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ANALYTICAL STUDIES

Recent Mortality Trends in Chile

A study of the trend of the death rate in Chile with consideration of sex, age, and cause groups and selected socioeconomic factors.

Washington, D.C. April 1964

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
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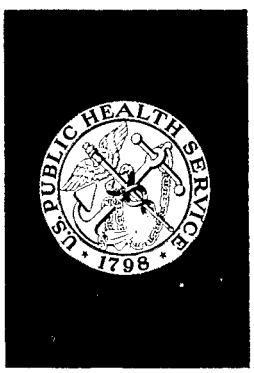

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NATIONAL CENTER FOR HEALTH STATISTICS

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PREFACE

This is the second in a series of analytical studies of the Office of Health Statistics Analysis designed to ascertain causes underlying the change in mortality trend in a number of countries in recent years.

These studies are part of a program of the Office to encourage observation and interpretation of national trends by contracts with responsible investigators in various countries, in order to provide clues for comparison with findings in the United States and other countries. For the most part the change in trend is observable in countries of low mortality. However, Chile is one of the countries of higher mortality where the same phenomenon is apparently occurring. In an effort to find the reasons for the leveling off of the death rate in Chile, a contract was made with Dr. Hugo Behm, Professor of Biostatistics, School of Public Health, University of Chile, who directed the project.

Dr. Clara E. Councell of the Office of Health Statistics Analysis edited the research report for publication.

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SYMBOLS

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RECENT MORTALITY TRENDS IN CHILE

The following research report was prepared by Hugo Behm, M.D., M.P.H., Professor of Biostatistics, School of Public Health, University of Chile; and Albino Bocaz, Hector Gutierrez, Adela Legarreta and Luis Marchant, Staff Members, Department of Biostatistics, School of Public Health. The methodology, findings, and conclusions are those of the investigators.

SUMMARY

The trend of mortality rates by sex and age has been studied in Chile for the years 1933 through 1960 and for selected causes by sex and age for 1937 through 1959. The crude death rate which declined steadily from 1933 to 1953 has since leveled off for males and females. The rate is 12.3 per 1,000 population in 1960. The change in trend occurred almost exclusively for the population under 50 years of age. The breakpoint was followed by a relatively constant rate, a slight increase, or a decline at a lower rate. A comparison of death rates by sex showed that between the ages of 20 and 50 years the interruption in the downward trend of mortality occurred 1 or 2 years earlier for males than for females. Analysis by cause showed that the notable decline in mortality for the period 1937-53 was due largely to fewer deaths from a group of diseases of infective etiology (i.e., pneumonia, tuberculosis, gastritis and related diseases, and other infective diseases). Since 1953, these diseases had less of an average absolute decline (tuberculosis and gastritis, duodenitis, enteritis, and colitis) or a clear increase (influenza, pneumonia, and bronchitis). On the other hand, the diminishing relative importance of these groups as causes of death gave progressive emphasis to the causes with rates showing little change or a slightly increasing trend such as accidents, malignant neoplasms, vascular lesions affecting central nervous system, and certain diseases of early infancy. These diseases also contributed to the leveling of the total crude death rate.

About one-third of all deaths were under 1 year of age when the change in trend seemed to be related to diminishing efficient control of mortality due to malnutrition and enteric and respiratory infections. Between 15 and 34 years of age, the trend of the total rate was influenced by the change in direction of mortality from tuberculosis and pneumonia, both important causes of death with declines interrupted in 1953. For older age groups, the weight of mortality from accidents and degenerative diseases became more important. Differences in trend by sex showed a more rapid decline in tuberculosis mortality for females and a more marked increase for males in death rates due to accidents and malignant neoplasms.

The major findings were: (1) leveling of the death rate had occurred since 1953 for both sexes in all age groups under 50; (2) the decline in mortality from 1937 to 1953 was due largely to a decrease in death rates for infective diseases, while in recent years the decline has slowed or rates have increased; and (3) other causes of death with long-term constant or slightly increasing trend have become progressively important. It was concluded that health programs, even though continuing to expand, have not been able to provide adequate services for a large segment of the population with poor socioeconomic conditions.

