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VITAL and HEALTH STATISTICS

ANALYTICAL STUDIES

Recent Retardation of Mortality Trends in Japan

A study of recent trends in the death rates of Japan according to sex, age, and cause of death, undertaken as part of a survey of mortality trends in the United States and other countries.

Washington, D. C. June 1968

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FOREWORD

This is the fourth in a series of reports on studies undertaken to suggest possible reasons for changes in mortality trends observed in the United States in recent years.

In Japan as in a number of countries, the rapid decline in mortality which occurred earlier in this century has ceased. Mortality trends have leveled off, and in some cases the crude death rate has increased. Since the phenomenon has been observed in countries with different levels of mortality and varied social and cultural conditions, analyses of data from these nations may identify common factors associated with its occurrence. The results should provide a broader base of knowledge for interpreting changing trends in the United States.

The Office of Health Statistics Analysis has arranged for investigators in the countries concerned to undertake these studies and report their results. Three previous reports bearing on this problem have appeared in Series 3 of *Vital and Health Statistics:*

Number 1, "The Change in Mortality Trend in the United States"
Number 2, "Recent Mortality Trends in Chile"
Number 3, "Changes in Mortality Trends in England and Wales"

The methodology, findings, and conclusions presented are those of the investigators.

Iwao M. Moriyama, Ph.D.
Director
Office of Health Statistics Analysis

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CONTENTS

THIS REPORT continues a series of analytical studies designed to ascertain causes underlying the change in mortality trend observed in the United States and in a number of other countries in recent years.

In this report retardation of mortality decline is defined as an abrupt and discontinuous change in rate of decrease of a declining mortality trend. Two measures of this phenomenon—the retardation index and the retardation ratio—are presented and used in the analysis of recent mortality trends in Japan.

Retardation of mortality decline occurred around 1955 in Japan. The phenomenon was observed in all prefectures and was especially noticeable among males in the middle-aged groups. Changes in the trend of mortality from infectious diseases were primarily responsible for the retardation. Further analysis of these changes by age and detailed cause of death revealed significant retardation of trends for bronchitis and pneumonia and for enteritis and related causes. For these cause groups retardation was noticeable in the age groups of 15-44 and 45-64 years for each sex.

Information on occurrence of influenza, use of antibiotics, and infection by resistant strains during the same period was analyzed. No definite relation between these factors and the retardation of mortality decline was found. Some retardation of a declining trend in the incidence of bacterial and viral infections, however, is suspected to be a factor in the retardation of mortality decline.

RECENT RETARDATION OF MORTALITY TRENDS IN JAPAN

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INTRODUCTION

Retardation of Mortality Decline

After World War II, mortality of Europe and the American countries had been steadily improving. However, around 1950, retardation of mortality decline started to show up, and, in Norway and other countries, a slight increase in the crude death rate was observed.

Moriyama observed a similar retardation of mortality decline for infants and most other age groups, for most States, and for both white and nonwhite persons in the United States, and investigated the various possible sources of this retardation phenomenon.[1,2] It is suspected that a specific underlying cause may exist to make a retardation of mortality decline.

In Chile, a similar analysis was undertaken.[3] According to this report, a significant retardation of mortality decline in the middle-aged groups of men was attributed to infectious diseases; the authors point out that the main reason for this retardation was insufficient public health activity.

In England and Wales, improvement in mortality of all age groups dampened between 1955 and 1961.[4] The main cause of this dampening was reported to be an imbalance between increase for coronary artery disease and diminishing improvements in infectious and respiratory diseases. Although a mathematical analysis of this trend indicates the dampening mortality, it was reported that a complete alteration of trend was not observed in those years.

In order to examine whether a similar retardation phenomenon exists in Japan, the yearly changes in selected diseases between 1900 and 1963 have been investigated.

The results show that the retardation of mortality decline, that is, the leveling off of the trend, was observed for deaths from pneumonia and bronchitis (figs. 1 and 2).

The retardation or the leveling off of these mortalities did not seem to take place at a gradual pace but suddenly happened at a certain year or around that year, changing the inclination of the trend observed up to that time.

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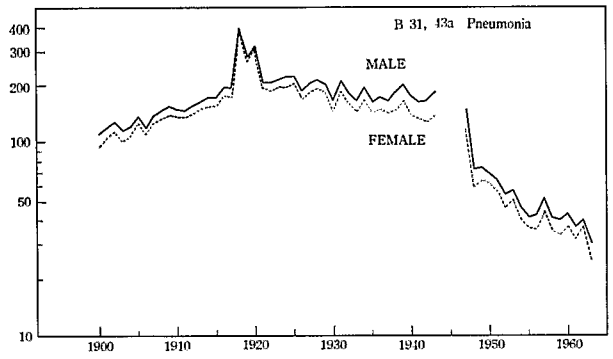

Figure 1. Death rates per 100,000 population for pneumonia, by sex: Japan, 1900-1943 and 1947-63.

Meaning of the Retardation

Broadly speaking, the retardation phenomenon means that the improvement in mortality during a specific time interval under observation is gradually curtailed with time. Here, however, the retardation phenomenon is limited to the specific meaning that the improvement in mortality, which has been following a certain regular trend, changes discontinuously its trend in a certain year and shifts to a new and slower course of improvement. In this case, the mortality curve of trend is observed to have a breaking point and to be composed of two trend lines for the respective periods before and after this point of time.

Mortality from some diseases, especially the infectious diseases, might be reduced to no cases in the future. On the other hand, mortality due to the diseases of old age cannot be reduced to the zero level, as it can be suppressed only to a certain limit above zero. When mortality is lowered and approaches this limit, the proportion of decrease becomes smaller. Even in this case, so far as each of the component death rates changes following a certain regular trend, the rate of decrease in the total mortality may be said to diminish with a certain regularity. Accordingly, this case may be considered as a retardation in a broad sense, but it is not called as such according to the stated definition.

Lotka proved that the retardation of decrease and even the increase of crude death rates are observable in a logistically growing population.[5] This retardation can also be estimated according to a mathematical rule and the change of mortality is not the retardation phenomenon to be discussed here. Therefore, it was sought to avoid various complicated problems involved in the crude death rate by studying mortality rates specific for sex and age as far as possible.

The curve of retardation may be the result of the addition of two or more different trends, some increasing and others decreasing. The type of retardation of the aggregate mortality will depend on the mixing proportion of deaths in each category. If a new category of disease is considered to show up from a certain year, this would be one of the main causes for retardation defined here.

METHOD OF ANALYSIS

Identification From Graphs

Annual changes in mortality during the period 1947-63 are drawn in the figures according to various combinations of such variables as age, sex, region, and cause of death. Six experts in vital statistics were divided into three teams of two persons each. The teams were asked to examine such figures and determine on each graph where the retardation occurred. The graphs were

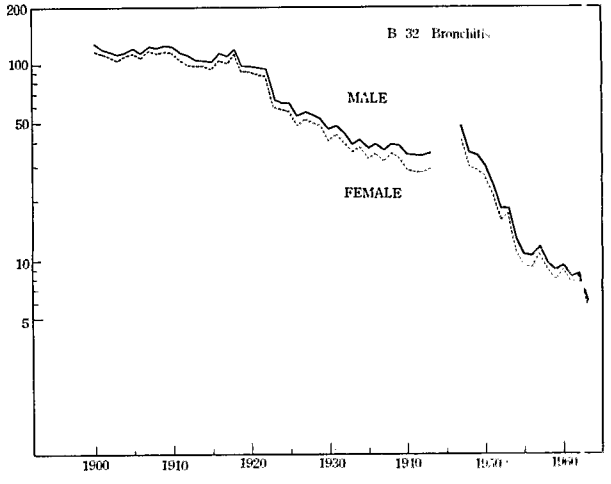

Figure 2. Death rates per 100,000 population for bronchitis, by sex: Japan, 1900-1943 and 1947-63.

also classified according to whether the retardation phenomenon was clearly identifiable, identifiable, or unidentifiable. The three teams of experts designated the time of the breaking point when the retardation phenomenon was observed to occur. If the year of the breaking point was difficult to determine, selection of two points was permitted. This method was used mainly for the analysis of data on cause of death according to broad categories and according to the detailed classification of the International Classification of Diseases.

Retardation Index and Its Changes

Case I.—If mortality, q_t, were reduced by a constant proportion each year during a certain period, that is, the amount of annual decrease approaches zero in a geometric series, the following equation for the curve can be considered:

$$\frac{q_{t+a}}{q_t} = \frac{q_t}{q_{t-a}} = k.$$

Here, k is a constant, and

$$\frac{q_{t+a}}{q_t} \Big/ \frac{q_t}{q_{t-a}} = R.I. = 1.$$

This index is designated as the retardation index (R.I.). If the trend of death rate changed near year t, the value of k at this breaking point naturally changes and the R.I. is either greater or smaller than 1. When a retardation in trend is observed, it is obvious that the R.I. should be greater than 1, and when the decline in mortality continues at a new and constant rate again, the R.I. would return to 1 again.

The R.I. can be calculated continuously using 1-year intervals $t-1$, t, $t+1$, or using 5-year intervals, $t-5$, t, $t+5$. Here, the R.I. has been calculated for each year using 5-year intervals. If the breaking point exists at year t_r, the break in trend can be detected by the changing R.I. as t moves along the time axis near t_r. The R.I. increases as t approaches t_r, and it reaches the highest value at t_r. After t_r is passed, the R.I. returns to its previous level.

Case II.—If mortality, q_t, has a lower limit, $\bar{q}$, and $q_t - \bar{q}$ diminishes exponentially as t proceeds,

$$\frac{q_t - \bar{q}}{q_{t-a} - \bar{q}} = k'$$

where k' is a constant. Then the retardation index is

$$R.I. = \frac{q_{t+a}}{q_t} \Big/ \frac{q_t}{q_{t-a}} > 1.$$

Thus, the R.I. is always greater than 1 in this case. Generally, a lower limit exists for most causes of death, with some exceptions such as some of the infectious diseases. Mortality for each age group also has a lower limiting value. Thus, within the range of observable mortality, the R.I. is always expected to be greater than 1, and in most cases the calculated values are actually greater than 1. Even when the mortality has a lower limit, if the abrupt change in decreasing trend is observed at t_r, the R.I. makes a peak point at t_r, as in Case I. Thus, the year of a significant change in mortality trend also can be easily detected by observing an exceptional fluctuation in the R.I. over time, though the index always remains above 1.

Determination of Trend Lines and Degree of Retardation

By taking into account expert judgments of retardation based on the examination of a graph of mortality trend, and change of the retardation index, the time of the breaking point can be determined from the data. A trend with a breaking point at t_r is represented by two equations, fitted by the method of least squares,

$$y_1 = e^{-(a_1 + b_1 x)}, \quad x \leq t_r.$$

and

$$y_2 = e^{-(a_2 + b_2 x)}, \quad x \geq t_r.$$

The ratio of the difference between slopes before and after the breaking point, to the original slope, is designated as the retardation ratio (R.R.), expressed as a percent.

$$R.R.(\%) = \frac{b_1 - b_2}{b_1} \times 100 = 100 - \frac{b_2}{b_1} \times 100.$$

If slopes b_1 and b_2 are equal, R.R. is zero. If b_2 approaches zero, R.R. approaches 100 percent. In other words, if the trend line becomes horizontal after t_r, R.R. approaches 100 percent.

Problems Concerning Classification of Causes of Death

There are several tabulation lists presented in the WHO *Manual of the International Statistical Classification of Diseases, Injuries and Causes of Death.*[6] In Japan, mortality analysis, crossed with sex, age, locality, and other variables, is generally based on List B. In this research, besides this B List, another classification by broader categories, adopted by the Health and Welfare Statistics Division, Ministry of Health and Welfare of Japan, such as A, B, C, D, and E groups, was also employed. These groups contain categories of deaths classified as infectious diseases (Group A), adult diseases (Group B), diseases of pregnancy and infancy (Group C), external causes of death (Group D), and causes not elsewhere classified (Group E). Specific B-List categories included in each group are shown below.

Group A: B1-B17, B23, B30, B31, B32, B36, B43a,[g] B43b[g]
Group B: B18, B19, B22, B25, B27, B28, B29, B45a[g]
Group C: B40, B41, B42, B43c,[g] B44
Group D: BE47-BE50
Group E: All B-List classifications other than A, B, C, and D groups

A table containing the detailed list of causes of death by age groups can be found in the annual statistical reports on causes of death in Japan.[7] However, the analysis of causes of death is usually carried out using B-List categories and 5-year age groups. In this study, categories from the detailed list were also analyzed, using five broad age groups—under 1, 1-14, 15-44, 45-64, and 65 and over—and the annual change in each cause was examined.

