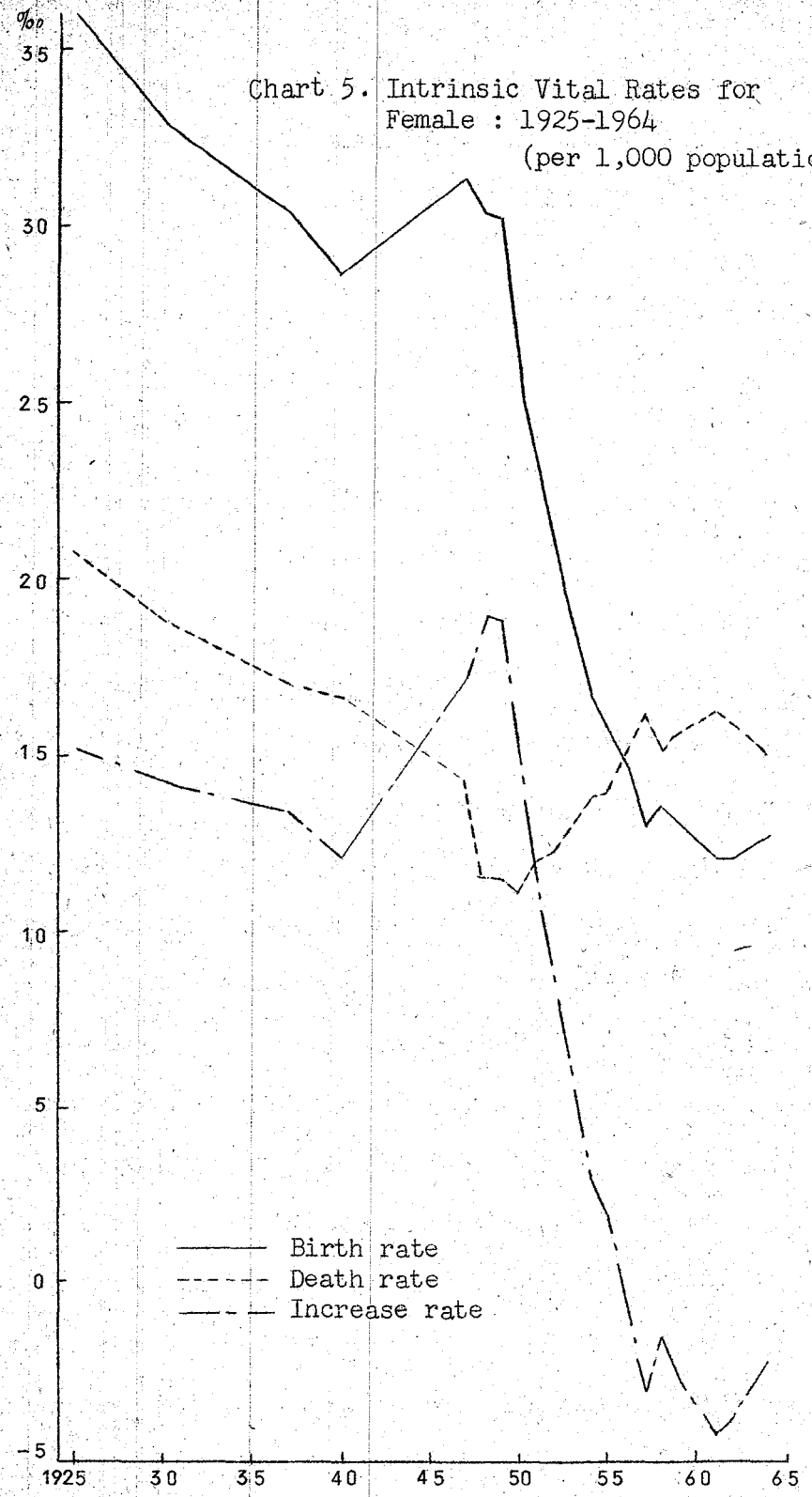
Year	Intrinsic vital rates			Crude vital rates		
	Birth rate	Death rate	Natural inc.rate	Birth rate	Death rate	Natural inc.rate
1925	35.95	20.76	15.19	34.49	19.83	14.66
1930	32.87	18.68	14.19	31.68	17.68	14.00
1937	30.37	16.97	13.40	29.99	16.40	13.59
1940	28.60	16.61	11.99	28.23	15.63	12.60
1947	31.30	14.16	17.14	32.57	13.57	19.00
1948	30.31	11.48	18.83	31.88	11.18	20.70
1949	30.15	11.38	18.77	31.57	10.92	20.65
1950	25.62	11.06	14.56	26.76	10.33	16.43
1951	22.92	11.96	10.96	24.21	9.44	14.77
1952	20.80	12.24	8.56	22.36	8.46	13.90
1953	18.52	13.04	5.48	20.56	8.42	12.14
1954	16.65	13.75	2.90	19.11	7.61	11.50
1955	15.72	14.00	1.72	18.52	7.23	11.29
1956	14.67	15.09	-0.42	17.63	7.47	10.16
1957	13.02	16.16	-3.14	16.44	7.66	8.78
1958	13.51	15.14	-1.63	17.20	6.85	10.35
1959	12.89	15.69	-2.80	16.72	6.82	9.90
1960	12.43	15.96	-3.53	16.37	6.90	9.47
1961	12.02	16.19	-4.17	16.03	6.73	9.30
1962	12.01	15.81	-3.80	16.17	6.78	9.39
1963	12.27	15.27	-3.00	16.45	6.31	10.14
1964	12.68	14.85	-2.17	16.84	6.25	10.59