INTRODUCTION

In areas of the world where vital records have been available over a long period of years, death and infant mortality rates have shown a general downward trend from the earliest re-

corded data. Significant improvements in mortality rates were made in many countries after the close of World War II, particularly for the younger age groups. In a number of countries, as in Chile, after a period of rapidly declining mortality, there has been a deceleration in the rate of decline of the crude death rate and infant mortality rate at varying years since 1950. The purpose of this study was to describe characteristics of changes in the mortality trend in Chile during the period 1933-60 and to study the possible relation of medical care, level of living, and other socioeconomic indicators to these changes.

MORTALITY TRENDS BY SEX AND AGE, 1933-60

Trend of Total, Male, and Female Death Rates

In recent years, an important change in mortality trends has occurred. An analysis of infant mortality showed that beginning in 1953 the decline in this death rate was interrupted and there was an increase in the rate for several geographic areas of the country.[1] The crude mortality rate showed a marked and approximately linear decline for the period 1933-53 with an annual average reduction of 0.64 per 1,000 population. Mortality for that period declined from 26.0 to 12.4 per 1,000 population or approximately 50 percent. After 1953, mortality leveled off at an average rate of 12.5 per 1,000 population (table 1 and fig. 1).

The significance of this change is evident if the mortality for 1960 is estimated on the basis of regression for 1933-53. The expected rate was 8.6 and the observed rate was 12.3, which means that 28,024 of the total 93,625 deaths registered in 1960 would not have taken place if the previously described trend had continued.

The leveling of death rates in recent years occurred in Chile at high levels as may be seen

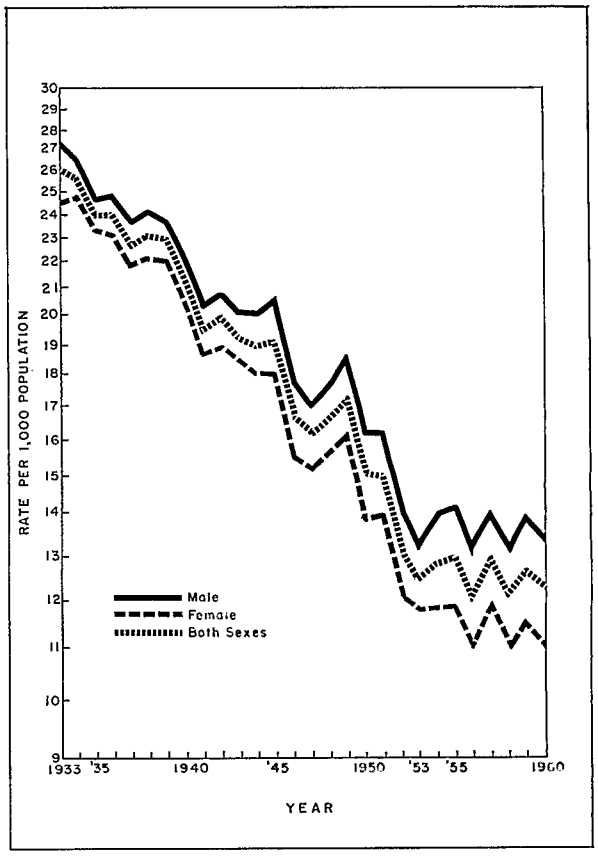

Figure 1. Total crude death rate and death rates by sex: Chile, 1933-60

by a comparison with U.S. rates for the same year. For 1959 the rates were as follows:

	Chile	United States
Crude death rate (per 1,000 population)	12.7	9.4
Infant mortality rate (per 1,000 live births)	111.5	26.4
Neonatal	34.9	19.0
Postneonatal	77.0	7.4
Tuberculosis (per 100,000 population)	56.1	6.5
Other infective and parasitic diseases (per 100,000 population)	44.4	6.2

[1] Behm, H.: *Mortalidad infantil y nivel de vida.* Santiago de Chile. Ediciones de la Universidad de Chile. 1962.