RETARDATION BY AGE GROUP

Figures 3 and 4 show death rates by sex for each age group. Corresponding changes in the retardation index, as described in the discussion of methodology, are shown in figure 5.

The R.I. based on the interval 1947/52/57 is very high and greater than at any other time. This proves a significant retardation of mortality decline after 1952, compared with the trend between 1947 and 1952. This phenomenon occurred more or less regularly in each of the age groups. This may be considered as a change reflecting transition, or the recovery process from unusual to more usual living conditions following World War II.

The R. I. based on 1950/55/60 is also higher than those based on earlier and later intervals for all age groups (the peak occurs 1 year earlier for infant mortality), and this proves a possible break in trend about 1955.

Similar analyses by age group have also been attempted for representative prefectures in Japan i.e., Hokkaido, Tokyo, Shizuoka, Kyoto, Okayama and Kagoshima.

Differences between urban and rural prefectures were very small and the retardation indexes for the crude death rates in these prefectures were within the range between 1.3 and 1.5. The

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[g] [Ed. note: In Japanese vital statistics reports, subcategories of certain B-List causes are shown separately. These subcategories are designated by a lower case letter following the B-List number. The subcategories listed in the text correspond to three-digit International Lists numbers as follows:

B-List subcategory	Detailed list numbers
B43a	763
B43b	764
B43c	765-768
B45a	794

For a listing of all such subcategories, see Vital Statistics 1964, Japan, Vol. 2, Health and Welfare Statistics Division, Ministry of Health and Welfare, Japan, pp. 39-43.]

change of index for each age group in these prefectures was similar, with a few exceptions, to the national average.[8]

RETARDATION BY CAUSES OF DEATH

Broad Categories of Causes of Death

Figure 6 shows the changes of the crude death rate from 1947 through 1963 for causes of death classified in each of the broad groups A through E.

In order to detect the occurrence of retardation, the retardation index was calculated, using 5-year intervals, for each of the years of 1952-58. The change of R.I. is shown in figure 7.

Group A shows peculiar change, with a high R.I. for both 1952 and 1955, i.e., 1.7 and 1.9. Almost similar trends are observed for Groups B and E. Group E shows a high R.I. for the years 1952, 1955, and 1958. Group B has R.I.'s ranging between 0.8 and 1.2, and the trend is considered to fluctuate around 1.0. It should be noted, however, that these Groups B and E have a pattern similar to that of Group A. Group C has a mortality rate

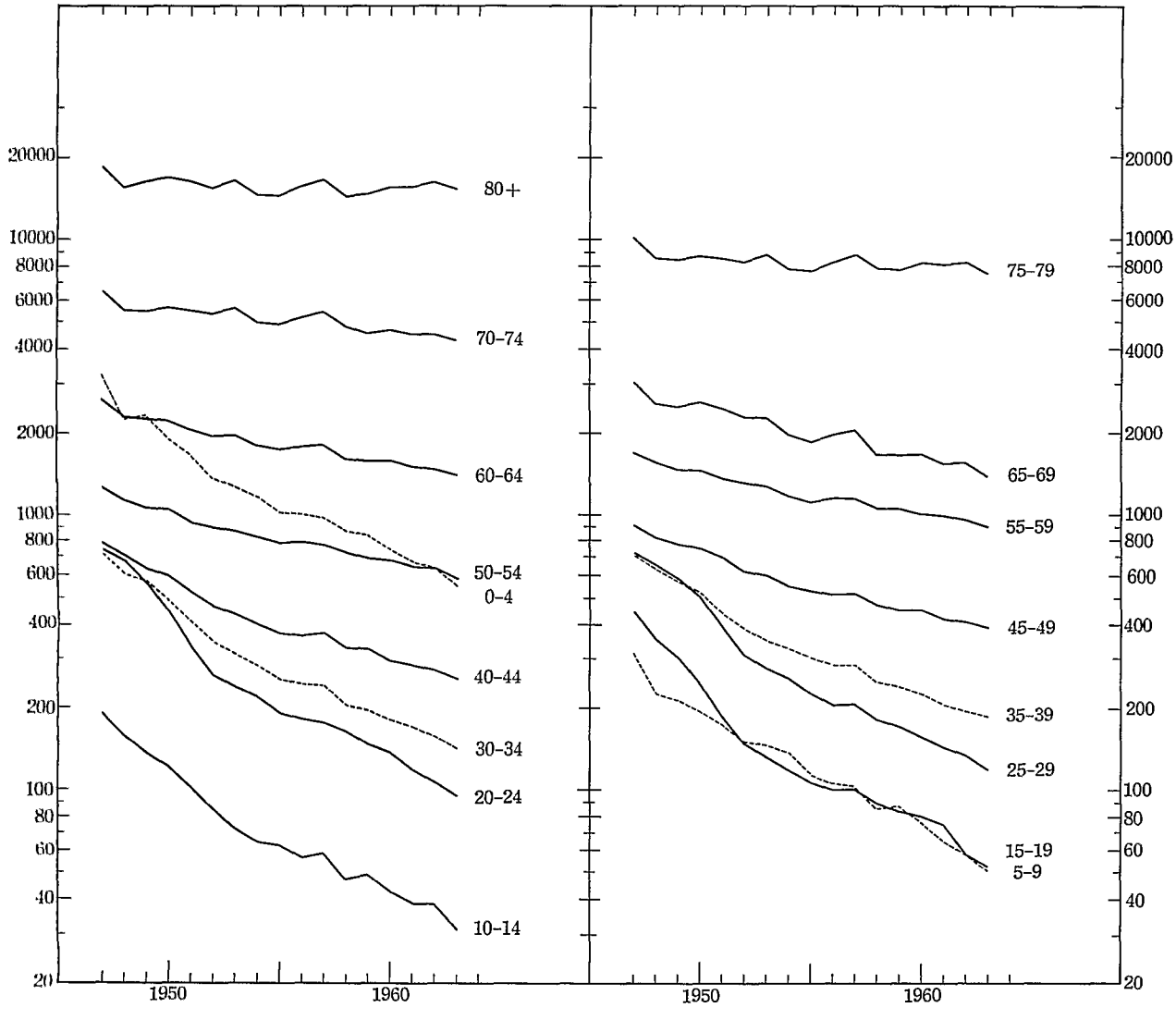


Figure 3. Death rates per 100,000 population among males for all causes of death, by age groups: Japan, 1947-63.

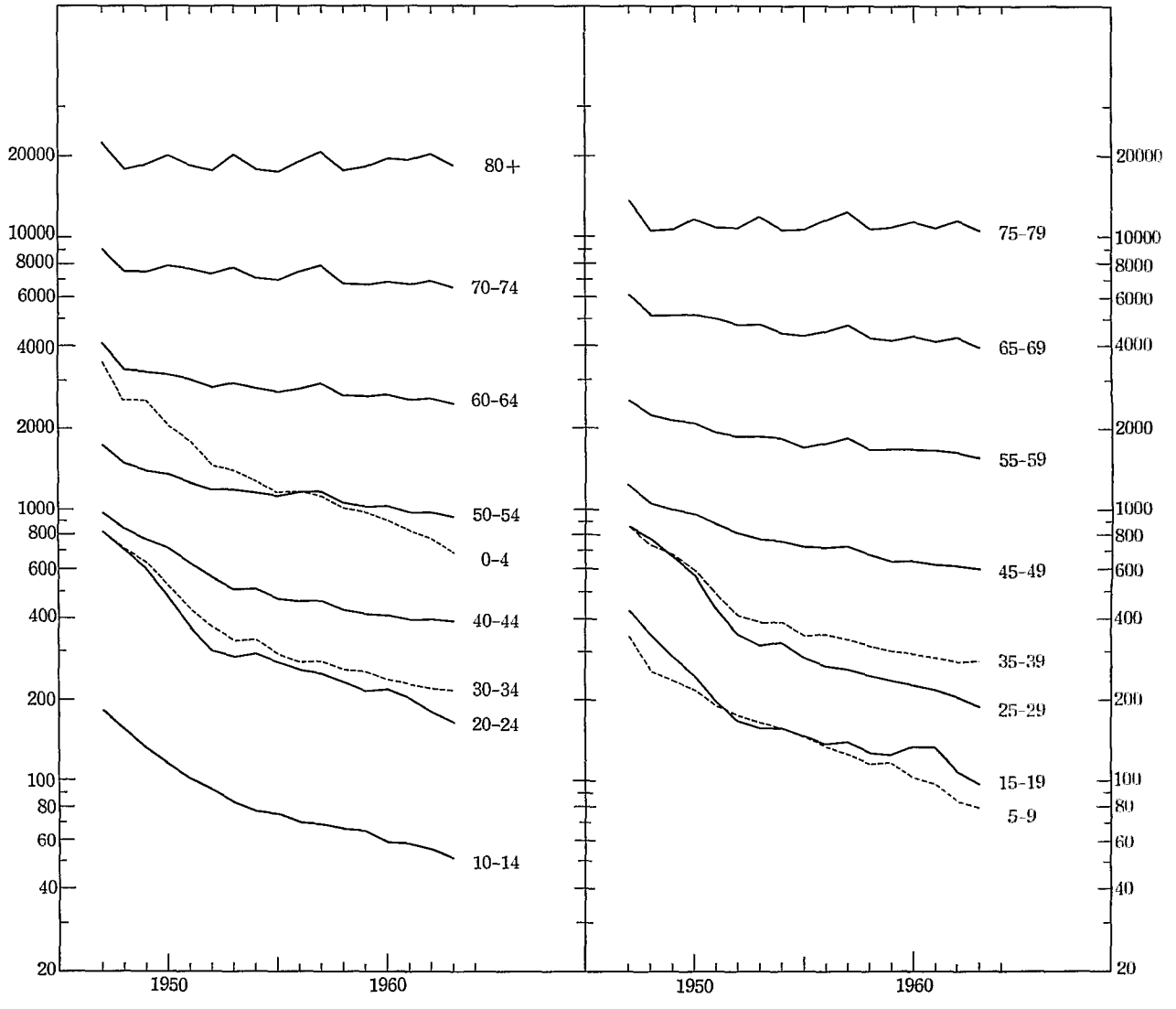


Figure 4. Death rates per 100,000 population among females for all causes of death, by age groups: Japan, 1947-63.

which tends to decrease, and its R.I.'s for 1957 and 1958 are 0.8. Group D has the highest R.I., 1.3 for 1952, and shows changes different from the other groups. The R.I. decreases almost linearly. The trend of mortality rates (fig. 6) shows that Group D mortality decreased until 1952 and turned to increase at 1953, where the trend stayed at a steady rate until quite recently when actual mortality decline again was observed.

As can be seen in figures 6 and 7, retardation of mortality decline for Group A (infectious diseases) seems to occur around 1955. Group E (other diseases) shows retardation in the same year, and the presence of another breaking point is also estimated around 1958. Mortality trends for Group A, Group E, and also Group B(acult diseases), all showing a similar change of R.I., overlap to produce a general mortality trend for all causes, with a breaking point of trend at 1955.

While the R.I. was examined to detect breaking points, judgments of experts of the breaking points as observed on charts of the trends were also obtained. The breaking points thus obtained were observed in 1955 for Group A, 1955 for Group C, and 1953 and 1957 for Group E. No definite breaking point at any given year was observed for

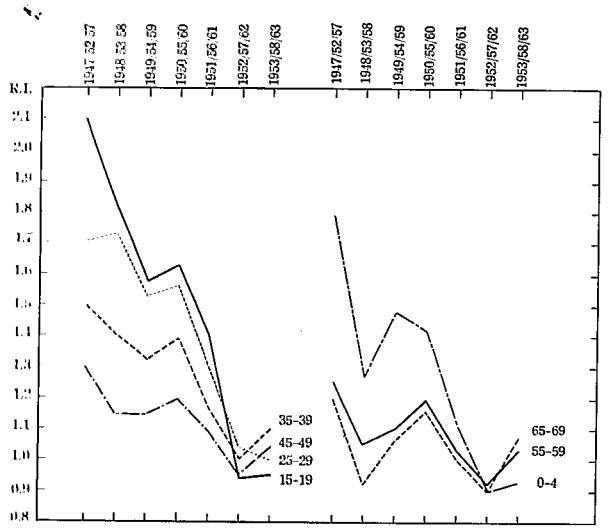


Figure 5. Change in retardation index, by selected age groups: Japan, 1947/52/57-1953/58/63.