Computed based on the number of births and deaths from the Vital Statistics Reports, enumerated and estimated populations by ages and life table L(x).

Prior to 1945, includes former Okinawa Prefecture.

Source : Computed by the Institute of Population Problems, Ministry of Health and Welfare (The Journal of Population Problems and Research Series).

Chart 5. Intrinsic Vital Rates for Female : 1925-1964
(per 1,000 population)



The calculations of more recent data show the intrinsic increase rate of females at -2.2‰, same birth rate 12.7‰ and same death rate at 14.9‰ . The continuous post-war decline of the intrinsic birth rate for the first time changed the trend in 1962-63 into gradual rise which continued again in 1963-64 to record the increase of 0.4‰ from 12.3‰ . On the other hand, following the decrease in 1961-62, the intrinsic death rate annually decreased to fall below 15‰ in 1964. The natural increase rate of the intrinsic vital rates showed the minus value since 1956 as mentioned above, recording the lowest rate in 1961 at -4.2‰ , but since then increase has been recorded every year as -3.0‰ in 1963, -2.2‰ in 1964, although still in red figures.

The intrinsic age-group-specific percentages of the stable population show the continuous progress of ageing in post-war years (similarly with the case of actual female population), but in 1963 the percentage of the population aged 0-14 years increased to 18.3% from 18.0% and the percentage of over 65 years population decreased on the contrary from 17.9% to 17.7%. This is also an epoch-making fact together with the rise of the intrinsic birth rate and considerable effect of this rise of intrinsic birth rate can be assumed. Such trend remained again in 1964, where the child population

Table 9. Age Composition of Stable and Actual Populations for Female : 1925-1964 (%)