An analysis of the mortality trend by sex showed a similar pattern of change, and the breakpoint was situated around 1953. The death rate for males was always higher than that for females, and the difference in rates between males and females tended to be proportionally greater because of a slightly greater decline in female mortality. The respective regression equations were:

	1933-1953
Total	$y = 25.83 - 0.64x$
Male	$y = 26.72 - 0.63x$
Female	$y = 24.96 - 0.64x$
	1953-1960
Total	$y = 12.67 - 0.03x$
Male	$y = 13.67 - 0.01x$
Female	$y = 11.78 - 0.08x$

Trend of Mortality by 5-Year Age Groups

An overall picture of the course of mortality for each 5-year age group is shown in figure 2. The relative reduction in the rates was generally greater for the younger age groups, except for under 1 year of age. On the other hand, it can be observed that the declining trend of mortality was broken for all ages under 50 years—the point of change being between 1953 and 1956. After these years, mortality increased, leveled off, or decreased its rate of decline.

Straight lines of regression were drawn freehand to determine whether there had been a breakpoint around 1953. If so, linear regressions were adjusted in the respective age groups for the period immediately before and after the year of change. For the remaining age groups, regression lines showed no breakpoint. It is evident that the year in which the breakpoint was situated was approximated. For the adjustment, some values which occasionally disturbed the general trend were substituted—for example, the increased accident mortality of 1939 due to an earthquake.

In 1933, the beginning of the period under study, the death rates for persons under 50 years of age continued to be high until 1938-40. The abrupt increase for the year 1939 resulted from deaths caused by the earthquake. In many of these age groups, a rapid decline which had started earlier for some of the other age groups then began.

The course after 1939 presented different characteristics according to age. For all ages under 50 years and also for the age groups 55-59 and 85 and over, an evident interruption of the favorable mortality trend was observed. For some age groups the change usually occurred during 1953-54, but for others it did not occur until 1955-56.

For the ages under 1 year and 5-9 years, the breakpoint was followed by an increase in mortality. For the age groups 1-4, 10-14, 20-24, 25-29, 40-44, 45-49, and 85 years and over, the trend showed little change for recent years. Finally, at ages 15-19, 30-34, 35-39, and 55-59 years, the rates continued descending but with an absolute mean reduction lower than that for the preceding period.

In contrast with this course, no significant changes in the trend of mortality for the older age groups were observed during 1953-56. The rates continued to decline slowly for ages 50-54 and for ages between 60 and 79 years. For the age group 80-84 years, the leveling occurred from approximately 1940.

A summary of the trend for the groups which had a change in 1953-56, separated into two periods according to the presumable breakpoint, is indicated below.

Age	Period I		Period II	
	Years	Regression slope	Estimated breakpoint	Regression slope
Under 1	1936-53	-7.74	1953	1.22
1-4	1933-53	-1.15	1953	-0.05
5-9	1933-56	-0.18	1956	0.07
10-14	1940-55	-0.17	1955	-0.01
15-19	1944-53	-0.47	1953	-0.09
20-24	1938-56	-0.44	1956	0.01
25-29	1939-53	-0.45	1953	-0.03
30-34	1933-47	-0.26	1954	-0.10
	1947-54	-0.56		
35-39	1938-54	-0.41	1954	-0.18
40-44	1933-53	-0.37	1953	-0.07
45-49	1933-53	-0.46	1953	-0.06
55-59	1933-54	-0.54	1954	-0.23
85+	1935-53	-4.78	1953	-0.48