(NOTE: For all ages, R.I. is 1.53, 1.11, 1.28, 1.36, 1.14, 0.97, 1.14, respectively)

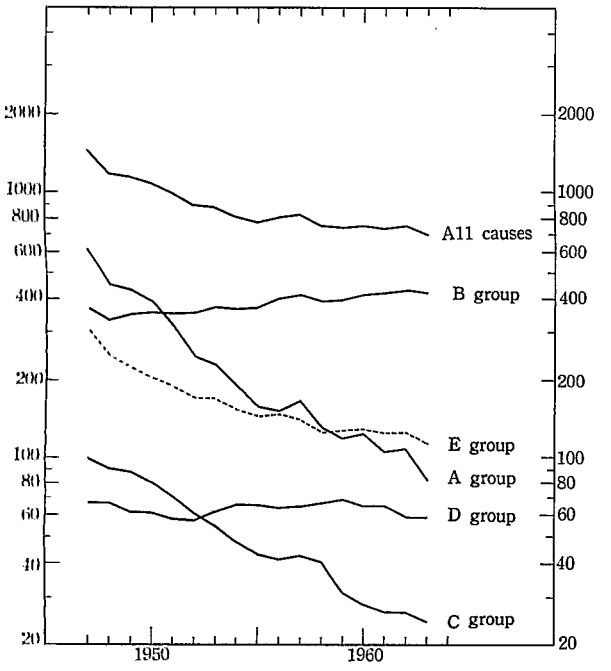


Figure 6. Death rates per 100,000 population for major groups of causes of death: Japan, 1947-63.

Groups B and D. Table 1 shows the R.R. and presents slopes for the trend lines on either side of the breaking point, as obtained by the method of least squares. The calculations were done for each sex separately. The value of the slope before the breaking point is highest for Group A, with b_1 = 0.07. Next come Groups C and E with 0.04. Slope b_2, after the breaking point, is largest for Group C with a value of 0.03-0.04 for each sex, followed by Group A with a value of about 0.025 and Group E, about 0.015.

Group A had the largest R.R. of about 65 percent with a breaking point at 1955 and Group E

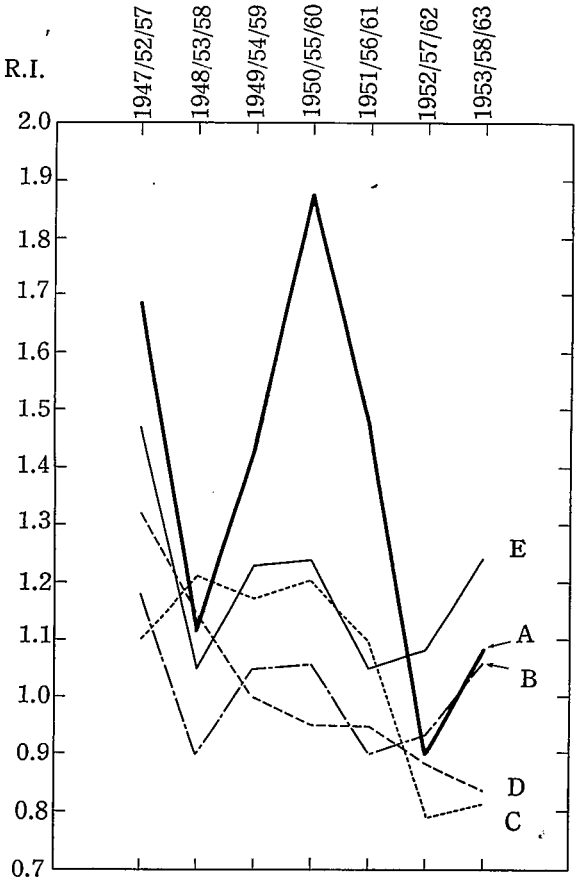


Figure 7. Change in retardation index, by major groups of causes of death: Japan, 1947/52/57-1953/58/63.

(NOTE: For all causes of death, R.I. is 1.53, 1.11, 1.28, 1.36, 1.14, 0.97, 1.14, respectively)

had R.R. of 60-63 percent (1953) or 51-54 percent (1957). For Group C, the R.R. about the 1955 breaking point was 20-30 percent and the retardation was not so significant. There seems to be no relation between the R. R. and the levels of b_1 and b_2. No difference between the sexes was observed in the R.R.'s of Groups A and E.

Retardation by B-List Categories and Age or Locality

In figure 8 the trends of mortality by age for selected categories of the B List are shown.

Calculated values of the retardation index based on 1950/55/60 for three selected causes

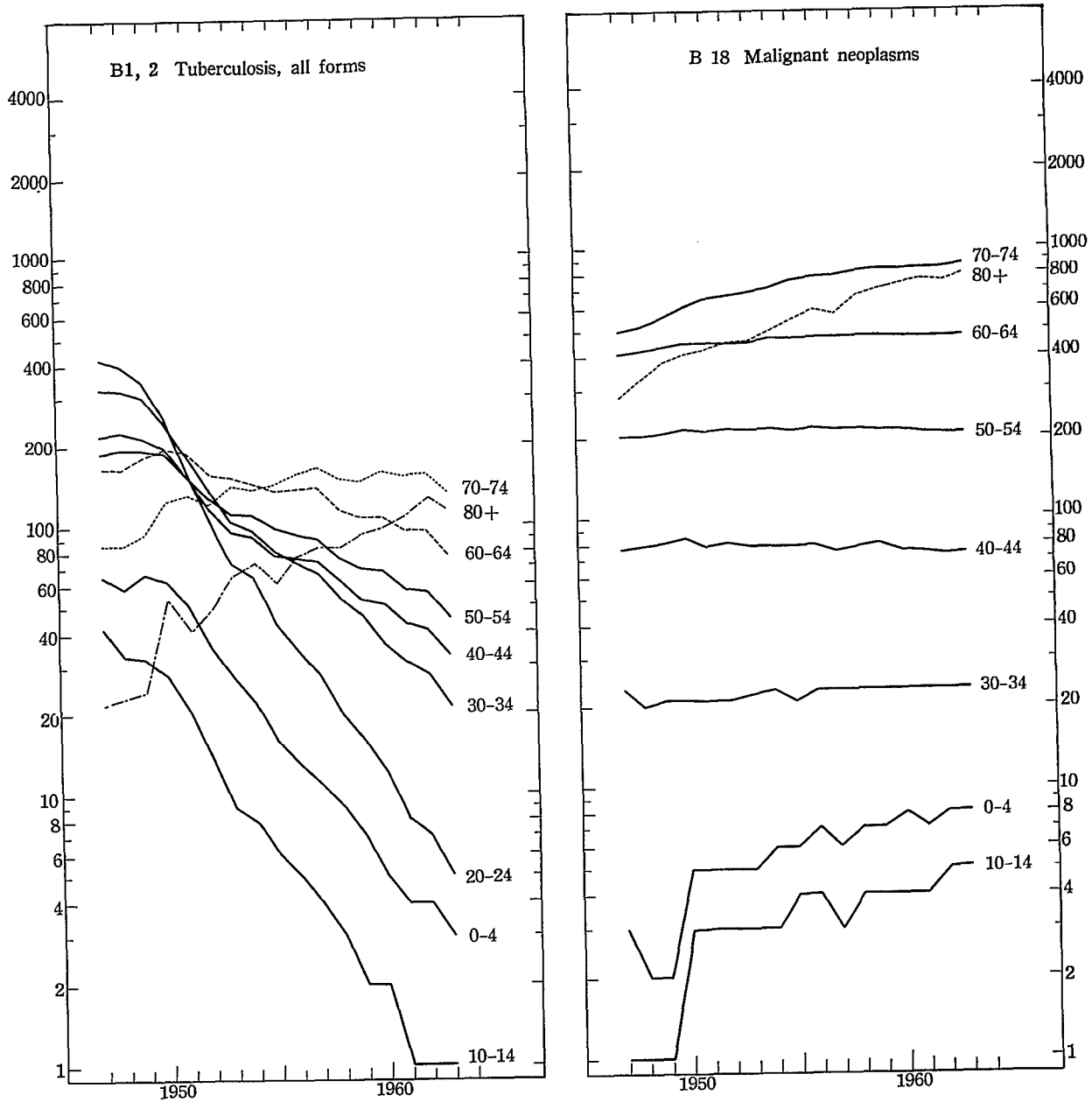


Figure 8. Death rates per 100,000 population for selected causes of death, by selected age groups: Japan, 1947-63.

are shown in figures 9-11. Values for the causes presented—tuberculosis, pneumonia and bronchitis, and gastrointestinal diseases—are higher than those for other causes of death. For pneumonia and bronchitis, a retardation index greater than 2.5 occurs in three age groups—20-24, 40-44, and 45-49 years—when data for both sexes are combined. For males alone such high values occur in each 5-year age group of 30-34, 35-39, 40-44, 45-49, 50-54, and 55-59. Values are especially high between ages 30 and 50. The index for tuberculosis is higher for persons around 20 and 40 years, and that for the gastrointestinal diseases is higher for persons in their twenties. A trend

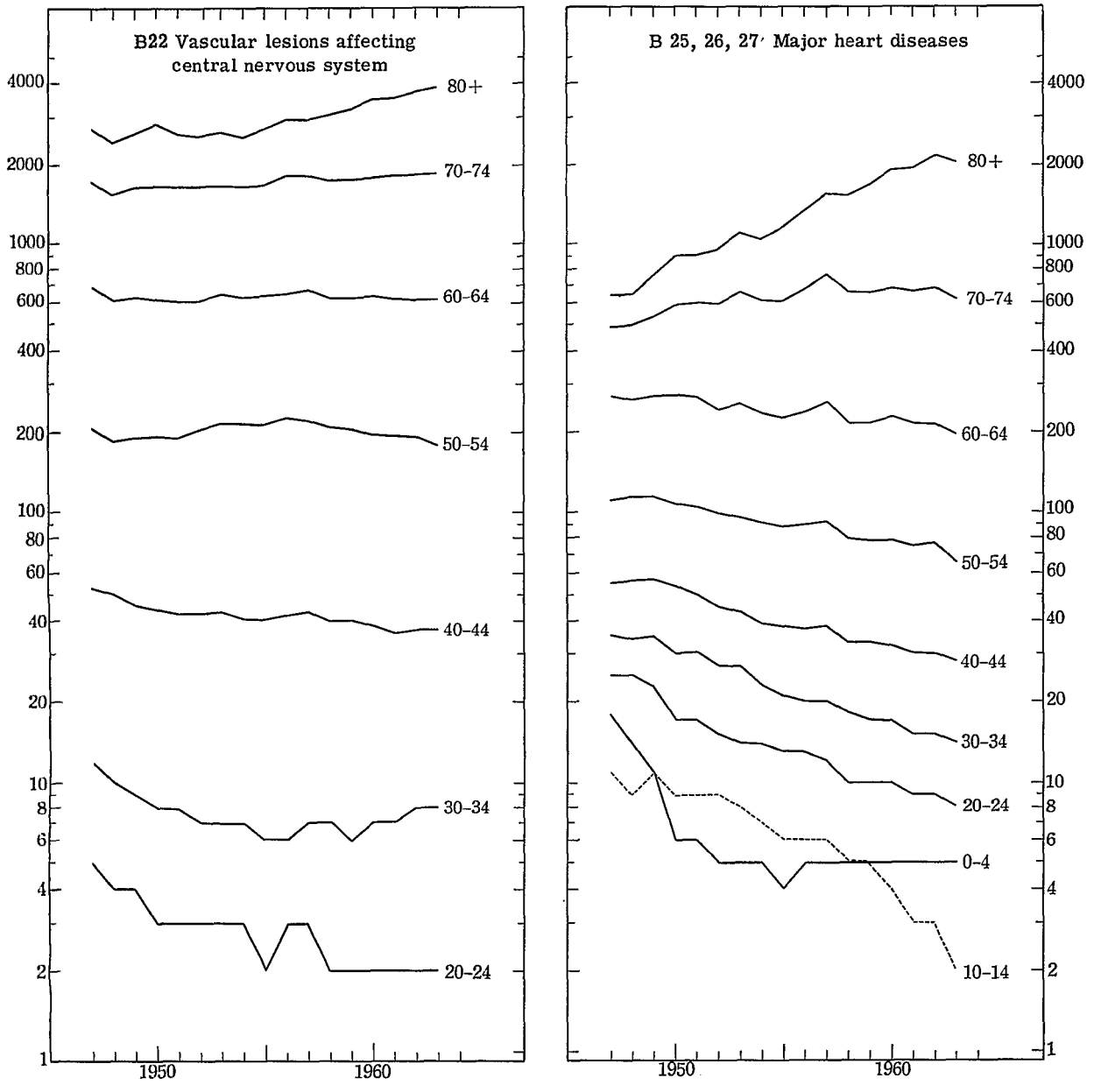


Figure 8. Death rates per 100,000 population for selected causes of death, by selected age groups: Japan, 1947-63—Con.