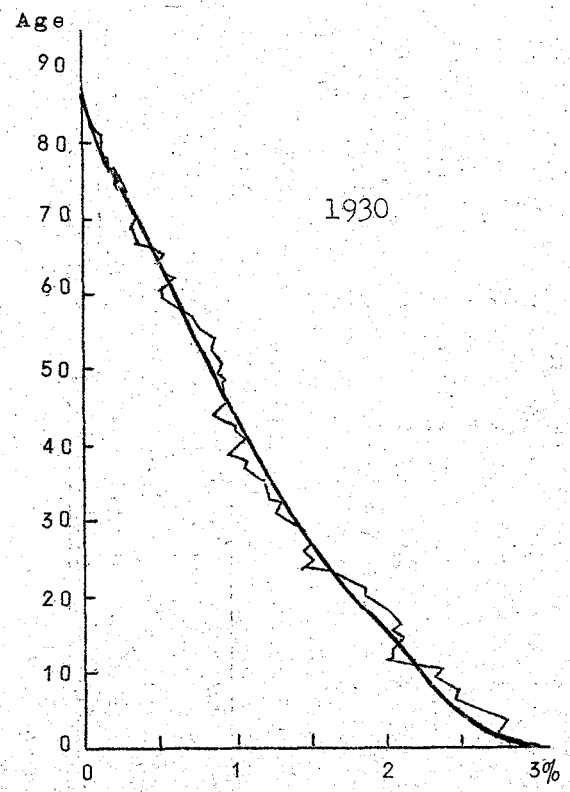
Year	Stable population			Actual population		
	0-14	15-64	65+	0-14	15-64	65+
1925	37.57	57.77	4.66	36.54	57.73	5.73
1930	35.79	58.83	5.38	36.45	58.11	5.44
1937	34.57	59.49	5.94	36.48	58.14	5.38
1940	33.59	60.36	6.05	35.71	58.84	5.45
1947	35.92	58.69	5.39	34.10	60.46	5.44
1948	36.08	58.15	5.77	34.16	60.39	5.45
1949	35.80	58.48	5.72	34.29	60.20	5.51
1950	31.90	60.71	7.39	34.17	60.21	5.62
1951	29.28	61.97	8.75	33.89	60.50	5.61
1952	27.31	63.06	9.63	33.47	60.85	5.68
1953	24.94	63.68	11.38	33.02	61.22	5.76
1954	23.04	64.04	12.92	32.68	61.44	5.88
1955	22.08	64.10	13.82	32.19	61.82	5.99
1956	20.93	65.07	14.00	31.42	62.55	6.03
1957	19.05	64.85	16.10	30.59	63.33	6.08
1958	19.66	64.31	16.03	29.85	63.99	6.16
1959	18.95	64.47	16.58	29.10	64.64	6.26
1960	18.47	64.63	16.90	28.72	64.93	6.35
1961	18.01	64.65	17.34	28.45	65.11	6.44
1962	18.00	64.14	17.86	27.40	66.08	6.52
1963	18.34	63.96	17.70	26.24	67.10	6.66
1964	18.89	64.15	16.96	25.10	68.13	6.76

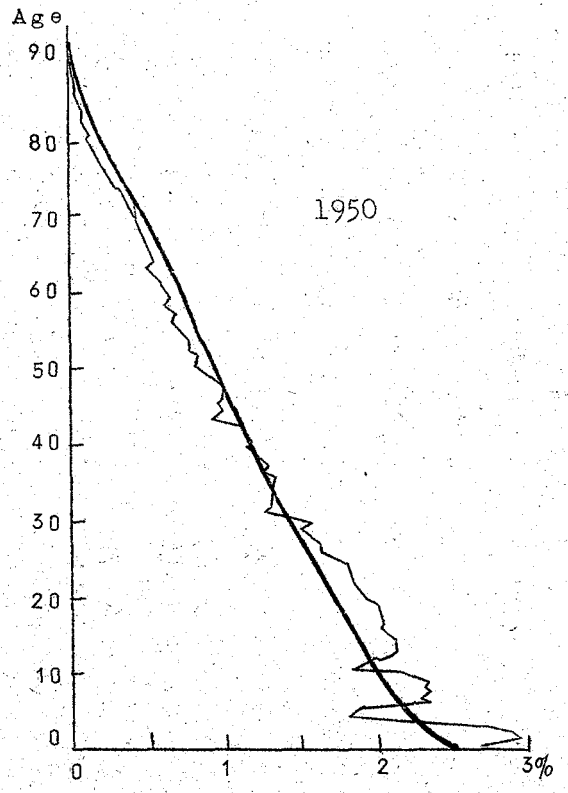
Computed based on the number of births from the Vital Statistics Reports, enumerated and estimated populations by ages and life table L(x).