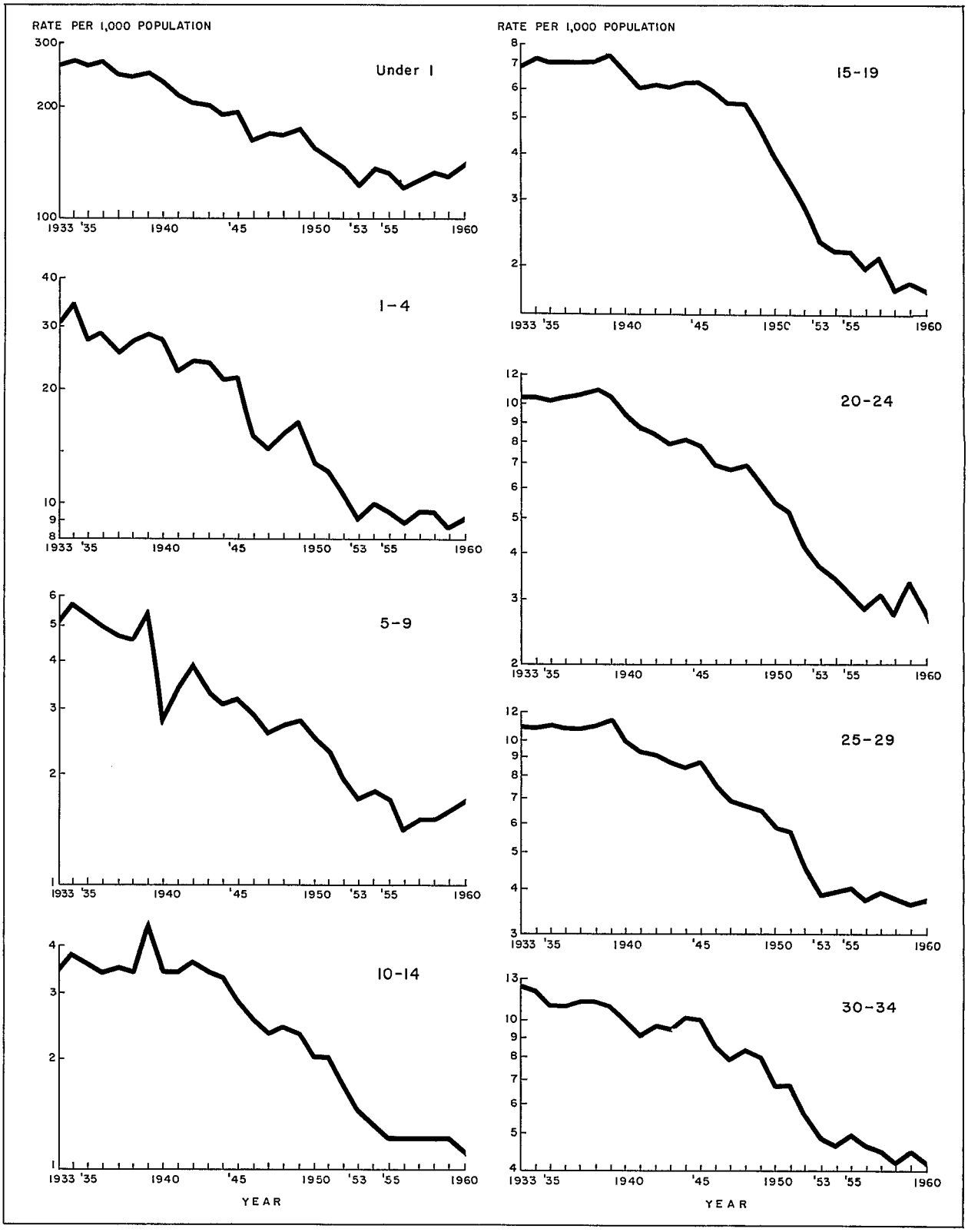

Figure 2. Death rates by age: Chile, 1933-60

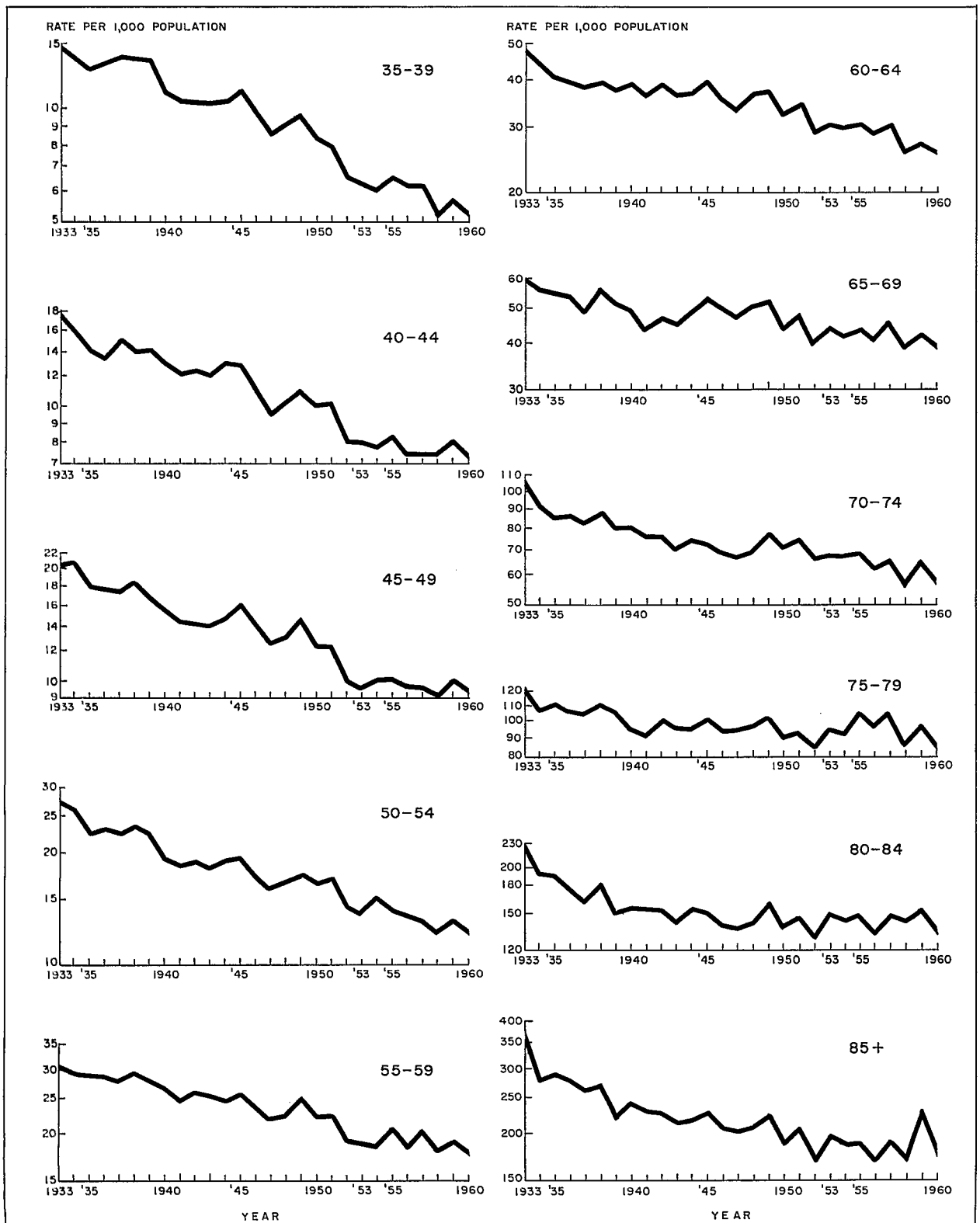

Figure 2. Death rates by age: Chile, 1933-60—Continued

These age groups contributed 82 percent of the deaths in 1937, 70 percent in 1953, and 73 percent in 1960. This explains why these age groups, which presented a remarkable leveling off in mortality in recent years, have determined the change in the crude rate. Moreover, due to the high infant mortality that prevailed in the country (119.6 per 1,000 live births in 1960), the course of the rates during the first year of life had a strong influence on the total rate; deaths at this age (under 1 year) were 34,003 in 1960—36 percent of the total 93,625 deaths.