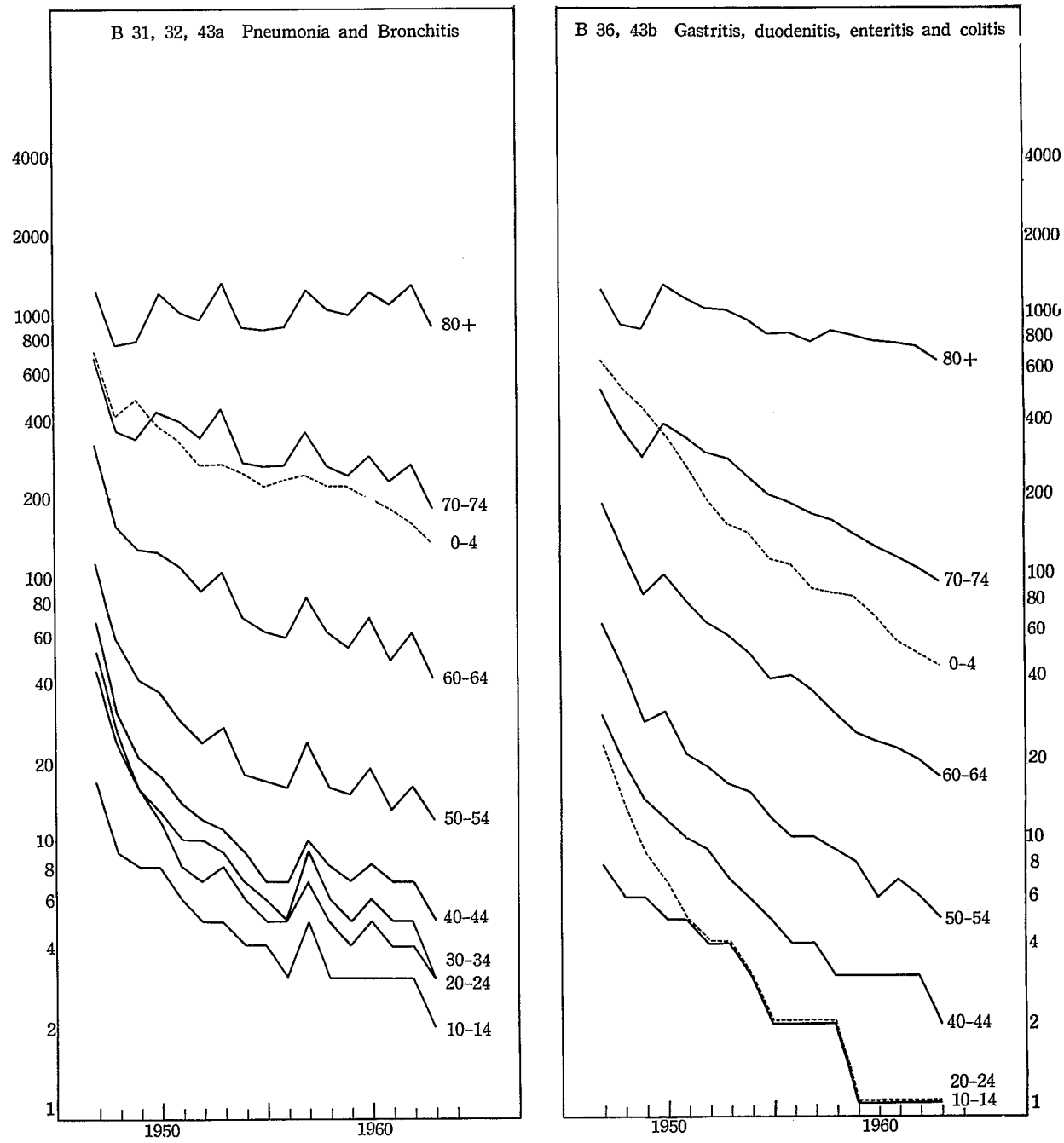
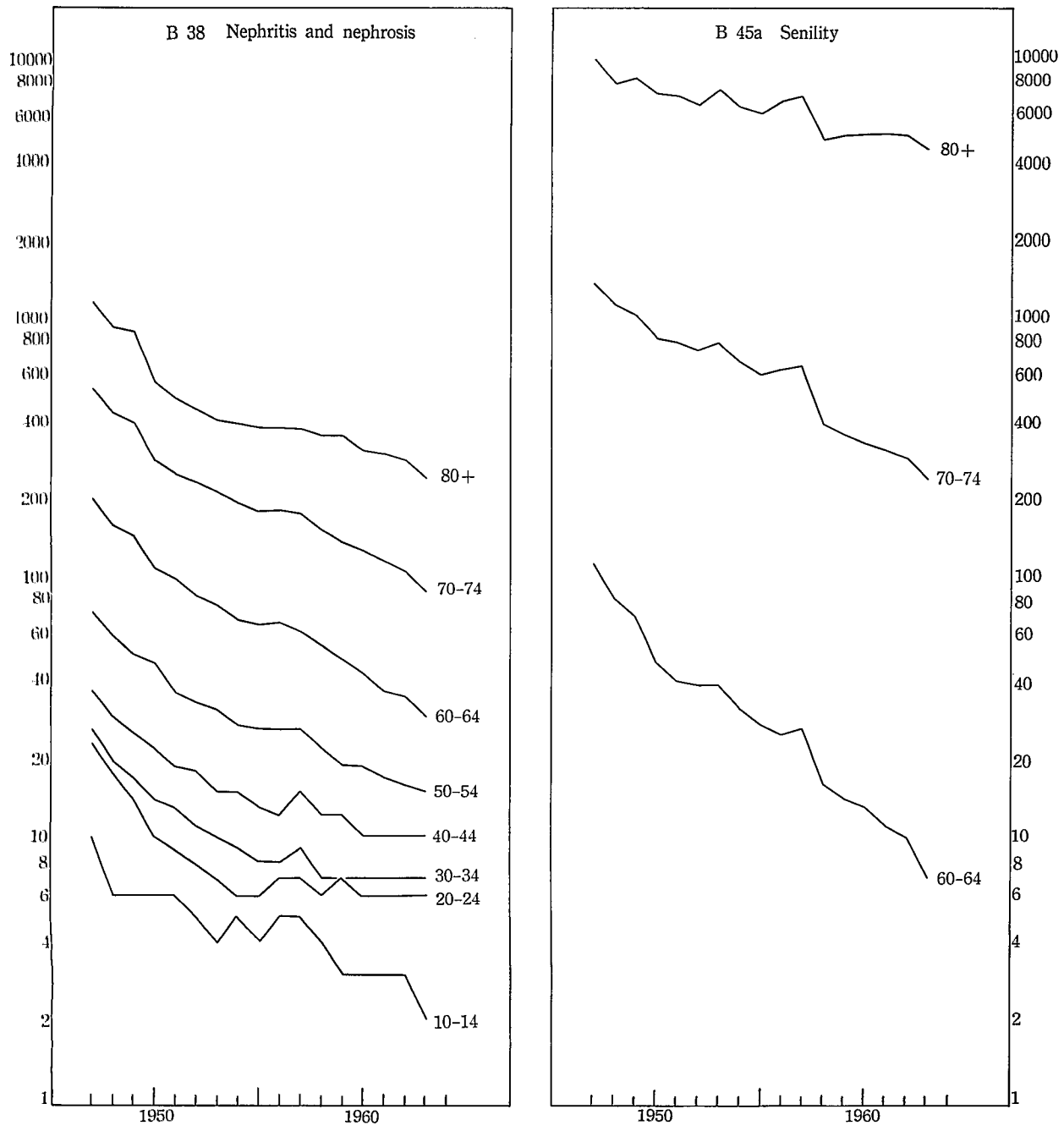


Figure 8. Death rates per 100,000 population for selected causes of death, by selected age groups: Japan, 1947-63—Con.



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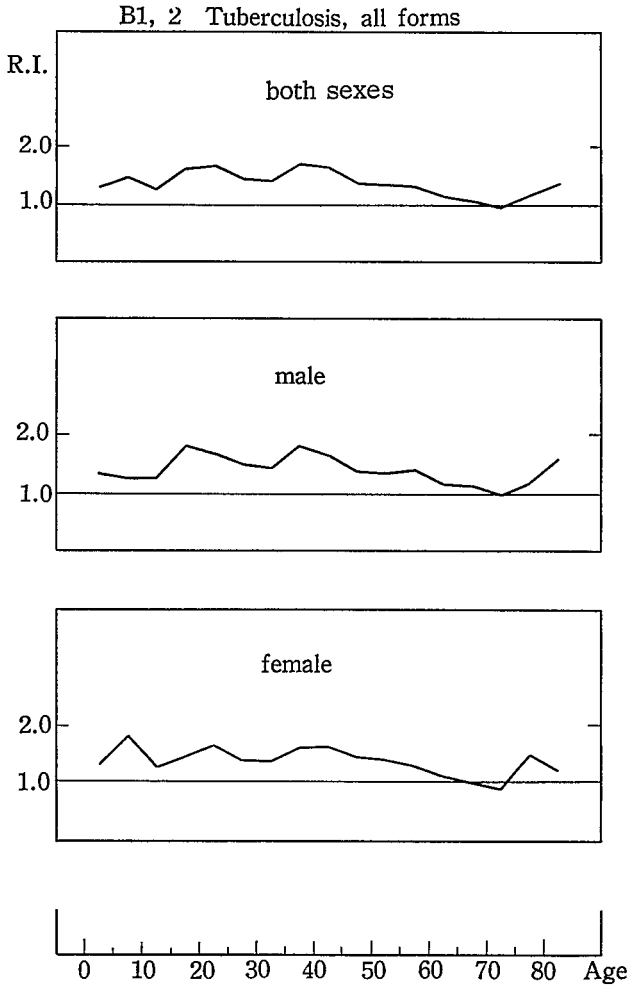

Figure 9. Retardation index for tuberculosis, all forms, by sex and age: Japan, 1950/55/60.

similar to that of tuberculosis is observed for nephritis and nephrosis.

The retardation phenomenon for bronchitis is observed in all prefectures around 1955 (fig. 12). Thus, the phenomenon is certainly not related to the geographical differences.

Retardation by Detailed Classification of Causes of Death

As can be seen from the analysis using broad categories and the B-List classifications, the retardation phenomenon is significant for infectious diseases, particularly the respiratory infectious diseases. However, some categories in the B List are subdivided into more detailed classifications, which differ more or less in nature, clinical appearance, complication, or origin of the disease. And the use of some detailed list categories is inevitably necessary for a further, more accurate analysis of the retardation phenomenon of mortality.

On the other hand, when the detailed classification is used, the number of deaths in each disease category becomes smaller and the fluctuation with time is greater; sometimes it is difficult to analyze and detect changes in trend effectively.

Therefore, causes with the following characteristics were selected from the detailed classification: (a) number of deaths sufficiently large to

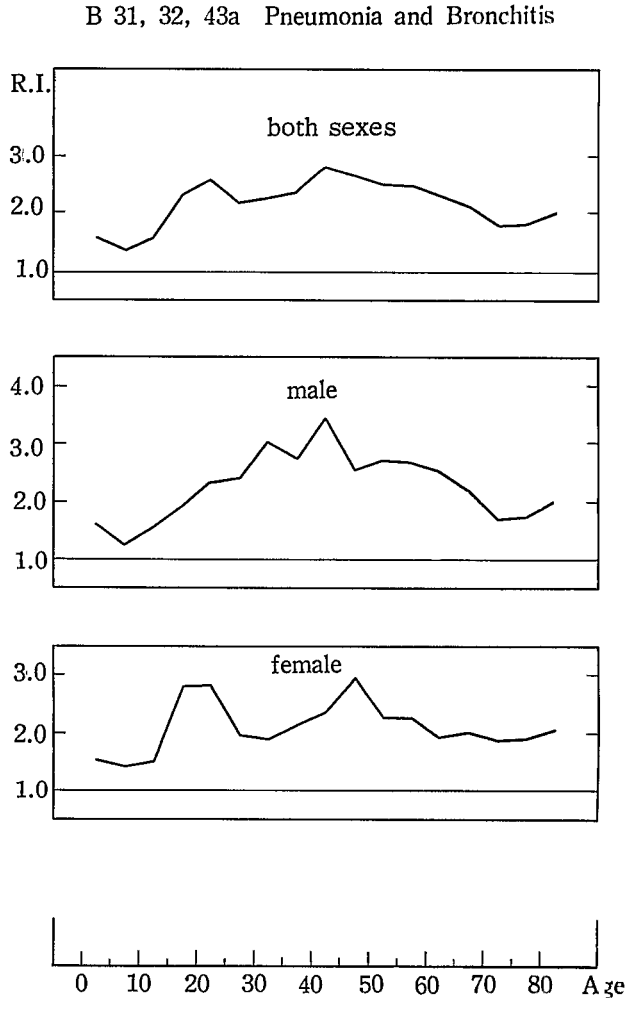

Figure 10. Retardation index for pneumonia and bronchitis, by sex and age: Japan, 1950/55/60.