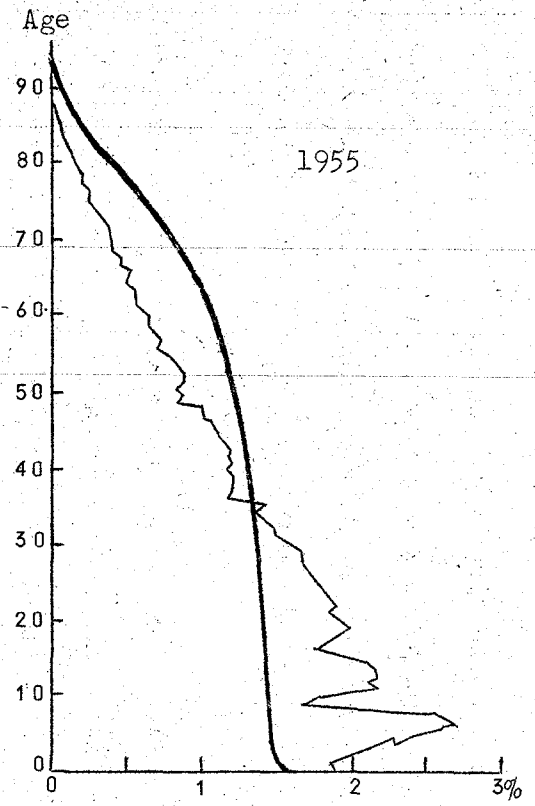
Prior to 1945, includes former Okinawa Prefecture.

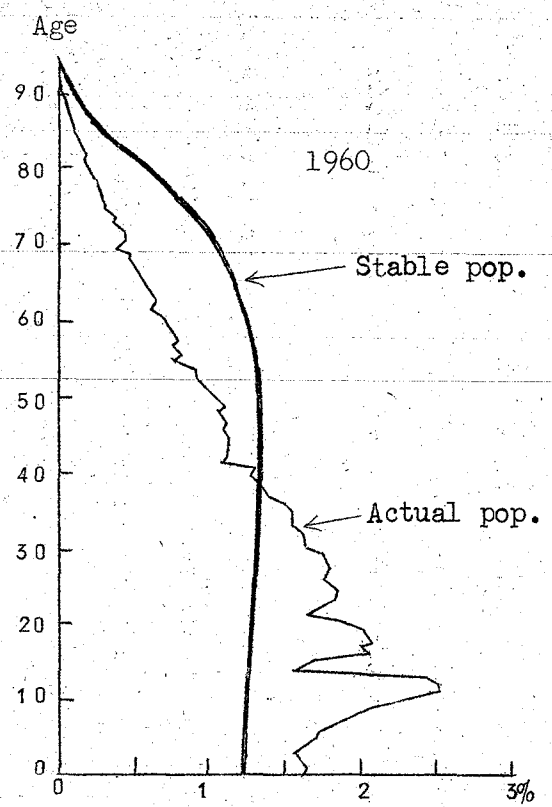
Source : Computed by the Institute of Population Problems, Ministry of Health and Welfare (The Journal of Population Problems, and Research Series).

Chart 6. Comparison of Age Composition of Actual and Stable Populations for Female: 1930, 1950, 1955 and 1960






Age
90
80
70
60
50
40
30
20
10
0
1955
0
1
2
3%


Age
90
80
70
60
50
40
30
20
10
0
1960
Stable pop.
Actual pop.
0
1
2
3%

ratio increased to 18.9% and the aged population ratio decreased to 17.0%. Yearly changes of the ratio of the productive age population of 15-64 years have been relatively irregular, and it declined in 1962 and 1963 but increased, though slightly, in 1963-64 from 64.0% to 64.2% (see Table 9 and Chart 6).

Followingly, some mention is to be made on crude vital rates of Japan (Only females are considered here as in the case of the stable population and the result is given in Table 8). Although death rate came down in post-war years, more rapid decline in birth rate caused the gradual fall of natural increase rate. Since 1954, death rate had been somewhat over 7‰, and in 1958 the rate became below 7‰ and is remaining stagnant, while birth rate had been around 17‰ since 1956 and started to show the stagnant trend, though with slight increase in very recent years. This balances the natural increase rate at the level of stagnancy or slight rise around 10‰.

One may question that it is apparently contradictory that there is considerable increase in actual population on one hand, while the reproductive capacity is in deficit on the other. Is the reproductive capacity not giving shadowy threat and rousing unfounded apprehensions? This seeming contradiction

is caused by the inheritance of past high fertility being latented in the present age composition. At present, as the ratio of child-hearing age population is high, the birth rate as the total results in high level in spite of low individual fertility. This inheritance, however, can not last long and sooner or later these red figures of the reproductive capacity will break cover.