Trend of Mortality for Each Age Group by Sex

Mortality for both males and females generally followed a similar course for the majority of age groups, with the usual pattern of higher rates for males. There was an exception for the age groups 10-14, 15-19, 20-24, and 25-29 years, where death rates for females were similar or higher than those for males at the beginning of the study period. However, the downward trend was more marked for females and did

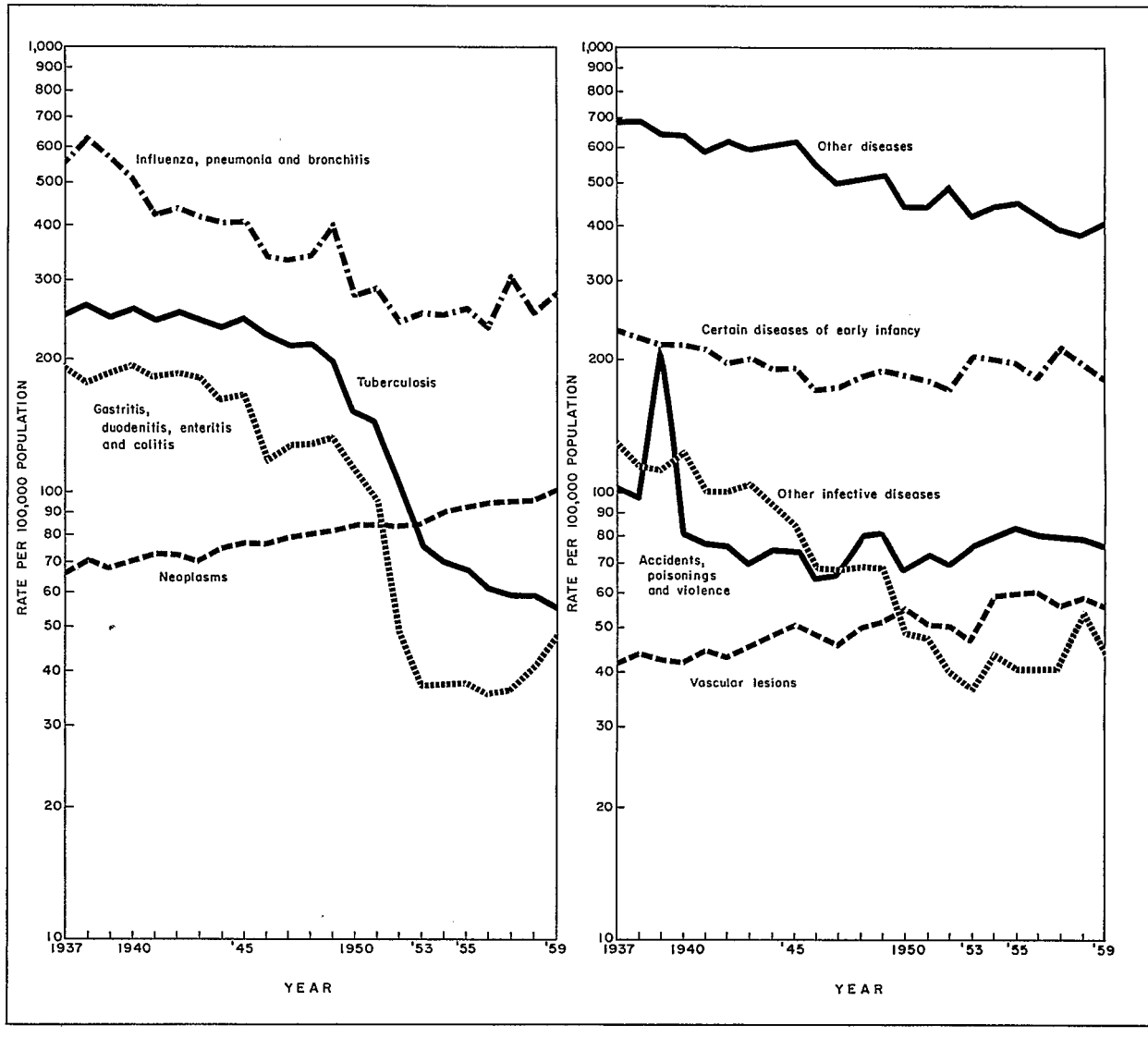

Figure 3. Death rates by cause: Chile, 1937-59

not level off until 1955-56, while the death rates for males leveled off earlier. Thus, mortality for females exceeded that for males at ages 10-19 until the years 1948-49 and at ages 20-29 until 1942-43. An explanation of these differences can be found in the analysis of causes of death for these ages.