B 36, 43b Gastritis, duodenitis, enteritis and colitis

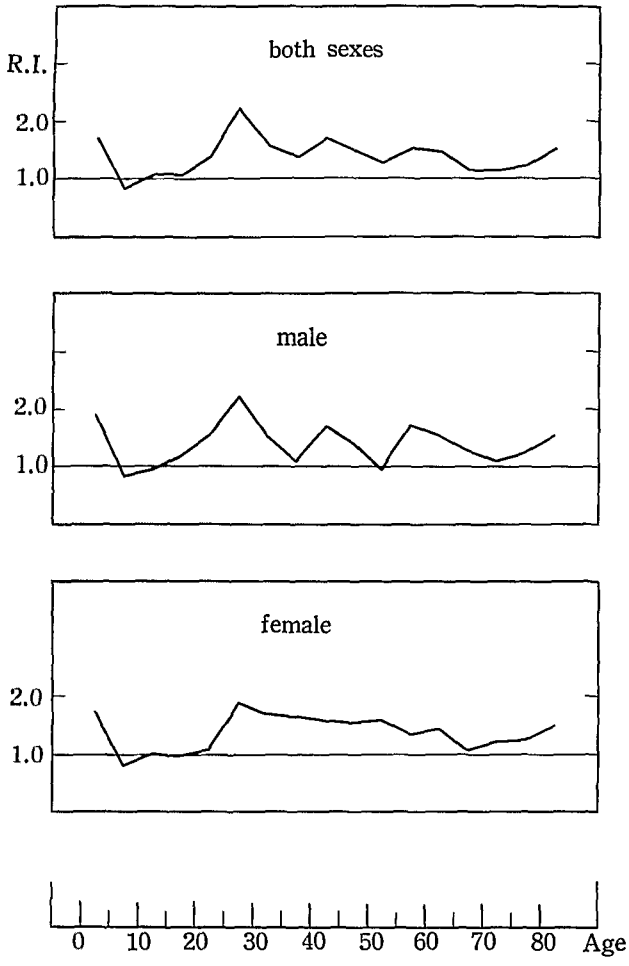

Figure 11. Retardation index for gastritis, duodenitis, enteritis, and colitis, by sex and age: Japan, 1950/55/60.

be divided into certain age groups; (b) deaths not concentrated near extreme ages (causes specific to infants are included); (c) causes related to infectious diseases. There were 33 causes of death or groups of causes selected. Their changes in mortality trend are shown in tables 2 and 3; changes for some of these causes are also shown in figures 13 and 14.

When the retardation index is calculated for both of the periods, 1950/55/60 and 1952/57/62, the value is higher for 1950/55/60 and the breaking point is estimated at 1955 or before. After 1955 the trend becomes more horizontal. Disease categories and their category numbers for which retardation was significant are acute bronchitis (500), bronchitis, unqualified (501), other bacterial diseases (050-064), acute upper respiratory infections (470-475), bronchopneumonia (491), pneumonia, other and unspecified (493), gastroenteritis and colitis, except ulcerative (571), and lobar pneumonia (490), as shown in table 4.

The results of the judgments of the experts for these detailed causes of death agree with those based on the retardation index. When the retardation phenomenon is detected on the graph by experts, and the degree of retardation is remarkable, the index for the cause is high. On the other hand, when the retardation for the category in the detailed classification is not detected at all, the index is low. Thus, such a cause of death is assumed to follow the same unbroken declining trend or a more remarkably diminishing trend.

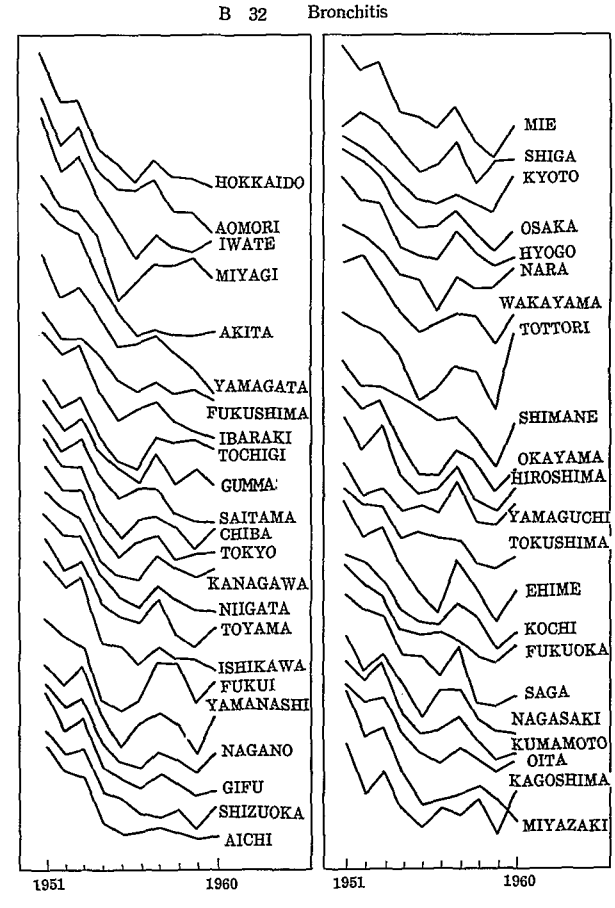

Figure 12. Death rates per 100,000 population for bronchitis, by prefecture: Japan, 1951-60.

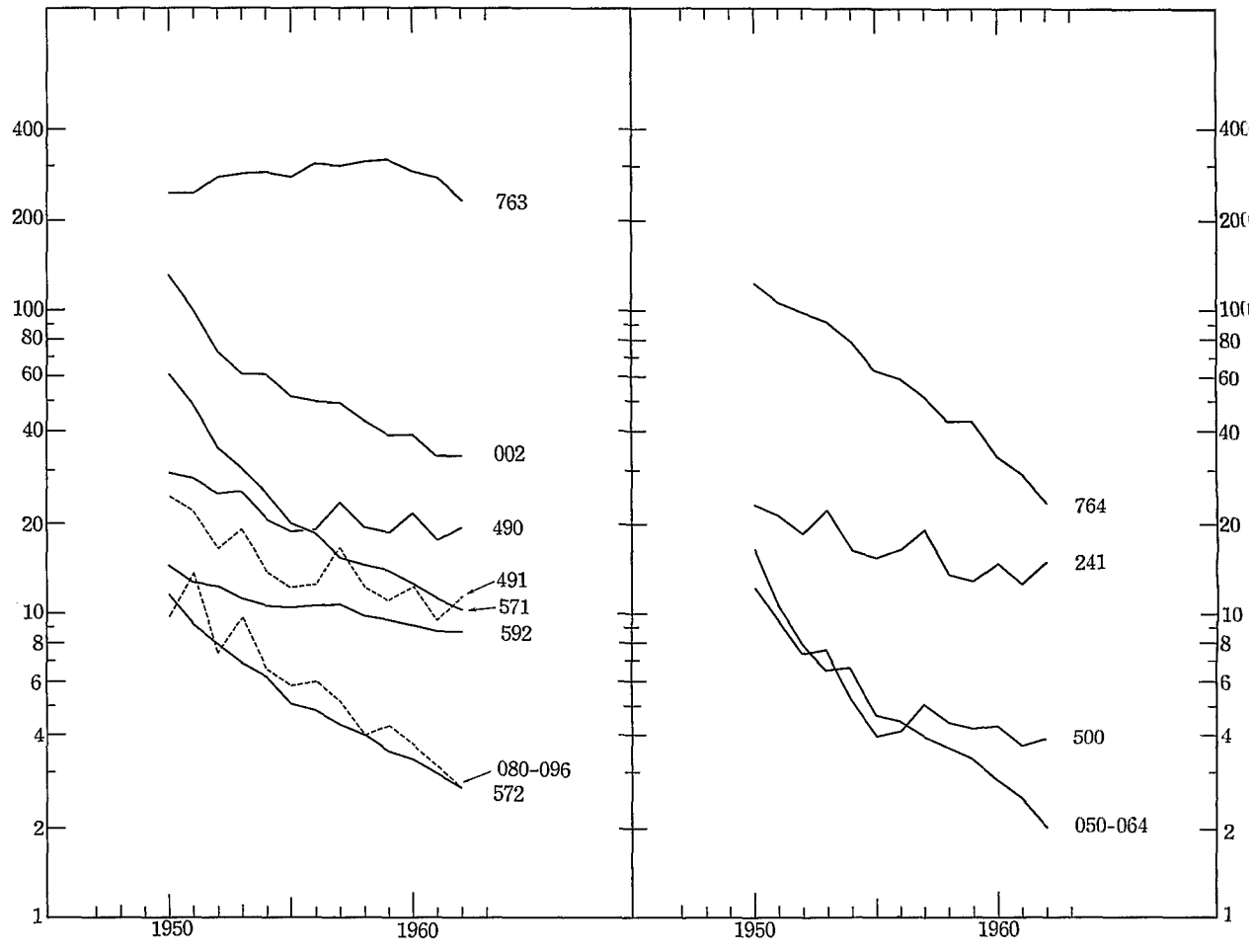

Figure 13. Death rates per 100,000 population among males for selected causes of death: Japan, 1950-62.

(Rates for 763 and 764 are based on 100,000 live births)

However, as can be seen from table 4, the retardation for some causes of death cannot always be detected on the graph in spite of the high index (e.g., 470-475,690-698,640 *et al.),* and sometimes on the contrary, the retardation for a cause of death can be fairly observed on the graph in spite of a low index (e.g., 591, 593). The reason for these paradoxical results is that large fluctuation of the death rates existed and the choice of 1950/55/60 for use in the calculations happened to produce a high index for the former cases. In the case of the nephritis group (591, 593) the breaking point was a few years before 1955 and the peak of the index had already passed in the year 1955.

Next, for each cause in the detailed classification which had a clear breaking point, trend lines before and after the breaking point were fitted, and the R.R. was calculated, first for both sexes, and then for males and females separately (table 5). For both sexes the bronchitis group—500, 501, and 502—has the highest R.R.'s, each exceeding 90 percent, and they are followed by causes of the pneumonia group—490, 491, and 493—with values of 77-93 percent. The pattern is about the same for males and females consid-

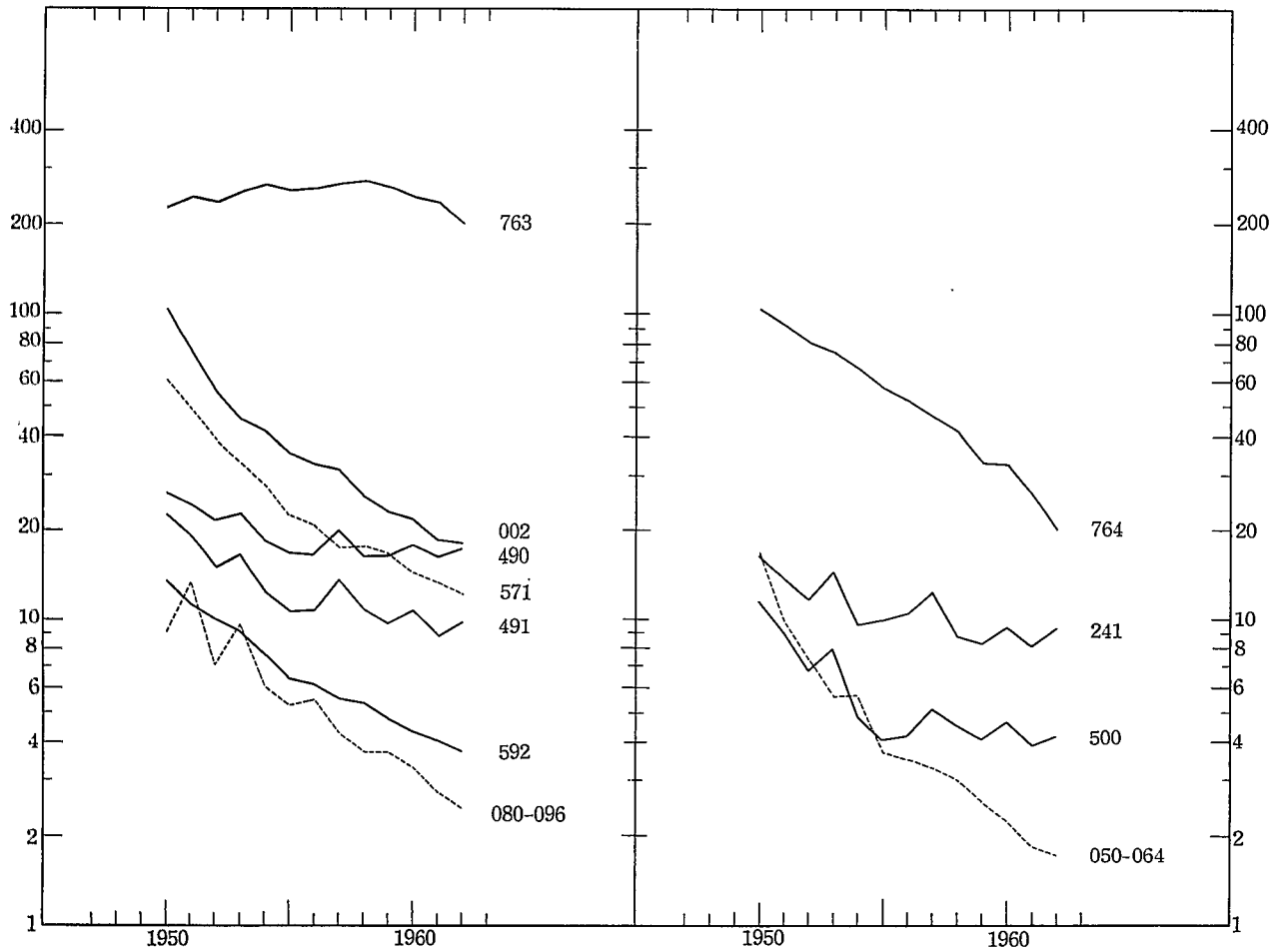

Figure 14. Death rates per 100,000 population among females for selected causes of death: Japan, 1950-62.