Although fair amount of birth excess is seen in natural increase rate of the actual population still, both intrinsic growth rate and net reproduction potential since 1956 having been weakened to such an extent as it can no longer maintain the present size of population. In fact, though the recent death rate in Japan is in sufficiently low level, fertility level is declining to the extent which can not counter-balance the mortality decline.

As seen in the international comparison given in Table 10, even among the countries of Europe and Americas where natural increase rates are lower than Japan, there is no other country than Hungary which has the intrinsic increase rate below zero or the net reproduction rate below 1. In Japan, it is totally due to the peculiar form of age distribution (high ratio of reproductive age population) that the actual natural increase rate is still showing considerable amount of birth

Table 10. Intrinsic Vital Rates for Female, Selected Countries : latest available year (per 1,000 population)

Country and administrative status	Date	Intrinsic increase rate	Intrinsic birth rate	Intrinsic death rate
New Zealand	1964	21.2	27.5	6.3
Canada	1962	20.9	27.3	6.4
U.S., Continental	1963	17.1	24.6	7.5
Whites	1963	15.6	23.2	7.7
Non whites	1963	26.7	33.8	7.1
Australia	1963	16.6	24.0	7.4
Netherlands	1963	14.3	22.0	7.7
Scotland	1964	13.1	21.8	8.7
France	1964	11.7	...	...
Norway	1961	11.0	19.8	8.8
England and Wales	1963	10.9	20.0	9.1
Portugal	1960	9.8	21.4	11.6
Poland	1961	8.9	19.6	10.7
Denmark	1963	8.2	18.2	10.0
Finland	1960	8.1	18.7	10.6
Belgium	1961	7.7	18.1	10.4
Sweden	1964	6.1	16.6	10.5
Italy	1963	5.6	16.8	11.2
Germany, Fed. Rep.	1963	5.6	17.6	12.0
Yugoslavia	1962	5.5	18.6	13.1
Switzerland	1962	5.3	16.5	11.2
Czechoslovakia	1962	3.3	15.7	12.3
Japan	1964	-2.2	12.7	14.9
Hungary	1961	-5.1	11.7	16.8

Source : Office of Population Research, Princeton University ; and Population Association of America, Inc., Population Index, Vol. 32 No. 2, April, 1966.

excess in spite of the intrinsic balance of fertility and mortality indicating death excess and this population increase is in fact in a deceptive appearance.

6. Closing Remarks

The interpretation of the maintenance power of population differs according to the different standpoints and no unanimous conclusion can be sought. The population increase taking place within the limited living resources may lower the level of living but when this population increase appears as the effective increase of labor force, it may increase the production of living resources. In order to correctly evaluate the effect of increase of population upon the status of living, therefore, it must be based on the detailed analysis of the complicated and delicate interaction of socio-economic conditions of the society and the composition of the population itself therein. Leaving the question as it may, hereafter the main points in connection with the present status of population reproductivity of Japan so far mentioned will be summarized as follows:

(1) The number of births amounted 2,679 thousand in 1947 (34.3 per 1,000), reached the peak of 2,697 thousand in 1949, and since then rapid decrease started to come down to 1,589

thousand in 1961. Such sudden decrease has never been experienced even in the countries of Europe and Americas. As the number of deaths also rapidly decreased from 1,138 thousand (14.6 per 1,000) in 1947, however, approximately 0.9 to 1 million net volume of reproduction is being made in recent years. These figures only give impressions of extremely voluminous population growth, even to fear the excessive population and to feel the need of strengthening of fertility control. However, calculated net reproduction rate which was at a high level of over 1.5 in 1947-50, shows annual decline to fall below 1.0 since 1956, indicating the decreasing reproduction in every recent years. This is an extremely rare phenomenon internationally and is in a way peculiar to Japan.

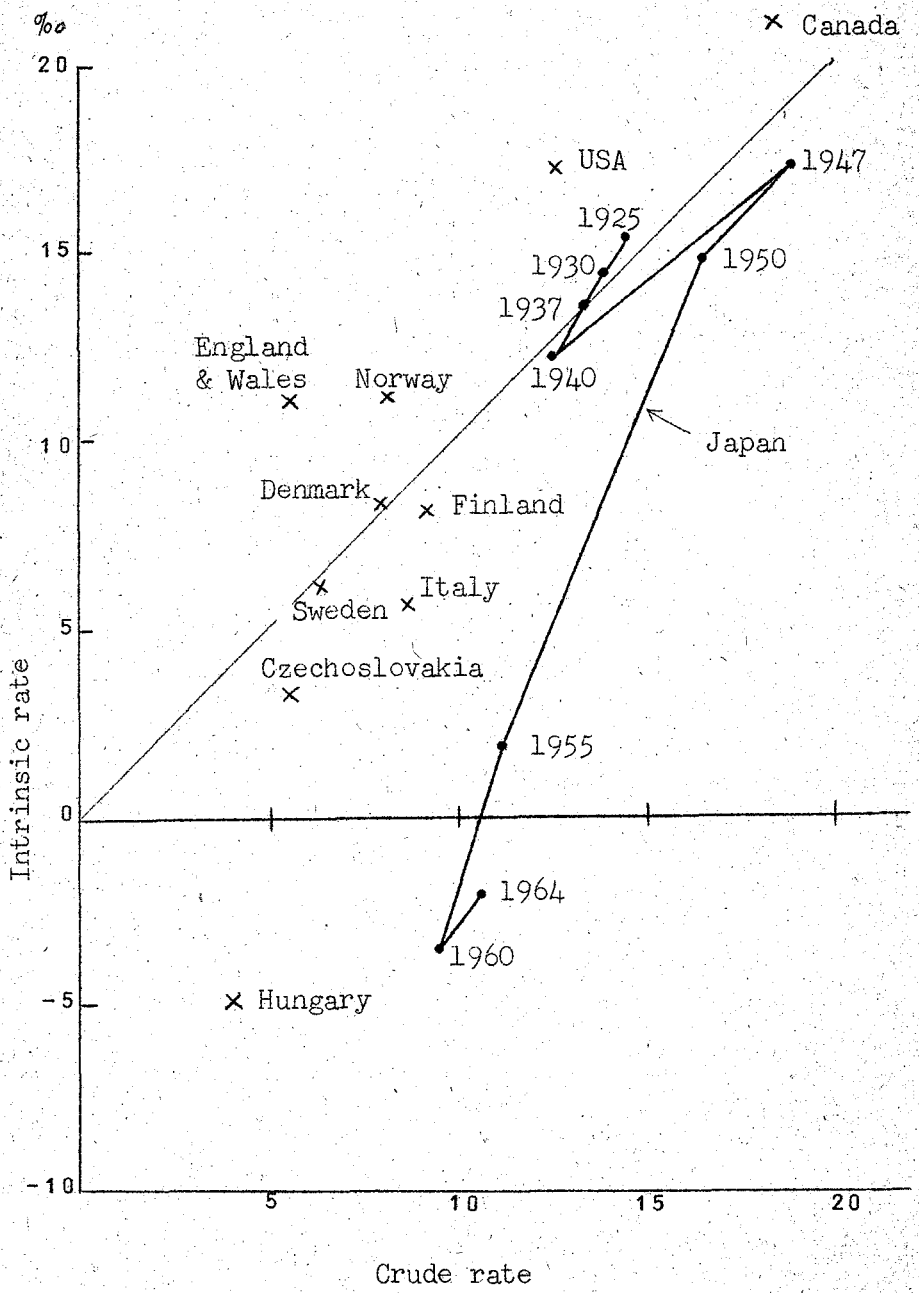
(2) If comparison is made between Japan and countries of Europe and Americas as shown in Chart 7 in seeming increase rate (crude natural increase rate) and in true increase rate (intrinsic increase rate), the intrinsic increase rate makes it clear that Japan is in failure of population maintenance in recent years. It is true that the actual natural increase rate shows the birth excess amounted around 10‰ still at present and Japan's population is certainly continuing its increase. But due to the intensive fertility decline lasting over ten years which caused a sudden decrease of child popula-

tion (mainly by means of family planning and induced abortion), Japan's population is no longer capable of maintaining the power, in its true potential, even to merely replace the population, in spite of the remarkable improvement in mortality. Only other country than Japan which has been under the similar situation is Hungary and even the countries of Western Europe, though their population reproductive power is not high, have not lost their capacity of increasing reproduction.