(Rates for 763 and 764 are based on 100,000 live births)

ered separately, but the breaking point for chronic bronchitis (502) was not clear for each sex. Retardation for gastritis and duodenitis (543) was clearly observed for males and females separately, and R.R.'s were 61-84 percent.

Retardation by Detailed Classification and Age

For detailed categories with a high retardation index a further analysis of the retardation phenomenon by age was conducted, using visual inspection of graphs. The following 11 causes of death were examined (some are shown in figure 15): pulmonary tuberculosis (002), pleural tuberculosis (003), lobar pneumonia (490), bronchopneumonia (491), pneumonia, other and unspecified (493), acute bronchitis (500), bronchitis, unqualified (501), chronic bronchitis (502), gastritis and duodenitis (543), gastroenteritis and colitis, except ulcerative (571), chronic enteritis and ulcerative colitis (572).

The diseases above are all included in Group A (infectious diseases) of the broad categories. As stated before, for Group A the breaking point stands out clearly and seems to be around 1952

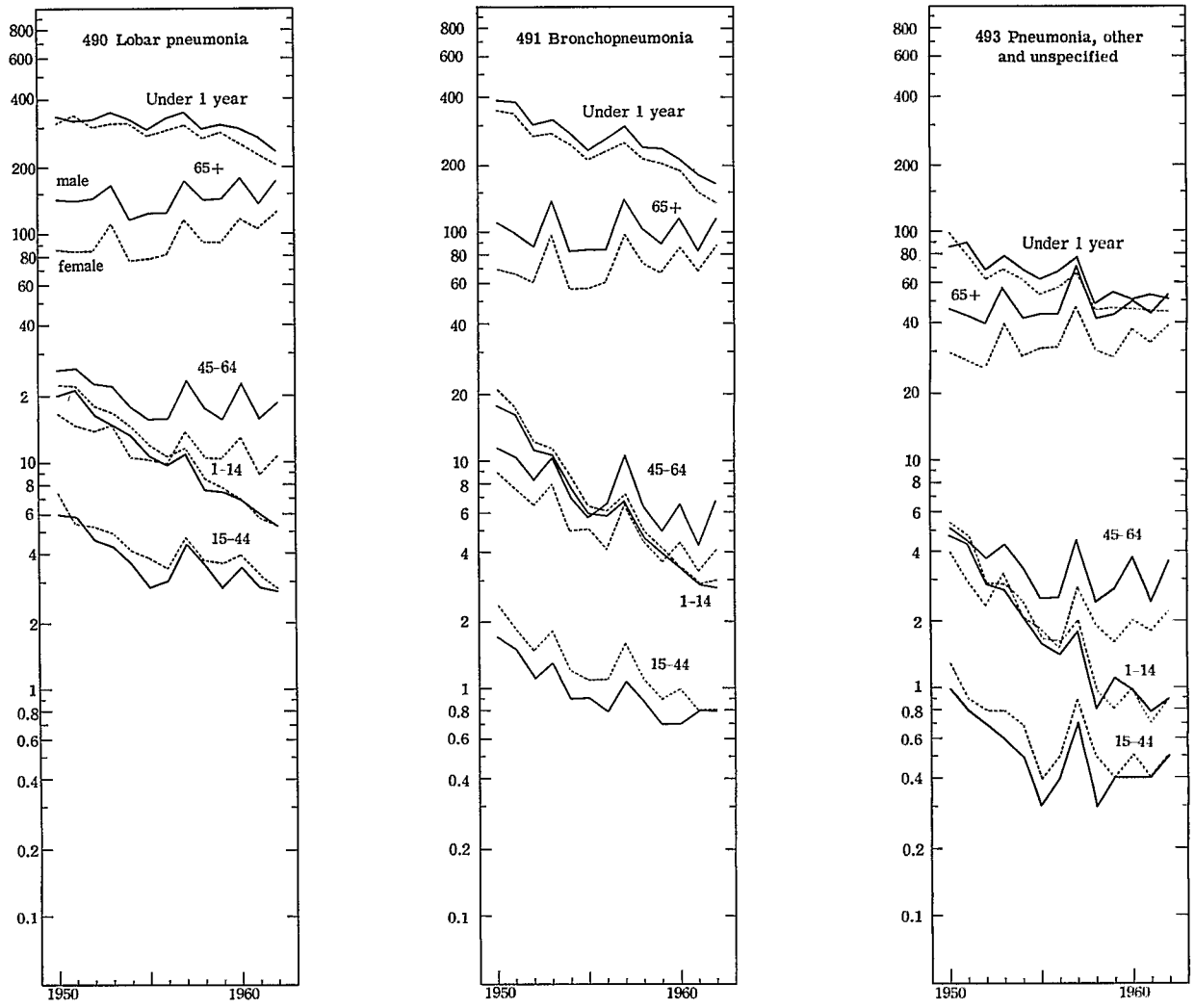

Figure 15. Death rates per 100,000 population for selected causes of death, by sex and age: Japan, 1950-62.

or 1955. Trend lines and the retardation index for the detailed causes indicate a breaking point in 1955 for the majority, and a breaking point at 1953 for a very few. Here, however, a slight difference according to age group in detailed classification exists. For acute bronchitis (500), bronchitis, unqualified (501), gastritis and duodenitis (543), and gastroenteritis and colitis, except ulcerative (571), almost the same retardation phenomenon appears for each age group and the trend is similar for males and females, with the breaking point at 1955. For lobar pneumonia (490) and bronchopneumonia (491), the retardation phenomenon varies by age and the time of the breaking points varies between 1953 and 1955. For pulmonary tuberculosis (002), the breaking point is barely observable in age groups between 30 and 60 for males and females. The breaking point is around 1953 but is not clear. For chronic bronchitis (502) and chronic enteritis and ulcerative colitis (572), the retardation phenomenon is not significant in each age group but can be observed for all ages combined.

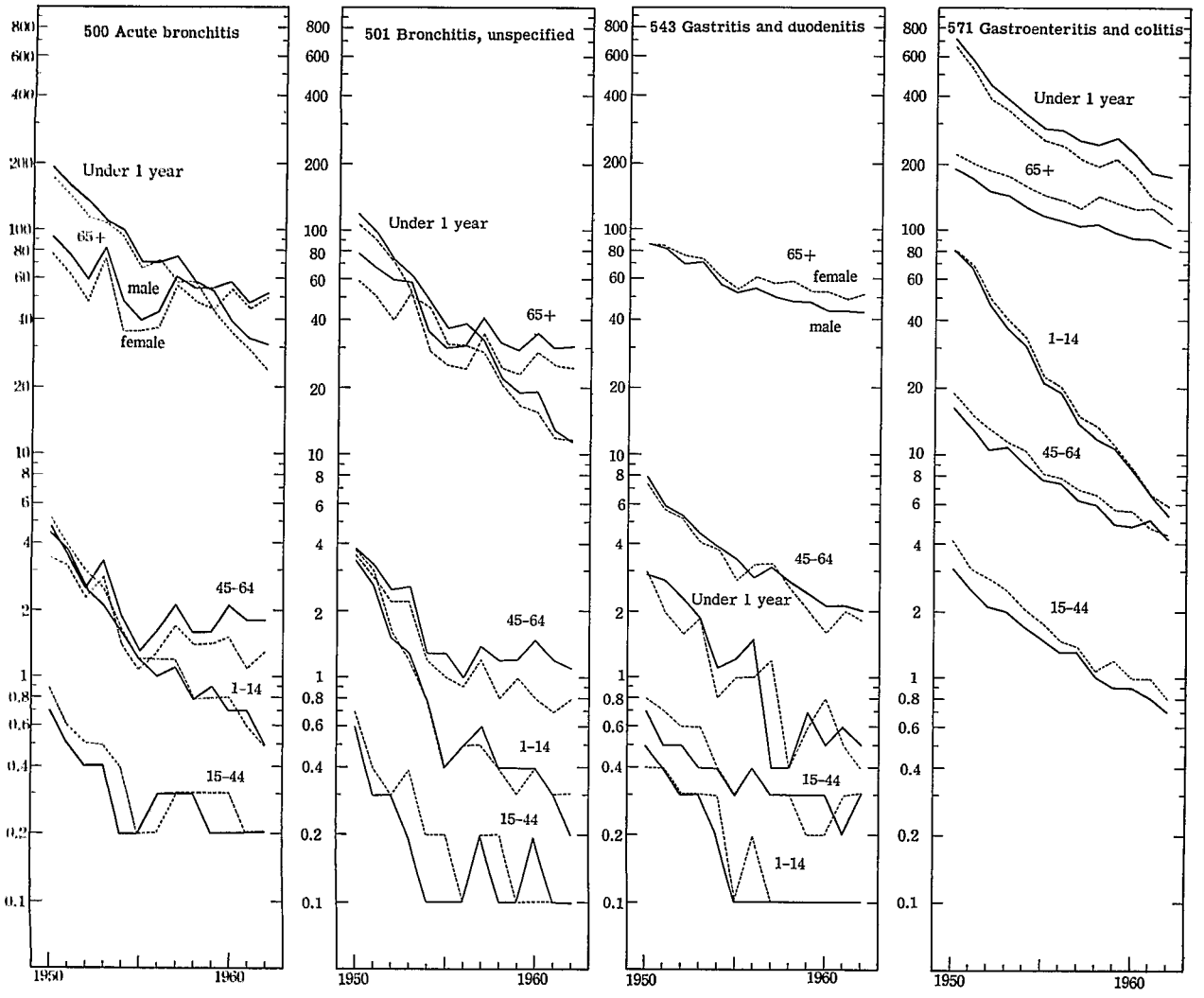

Figure 15. Death rates per 100,000 population for selected causes of death, by sex and age: Japan, 1950-62—Con.

The retardation phenomenon is generally clearer for the acute diseases than for the chronic and for the middle-aged groups than for other age groups.

FACTORS INFLUENCING THE RETARDATION PHENOMENON

(1) Operative hypotheses can be formulated considering any of the following as factors influencing the retardation phenomenon described above: virus mutation, radiation, cigarette smoking, antibiotics and other drugs, changes in diet, air pollution, urbanization, and public health and social security activities.

The retardation phenomenon can also be explained apart from these factors. Since strong persons survive and weak persons die during and immediately after a war, mortality declines significantly a few years after the war. But after several more years, the rate of mortality decline slows down as the after-war effect diminishes. On the other hand, weak persons may also have survived because of some new method of treatment

which introduces the possibility of reducing total mortality or the mortality resulting from some specific causes. After some years, such weak survivors might have begun to die dampening the decrease of death rates. It is doubtful, however, whether such changes occur suddenly or discontinuously.

(2) Morbidity data would need to be analyzed in the same manner to support the findings of mortality analysis.

When the incidence of disease is examined using household survey data observed by annual surveys using consistent methodology, it shows a steadier level since 1953. Respiratory diseases constitute a greater proportion of total diseases and the "common cold" is the most frequent of these. Next, the diseases of the digestive system, such as diarrhea and enteritis and duodenitis, are very frequent. The data in table 6 suggest an increasing trend of each disease incidence rather than a decreasing trend. But the tabulated data were not sufficient for further analysis.