(3) Mortality improvement in post-war years has been very substantial and it seems that the decline has approached very closely to the lower limit. As the reproduction survival rates of such countries where mortality is held in most low level are somewhere around 95%, Japan's survival rate seems to indicate a most noticeable degree of improvement. Not by any means diminishing the value and need of public health endeavors, it must be realized that there is relatively not much room for further improvement in mortality in spite of such endeavors. Accordingly, the determining force of future population growth and underlying reproductivity is no longer mortality but changes in fertility.

(4) Present reproductivity of Japan is below the stationary level and shows red figures every year. Whether or not the slight upwarding trend in very recent years will be immediately

Chart 7. Correlation of Crude and Intrinsic Natural Increase Rates for Female : 1925-1964 (per 1,000 population)



led into the expansion of the power requires a little more observational period before one's judgement. Upwarding the trend may be, it is still in considerable decreasing reproduction. Possibility is here acknowledged that the appropriate adjustment of fertility will adjust the future population growth. Population reproductive power of Japan has undergone series of rapid changes in over 10 years. To reflect these changes, the effects are appearing very rapidly in the composition of her population.

(Postscript)

Recently, the Ministry of Health and Welfare published an annual report on the basis of the data in "Monthly Vital Statistics". According to this report, the round numbers of 1965 are 1,822 thousand births (18.5 per 1,000), 700 thousand deaths (7.1 per 1,000) and 1,122 thousand increase (11.4 per 1,000). Compared with the previous year, both actual numbers and the rates increased and particularly the increase of births is noted. Crude birth rate of 18.5‰ means the recovery of 1956 level. It is said that the sudden increase of birth rate in 1965 may be due to the fact that the following year of 1966 is "hinoeuma" or "the year of horse and fire" but the extent to which this superstition effects fertility level can not yet be known at the present stage. On the other hand, the

increase of deaths being smaller than that of births, the net volume of reproduction as their difference has exceeded the amount of increase in 1953. Crude natural increase rate at 11.4‰ is in between the levels of 1955 and 1956. It is difficult to judge immediately whether or not such rise in births, deaths and natural increase will continue in the future to formulate a new trend.

Since the changes of births and deaths, among different vital statistical phenomena, have direct influence over population growth and the changes in age distribution of population, the recent retardation of decline in births rate and death rate or occassional rises and falls should be carefully examined as the characteristics of recent vital statistics of Japan. Such irregular movements can be considered to continue for some time in the future. Such future movements in vital statistics may change the age distribution of population which in turn may considerably affect the trend of vital statistics, and complicated pattern of transition may be expected.

Footnotes

1) This is called "standardization method by voluntary standard population" named so by Dr. Minoru Tachi, Director of this Institute. Opinions vary as to who originated this method, but the most representative is the method by Newsholme-Stevenson. There are direct and indirect methods and here the direct method was used. For the methodological

details, refer the following publication.

Arthur Newsholme and T.H.C. Stevenson, "An improved method of calculating birth rates", The Journal of Hygiene, Vol. V, 1905.

Arthur Newsholme, The elements of vital statistics in their bearing on social and public health problems, new ed., London, 1923.

Minoru Tachi, "A demographic study on regional population increase in Japan(1), standardized birth rates in Japan", Population Problems(Jinko Mondai), Vol.I, No.4, December 1936.

2) Which population should be selected as the standard population is as the name of the standardization method shows quite voluntary, but in the present study, the total population of Japan in 1930 is used as it is considered to be most appropriate in its basic structure as the standard population. Space here does not allow to go into the details but the following article is suggested for reference:

Minoru Tachi, "Standardization theory of vital rates, on the problem of selection of the standard population from the standpoint of formal demography", Health and Welfare Index (Kosei no Shihyo), Vol.VII, No.3, March 1960.

3) This method was originated by R.R. Kuczynski. The concept of total fertility rate was presented in 1907 as a method of measurement of "pure fertility" and later with the concepts of gross reproduction rate and net reproduction rate the method was systematized.

Robert R. Kuczynski, The measurement of population growth, methods and results, London, 1935, New York, 1936.

4) The basic formation of this theory was publicized by A.J. Lotka in 1907, and in 1925 the method of actual calculation was capacitated with L.I. Dublin. This method is, therefore, also called the Dublin-Lotka method.

A.J. Lotka, "Relations between birth rates and death rates", Science, Vol. 26, 1907.

Louis I. Dublin and Alfred J. Lotka, "On the true rate of natural increase as exemplified by the population of the United States, 1920", Journal of the American Statistical Association, Vol. XX, No.150, September 1925, pp.305-339.

5) This is a method for obtaining vital rates standardized in the extreme population corresponding to birth and death schedules of a given actual population, or the vital rates of the extreme population, and is called "the method of stable population standardization".

The standardization theory has undergone the development process of the standardization by voluntary standard population → by stationary population → by stable population. As the natural increase rate is stable in the stable population, unlike in stationary population which increases (or decreases) by geometric progression. In other words, the stationary population is nothing but the stable population at a particular stage where crude birth and death rates are equal and accordingly where natural increase rate is at 0. Rather than the method with the standard population of such specific population composition under special circumstances, that is, rather than the use of the method of stationary population standardization, it is theoretically more logical to standardize by the stable population as the standard population which is composed as the result of the continuation of actual fertility and mortality schedules.

See Minoru Tachi, Formal demography, analytical methods of population phenomena, Tokyo (Kokon Shoin), 1960.

In standardization by voluntary standard population mentioned in Section 3 of this report, the selection of the standard population is entirely voluntary and selection of different standard populations will give different figures of standardized vital rates. Any figure thus obtained is in the same correctness theoretically and it is not possible to determine which ones should be taken or not. The way to deliminate such weakness is to select such standard population which exists only in one and no other in theory, that is, the stable population.

Materials used for calculations

Among the figures listed in this report, years for which calculations were made at this Institute of Population Problems on major indices of population reproduction in Japan were limited because of the availability of basic data as the following:

Standardized Vital Rates:

Birth rates and natural increase rates: 1925, 1930, 1937-1940, yearly since 1947.

Death rates: 1920-1940, yearly since 1947.

Population Reproduction Rates (Females):

Total fertility and Gross Reproduction Rates: 1925, 1930, 1937-1940, yearly since 1947.

Net Reproduction Rates: 1925, 1930, 1937, 1940, yearly since 1947.

Stable Population (Female):

All the Indices: 1925, 1930, 1937, 1940, yearly since 1947.

The basic data required for calculations of these indices are the population of each year, numbers of births and deaths and the number of survival (stationary population L(x) of the life-table and used only for the calculation of net reproduction rates and the indices of stable population), all age-specific. Following materials were referred for such data. Standardized vital rates were calculated with the data by 5-year age groups and population reproduction rates and the indices of stable population with those for every age.

Populations:

For 1920, 1925, 1930, 1935, 1947, 1950 and 1955, reports of population census results of 1 October of respective years. For 1940, adjusted numbers of the census results. For the years other than above during 1920-1940, 1948, 1949, 1951-1954 and 1956-1959, estimated populations prepared by the Bureau

of Statistics of the Office of the Prime Minister. For years since 1960, estimated populations prepared by the Institute of Population Problems.

Number of Births:

For 1925 and 1930, reports of the results of special enumerations of vital statistics.
For 1937-1940 and since 1947, annual reports on "Vital Statistics".

Number of Deaths:

For each year, annual reports on "Vital Statistics".

Number of Survival:

For 1925, 1930, 1937, 1947, 1950 and 1955, 4th, 5th, 6th, 8th, 9th and 10th Complete Life Tables respectively. The 7th life table for 1940 was planned but not completed and the life-table prepared and reported in its substitute by Prof. Haruo Mizushima and his group was used.
For 1948, 1949, 1951-1954 and since 1956, "Abridged Life Table" prepared by the Institute of Population Problems in respective years.

The results obtained by L(x) of each life table mentional above or in the absence of L(x), the approximation by the following formurla were used.

$$L(x) \fallingdotseq \frac{l(x) + l(x+1)}{2}$$

For the data before 1940, former Okinawa Prefecture is included.