(3) The supply of antibiotics in the country, when estimated in monetary value, was 12.6 million yen in 1952 and was stable until 1956. Since 1957 it has gradually increased and reached 37.8 million yen in 1963. From these results, the use of antibiotics from 1950 to 1956 can be considered stable.

A standard was established for use of antibiotics in medical insurance schemes in 1953, but penicillin and its derivatives had been used by medical insurance schemes since 1948. Penicillin was probably widely used before 1953.

When the frequency of appearance of resistant strains against antibiotics in tuberculosis and dysentery patients was analyzed, the proportion of tuberculosis patients with resistant bacterial infection at the time of hospital admission was found to be over 10 percent in 1955 and near 20 percent recently. Increase of occurrence of resistant bacteria in patients with dysentery is more remarkable than among patients with tuberculosis, increasing from 1 percent in 1955 to 10 percent in 1958 and, more recently, exceeding 20 percent (fig. 16).

The increase in resistant strains along with the use of antibiotics had already begun before 1955, but it seems to have increased more rapidly since then.

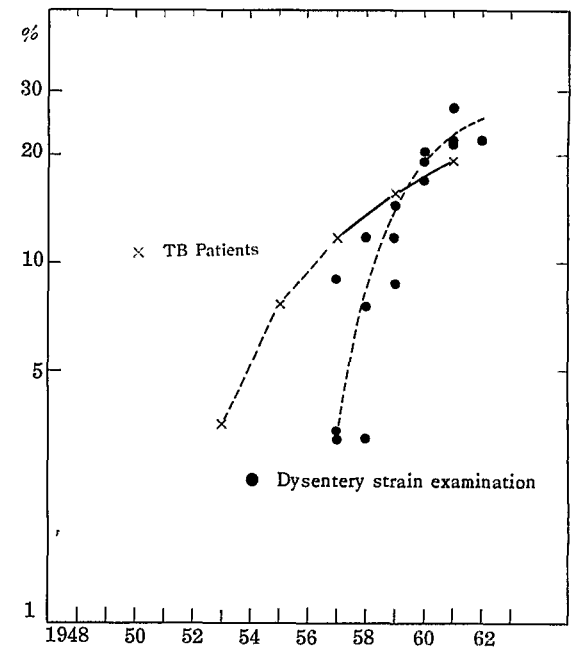

Figure 16. Percent of hospitalized tuberculosis patients with strains resistant against antibiotics, and percent of dysentery strains resistant against antibiotics.

(4) It is difficult to isolate sufficiently the role of influenza in the retardation, but it is important to analyze its influence, considering the parallel upheaval of pneumonia and bronchitis or the increase of mortality due to heart disease during the influenza epidemic period. Especially if the retardation phenomenon is to be studied on a worldwide scale, influenza with a rapid speed of infection should be considered as an important disturbing factor in the ever-improving mortality trend.

SUMMARY

In a broad sense, the retardation phenomenon means that decline in mortality over certain time intervals diminishes. Here, use of the "retardation phenomenon" is restricted to the meaning that a regular rate of mortality decline changes abruptly and discontinuously after a specific year, and the rate of decline is significantly reduced. When such data are observed, suspicion arises that some specific circumstance brought about

such a change in trend at that particular year. Thus, detecting that circumstance, it may be possible to find a way of recovering the earlier, rapidly lowering trend of mortality.

This retardation, in a restricted sense, of the declining mortality is especially significant near the year 1955 in the middle-aged group of males throughout the country, and the phenomenon is mainly due to infectious diseases. In Chile, a similar trend was seen and in England and Wales a dampening of mortality decline was observed.

For broad cause-of-death categories, the retardation phenomenon is significant for Group A (infectious diseases) in 1955. Breaking points are also observed for Group E (all other diseases) in 1953 and 1957 by visual observation.

For pneumonia, bronchitis, enteritis, and nephritis of the B List, the R.I. for males of the middle-aged group is noticeably high.

In the detailed categories of the International Classification of Diseases, retardation is noticeable for the bronchitis and pneumonia group, and the R.R. trend line is over 80 percent. The R.R. for the enteritis group is over 60 percent.

When this retardation phenomenon is analyzed for detailed categories by age group, retardation is noticeable in age groups 15-44 and 45-64 for both males and females in the above-mentioned causes.

In order to investigate factors underlying the retardation phenomenon, information was gathered concerning influenza epidemics, utilization of antibiotics, and the frequency of occurrence of infection by resistant strains. These data are not supposed to have definite relation to the results of the mortality analysis described above. However, a generally decreasing trend of bacterial and viral infections showed a breaking point about 1953-55, and it cannot be denied that these influential factors are suspected to be essential for the sudden retardation of mortality in those years.

The recent change of morbidity, especially in respiratory and intestinal diseases, and its causes should be investigated further.

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DETAILED TABLES

Table 1. Identification of breaking points, inclination of trend lines before and after the breaking points, and retardation ratio (R.R.%),[1] by sex and broad classification of causes of death

Sex and broad cause group[2]	Breaking point	Inclination		Retardation ratio (R.R.%)[1]
		$b_1 \times 10^{-5}$	$b_2 \times 10^{-5}$	
Male				
All causes	1955	1,665	490	70.6
Group A--------B1-B17,B23,B30-B32,B36,B43a[3],B43b[3]	1955	7,162	2,576	64.0
Group B------------B18-B19,B22,B25,B27-B29,B45a[3]	...	...	...	...
Group C------------------------B40-B42,B43c[3],B44	1955	4,582	3,074	32.9
Group D--------------------------------BE47-BE50	...	...	...	...
Group E--------------------------------Residual	1953	4,462	1,784	60.0
	1957	3,052	1,490	51.2
Female				
All causes	1955	1,636	767	53.1
Group A--------B1-B17,B23,B30-B32,B36,B43a[3],B43b[3]	1955	6,842	2,332	65.9
Group B------------B18-B19,B22,B25,B27-B29,B45a[3]	...	...	...	...
Group C------------------------B40-B42,B43c[3],B44	1955	4,406	3,552	19.4
Group D--------------------------------BE47-BE50	...	...	...	...
Group E--------------------------------Residual	1953	4,214	1,558	63.0
	1957	3,648	1,674	54.1

[1]The retardation ratio (R.R.%) is defined as: $R.R.(\%) = \frac{b_1 - b_2}{b_1} \times 100$.

[2]Cause groups are composed of the designated categories of the B List, Seventh Revision of the International Lists, 1955.

[3]See editor's note, p. 4.

Table 2. Death rates for males, by selected causes of death: Japan, 1950-62

Cause of death (Seventh Revision—International Lists, 1955)	1962	1961
Pulmonary tuberculosis---002	34.2	33.8
Pleural tuberculosis---003	1.1	1.2
Tuberculosis of meninges and central nervous system---010	0.6	0.8
General paralysis of insane---025	1.3	1.3
Other bacterial diseases---050-064	2.0	2.5
Septicemia and pyemia---053	0.7	0.9
Tetanus---061	0.7	0.9
Diseases attributable to viruses---080-096	2.7	3.1
Acute infectious encephalitis---082	0.9	1.2
Asthma---241	14.9	12.4
Inflammatory diseases of central nervous system---340-345	2.3	2.7
Acute upper respiratory infections---470-475	3.2	3.0
Lobar pneumonia---490	19.3	17.6
Bronchopneumonia---491	11.2	9.5
Pneumonia, other and unspecified---493	4.8	4.1
Acute bronchitis---500	3.8	3.7
Bronchitis, unqualified---501	2.1	2.1
Chronic bronchitis---502	2.6	2.4
Abscess of lung---521	1.4	1.4
Bronchiectasis---526	1.2	0.9
Gastritis and duodenitis---543	2.8	2.8
Gastroenteritis and colitis, except ulcerative, age 4 weeks and over---571	10.2	11.1
Chronic enteritis and ulcerative colitis---572	2.7	2.9
Peritonitis---576	1.2	1.1
Acute nephritis---590	2.2	2.4
Nephritis with edema, including nephrosis---591	2.0	2.0
Chronic nephritis---592	8.6	8.7
Nephritis, not specified as acute or chronic---593	2.4	2.5
Infections of kidney---600	0.7	0.5
Infections of skin and subcutaneous tissue---690-698	0.6	0.8
Pneumonia of newborn---763	230.8	275.1
Diarrhea of newborn---764	23.2	29.2

Table 2. Death rates for males, by selected causes of death: Japan, 1950-62—Con.

1960	1959	1958	1957	1956	1955	1954	1953	1952	1951	1950
Rate per 100,000 males										
38.5	38.7	42.4	49.0	49.7	51.5	60.5	61.0	73.4	98.9	130.8
1.2	1.3	1.4	1.7	1.7	1.9	2.2	2.5	3.1	3.1	4.1
0.9	1.2	1.4	1.6	1.9	2.3	3.3	4.0	5.1	6.6	7.7
1.5	1.6	1.7	2.0	2.0	2.2	2.5	2.8	3.4	3.8	3.7
2.8	3.3	3.6	4.0	4.4	4.6	6.6	6.6	7.8	10.4	16.4
0.8	0.9	0.9	1.0	1.0	1.1	1.3	1.5	1.4	1.6	1.7
0.9	0.9	1.0	1.0	1.2	1.3	1.6	1.7	2.1	2.4	2.5
3.7	4.2	4.0	5.2	6.0	5.8	6.6	9.7	7.3	13.6	9.8
1.1	1.1	1.9	1.0	2.0	1.8	1.0	1.0	1.8	1.2	3.3
14.8	12.8	13.5	19.1	16.3	15.4	16.1	22.1	18.3	21.5	23.2
2.7	2.7	2.9	3.9	4.1	4.4	5.3	6.4	7.0	9.0	10.7
3.8	3.3	3.7	5.9	3.8	3.8	3.9	6.8	4.8	6.4	7.8
21.8	18.7	19.2	23.6	19.0	18.9	20.8	25.6	25.1	28.5	29.3
12.2	11.2	12.3	16.4	12.4	12.0	13.8	19.0	16.6	22.1	24.9
4.6	4.1	3.7	6.3	4.4	4.3	4.8	6.1	5.3	6.7	7.4
4.3	4.2	4.4	5.1	4.1	4.0	5.2	7.5	7.3	9.5	12.2
2.6	2.2	2.3	3.0	2.6	2.5	3.2	4.9	5.0	7.0	8.8
2.4	2.6	2.9	3.5	3.7	4.1	4.5	5.7	5.9	7.2	8.8
1.4	1.5	1.5	1.6	1.9	1.8	1.9	2.1	2.3	2.6	3.2
0.9	0.7	0.6	0.6	0.6	0.5	0.4	0.4	0.3	0.2	0.3
2.8	3.0	3.0	3.1	3.3	3.2	3.4	4.2	4.2	4.9	5.4
12.4	14.0	14.7	15.3	18.6	20.0	25.2	30.2	35.8	49.1	60.9
3.3	3.5	4.1	4.3	4.9	5.1	6.2	6.9	7.9	9.3	11.6
1.2	1.3	1.3	1.7	1.7	1.9	2.3	2.6	3.1	3.6	4.3
2.8	3.2	4.0	4.7	4.6	4.3	4.4	4.5	5.1	6.6	6.4
2.0	2.0	1.9	1.9	2.0	1.8	1.8	1.8	1.7	1.8	2.0
9.1	9.5	9.8	10.7	10.5	10.4	10.7	11.1	12.4	12.9	14.6
2.7	2.8	3.0	3.9	4.1	4.2	4.2	4.5	5.1	6.0	6.9
0.5	0.5	0.6	0.5	0.6	0.6	0.7	0.7	0.8	1.0	1.2
1.1	1.1	1.1	1.0	1.0	1.2	1.1	1.1	1.2	1.6	2.2
Rate per 100,000 male live births										
289.3	317.8	308.1	300.3	302.8	277.2	288.8	284.1	275.8	272.3	246.1
32.7	42.7	42.8	51.5	59.6	63.8	79.2	92.0	97.6	106.1	122.9

Table 3. Death rates for females, by selected causes of death: Japan, 1950-62

Cause of death (Seventh Revision—International Lists, 1955)		1962	1961
Pulmonary tuberculosis	002	17.9	18.4
Pleural tuberculosis	003	0.7	0.8
Tuberculosis of meninges and central nervous system	010	0.6	0.7
General paralysis of insane	025	0.4	0.4
Other bacterial diseases	050-064	1.7	1.8
Septicemia and pyemia	053	0.8	0.8
Tetanus	061	0.4	0.4
Diseases attributable to viruses	080-096	2.5	2.7
Acute infectious encephalitis	082	0.9	1.2
Asthma	241	9.4	8.2
Inflammatory diseases of central nervous system	340-345	1.9	2.0
Acute upper respiratory infections	470-475	3.9	3.7
Lobar pneumonia	490	16.2	15.1
Bronchopneumonia	491	9.8	8.7
Pneumonia, other and unspecified	493	4.2	3.6
Acute bronchitis	500	4.2	3.9
Bronchitis, unqualified	501	2.1	2.1
Chronic bronchitis	502	2.1	1.7
Abscess of lung	521	0.4	0.4
Bronchietasis	526	0.6	0.6
Gastritis and duodenitis	543	3.9	3.8
Gastroenteritis and colitis, except ulcerative, age 4 weeks and over	571	12.1	13.4
Chronic enteritis and ulcerative colitis	572	3.7	4.0
Peritonitis	576	1.1	1.2
Acute nephritis	590	2.2	2.7
Nephritis with edema, including nephrosis	591	1.4	1.5
Chronic nephritis	592	8.1	8.5
Nephritis, not specified as acute or chronic	593	2.3	2.5
Infections of kidney	600	1.2	1.1
Infections of skin and subcutaneous tissue	690-698	0.5	0.7
Pneumonia of newborn	763	200.6	233.4
Diarrhea of newborn	764	20.1	26.7
Sepsis of pregnancy, childbirth, and puerperium, including abortion with sepsis	640,641,651,681,682,684	3.9	4.9

Table 3. Death rates for females, by selected causes of death: Japan, 1950-62—Con.

1960	1959	1958	1957	1956	1955	1954	1953	1952	1951	1950
Rate per 100,000 females										
21.7	22.9	25.7	31.1	32.1	35.1	41.5	44.9	54.8	76.3	102.4
0.8	0.8	1.0	1.1	1.3	1.2	1.5	1.7	2.3	2.4	3.4
0.8	1.1	1.3	1.5	1.8	2.3	3.1	3.9	4.9	6.3	7.6
0.4	0.5	0.5	0.6	0.6	0.6	0.8	0.9	1.1	1.1	1.3
2.2	2.6	3.1	3.4	3.6	3.7	5.6	5.6	7.3	9.8	16.8
0.9	0.8	0.9	0.9	1.0	1.1	1.2	1.5	1.5	1.4	1.7
0.4	0.5	0.4	0.6	0.7	0.7	0.7	1.0	1.1	1.1	1.3
3.3	3.7	3.7	4.3	5.4	5.3	6.1	9.4	7.0	13.4	9.0
1.0	1.0	1.7	0.9	1.8	1.6	0.8	0.9	1.7	1.2	2.8
9.4	8.3	8.7	12.3	10.6	10.1	9.7	14.3	11.7	13.9	16.0
2.0	2.1	2.2	3.1	3.2	3.6	4.3	5.3	6.0	7.5	9.0
4.7	4.0	4.3	6.9	4.3	4.2	4.2	7.3	4.9	7.1	8.0
17.6	16.2	16.1	20.1	16.3	16.7	18.3	22.6	21.6	24.4	26.1
10.8	9.8	11.0	13.9	10.7	10.6	12.2	16.9	15.0	19.5	22.5
4.0	3.2	3.5	5.4	3.8	3.8	4.3	5.5	4.5	5.8	6.9
4.6	4.1	4.6	5.2	4.2	4.0	4.8	8.0	6.8	9.1	11.6
2.4	2.0	2.2	3.1	2.4	2.5	3.1	5.0	4.9	6.7	8.3
2.0	1.8	2.3	2.6	2.7	2.8	3.1	4.4	4.5	5.5	6.6
0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.7	0.9
0.5	0.3	0.3	0.3	0.3	0.2	0.1	0.2	0.1	0.1	0.1
3.8	3.8	4.2	4.2	4.4	3.9	4.5	5.2	5.5	5.9	6.6
14.7	16.3	17.6	17.4	20.8	22.5	27.9	33.1	38.5	50.1	60.7
4.3	4.8	5.3	5.5	6.1	6.3	7.8	9.0	10.0	11.2	13.5
1.3	1.4	1.4	1.9	1.9	2.0	2.4	2.9	3.4	4.0	5.1
3.0	3.4	4.1	4.8	4.6	4.6	4.8	4.8	5.7	7.1	7.0
1.6	1.6	1.7	1.5	1.6	1.8	1.6	1.7	1.5	1.8	1.9
9.2	9.6	10.3	10.9	11.2	11.2	11.7	12.4	13.6	14.6	17.2
2.7	3.1	3.1	4.4	4.5	4.5	4.9	5.4	6.4	7.5	8.7
1.0	0.9	1.0	0.9	1.0	1.0	1.1	1.3	1.5	1.7	2.3
0.8	0.9	1.0	0.8	0.9	1.0	1.0	1.0	1.0	1.2	1.9
Rate per 100,000 female live births										
245.5	260.8	272.4	266.5	258.2	252.8	267.8	255.7	235.7	243.5	229.2
33.3	33.7	42.0	47.1	52.6	57.9	67.2	75.9	81.3	94.0	102.8
Rate per 100,000 total births										
6.0	5.4	6.2	5.6	6.7	7.4	8.6	8.6	10.1	12.5	13.7

Table 4. Retardation index, 1950/55/60, compared with retardation judgments of three teams of experts for selected causes of death

Cause of death (Seventh Revision—International Lists, 1955)	Retardation index	Retardation observed by teams of experts	
		Number of teams[1]	Degree of assurance[2]
Acute bronchitis----------500	3.37	3	1, 1, 1
Bronchitis, unqualified----------501	3.37	3	1, 1, 1
Other bacterial diseases----------050-064	2.40	2	2, 2
Acute upper respiratory infections---------470-475	2.12	-	...
Bronchopneumonia----------491	2.12	2	1, 2
Infections of kidney----------600	1.93	3	1, 1, 1
Pulmonary tuberculosis----------002	1.87	3	1, 2, 2
Pneumonia, other and unspecified----------493	1.87	3	1, 1, 2
Gastroenteritis and colitis, except ulcerative, age 4 weeks and over----------571	1.82	2	2, 2
Lobar pneumonia----------490	1.71	3	1, 2, 2
Pleural tuberculosis----------003	1.58	3	1, 2, 2
Infections of skin and subcutaneous tissue-690-698	1.56	-	...
Gastritis and duodenitis----------543	1.55	3	1, 2, 2
Peritonitis----------576	1.51	3	1, 2, 2
Sepsis of pregnancy, childbirth, and puerperium, including abortion with sepsis----------640,641,651,681,682,684	1.50	-	..
Abscess of lung----------521	1.47	3	1, 2, 2
Chronic bronchitis----------502	1.46	3	1, 1, 2
Asthma----------241	1.46	3	1, 2, 2
Inflammatory diseases of central nervous system----------340-345	1.46	2	1, 1
Chronic enteritis and ulcerative colitis-------572	1.45	1	2
Tuberculosis of meninges and central nervous system----------010	1.24	2	2, 2
Chronic nephritis----------592	1.24	2	2, 2
Tetanus----------061	1.24	-	...
General paralysis of insane----------025	1.23	2	2, 2
Bronchiectasis----------526	1.18	-	...
Septicemia and pyemia----------053	1.17	1	2
Nephritis not specified as acute or chronic----593	1.12	2	2, 2
Nephritis with edema, including nephrosis------591	1.10	1	2
Diseases attributable to viruses----------080-096	1.07	-	...
Diarrhea of newborn----------764	1.01	-	...
Acute nephritis----------590	0.98	-	...
Pneumonia of newborn----------763	0.91	-	...

[1]Number of teams reporting occurrence of retardation among the three teams of experts who examined the graphs.

[2]Degree of assurance reported by each team that detected occurrence of retardation. Assurance reports are coded as 1, clearly identifiable; or 2, identifiable.

Table 5. Identification of breaking points, inclination of trend lines before and after the breaking points, and retardation ratio (R.R.%),[1] by sex and selected causes of death

Sex and cause of death (Seventh Revision—International Lists, 1955)	Breaking point	Inclination		Retardation ratio (R.R.%)[1]
		$b_1 \times 10^{-5}$	$b_2 \times 10^{-5}$	
Both sexes				
Pulmonary tuberculosis----------002	1955	9,364	3,500	62.6
Pleural tuberculosis----------003	1955	7,287	3,982	45.4
Other bacterial diseases----------050-064	1955	10,914	5,088	53.4
Inflammatory diseases of central nervous system-----340-345	...	...	...	...
Lobar pneumonia----------490	1955	3,428	398	88.4
Bronchopneumonia----------491	1955	5,868	1,374	76.6
Pneumonia, other and unspecified----------493	1955	4,285	314	92.7
Acute bronchitis----------500	1955	8,360	460	94.5
Bronchitis, unqualified----------501	1955	19,007	1,452	92.4
Chronic bronchitis----------502	1959	5,713	-692	112.1
Abscess of lung----------521	...	...	...	...
Gastritis and duodenitis----------543	...	...	...	...
Gastroenteritis and colitis, except ulcerative, age 4 weeks and over----------571	1957	8,300	3,506	57.8
Chronic enteritis and ulcerative colitis----------572	1955	6,097	3,772	38.1
Peritonitis----------576	1955	7,419	3,528	52.4
Acute nephritis----------590	...	...	...	...
Male				
Pulmonary tuberculosis----------002	1953	12,579	3,056	75.7
Pleural tuberculosis----------003	...	...	...	...
Other bacterial diseases----------050-064	1955	9,861	5,014	49.2
Inflammatory diseases of central nervous system-----340-345	1955	6,508	2,055	68.4
Lobar pneumonia----------490	1955	3,440	260	92.4
Bronchopneumonia----------491	1955	5,783	1,440	75.1
Pneumonia, other and unspecified----------493	1955	4,200	234	94.4
Acute bronchitis----------500	1955	8,424	708	91.6
Bronchitis, unqualified----------501	1955	10,275	1,496	85.4
Chronic bronchitis----------502	...	...	...	...
Abscess of lung----------521	1955	5,646	1,934	65.7
Gastritis and duodenitis----------543	1955	4,611	1,786	61.3
Gastroenteritis and colitis, except ulcerative, age 4 weeks and over----------571	1955	9,775	4,122	57.8
Chronic enteritis and ulcerative colitis----------572	1955	6,686	4,128	38.3
Peritonitis----------576	1955	6,879	3,206	53.4
Acute nephritis----------590	...	...	...	...
Female				
Pulmonary tuberculosis----------002	1953	13,921	4,630	66.7
Pleural tuberculosis----------003	1955	8,581	3,984	53.6
Other bacterial diseases----------050-064	1955	11,976	5,226	56.4
Inflammatory diseases of central nervous system-----340-345	...	...	...	...
Lobar pneumonia----------490	...	...	...	...
Bronchopneumonia----------491	...	...	...	...
Pneumonia, other and unspecified----------493	1955	4,386	402	90.8
Acute bronchitis----------500	1955	8,295	318	96.2
Bronchitis, unqualified----------501	1955	9,737	1,346	86.2
Chronic bronchitis----------502	...	...	...	...
Abscess of lung----------521	...	...	...	...
Gastritis and duodenitis----------543	1955	3,869	616	84.1
Gastroenteritis and colitis, except ulcerative, age 4 weeks and over----------571	1957	7,966	3,396	57.4
Chronic enteritis and ulcerative colitis----------572	1955	5,745	3,488	39.3
Peritonitis----------576	1955	7,972	3,820	52.1
Acute nephritis----------590	1953	4,478	3,966	11.4

[1]The retardation ratio (R.R.%) is defined as: $R.R.(\%) = \frac{b_1 - b_2}{b_1} \times 100$.

Table 6. Incidence rates for all diseases and for major groups of diseases: Japan, 1953-62

Year	All diseases	Major groups of diseases				
		Infectious and parasitic	Respiratory system	Digestive system	Nervous system and sense organs	Circulatory
	Rate per 1,000 persons					
1962--------	2,053	51	919	359	122	31
1961--------	2,109	55	830	397	127	42
1960--------	2,099	52	847	370	132	36
1959--------	2,134	48	849	371	132	36
1958--------	2,041	59	831	331	111	27
1957--------	2,150	59	1,024	273	111	23
1956--------	2,000	64	799	322	121	24
1955--------	1,783	62	728	276	102	21
1954--------	1,911	67	724	314	111	23
1953--------	2,053	86	851	316	106	20

SOURCE: Health and Welfare Statistics Division, Ministry of Health and Welfare, Japan, National Health Survey, Report, published annually, 1953-62.

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