For ages 20-49 years the breakpoint usually occurred in different years for males and females; death rates for males generally leveled off 1 or 2 years earlier than those for females.

The differences in the levels of mortality between males and females were proportionally smaller at ages from 1 year to around middle age. Nevertheless, differences for all age groups tended to increase during the period 1933-60. In general, there was a marked excess of mortality for males after age 40 except for the group 80-84; female mortality was higher at 85 years and over.

MORTALITY TRENDS FOR SELECTED CAUSES

Deficiences in certification of causes of death in Chile as well as irregularities in the application of the International Classification imposed some restrictions on the analysis of death by cause. For example, in spite of its numerical importance, the group of cardiovascular diseases was not included because of inconsistencies in statistics. Other causes of numerical importance were included in the group of other causes of death because the quality of cause certification precluded separate analysis.

Death rates per 100,000 population for different groups of causes are shown in table 2. Groups of causes shown in figure 3 were selected for their numerical importance and the quality of basic data. These groups comprise 68 percent of the deaths in 1937 and 69 percent of those in 1959.

The breakpoint shown by the crude death rate occurred in 1953. For the causes which had changes before and after this year (discussed as Period I and Period II, respectively), linear regressions were adjusted excluding some points with obvious accidental departures from the general trend. In the case of tuberculosis and gastritis, duodenitis, enteritis, and colitis the trend showed a break in 1948 and 1949, respectively. The group of certain diseases of early infancy presented irregularities, and because linear adjustment was not satisfactory, a parabola was used. For groups that had no obvious changes during the period 1937-59, only one regression line is shown.

Rates read from the regression lines for 1937, 1953, and 1959 have been discussed including those which changed the relative importance of various causes in relation to the total rate. Various deficiencies of the basic data added an error factor which could not be estimated to the regression coefficients and rates so determined. The effects of applying different revisions of the International Classification have not been analyzed since the error factors that have been discussed exceed by far the disparities resulting from use of the different revisions.

Rates by cause for all ages have not been adjusted by age and sex because an analysis was made by age groups. The percentage distributions of the enumerated population by age and sex according to the censuses of 1940 and 1952 were as follows:

Age	1940		1952	
	Male	Female	Male	Female
Total	100.0	100.0	100.0	100.0
Under 15	37.8	36.5	38.3	36.4
15-49	50.6	51.1	49.0	50.1
50-64	8.4	8.6	9.0	9.2
65+	3.2	3.8	3.7	4.3

SELECTED CAUSES WITH BREAKPOINTS IN TREND

Tuberculosis

For the period 1937-48 the decline was small (45 points), with an average annual reduction of 3.6. In 1948 a first change in slope was observed and the leveling off was accelerated to an annual decline of 27.6 per 100,000 population with a decrease of 217 in 1948 to 75 in 1953. Thus, the relative importance of tuberculosis decreased from 11 percent to 6 percent of all deaths in 1953. Another change in the trend took place in this year—the decline became slight and similar to that for 1937-48.

Other Infective and Parasitic Diseases

In Period I an important reduction occurred in this group of causes (b = -5.8), and the rates dropped from 129 to 38. There was an evident break in 1953 with a slight increase afterwards; the group produced 3 to 4 percent of all deaths in Period II.

Gastritis, Duodenitis, Enteritis, and Colitis

As for tuberculosis, there was a decline of relative importance (b = -5.9) for this group during the first period (1937-49), lowering the rate from 200 to 138. This favorable trend accelerated in 1949-53, when the average annual decline reached 25.8 and there was a gain of 103 points. A change in 1953 resulted in leveling off—these causes contributed only 3 percent of the total mortality as compared with 9 percent of all deaths in 1937.

Influenza, Pneumonia, and Bronchitis

Although this group of causes presented great irregularities in the magnitude of rates, it is evident that there was a steady decline in Period I (b = -20.7) with a considerable drop in rates from 567 to 249. Around 1952-53, a substantial change was produced in the trend which then showed an increase (b = +4.9). This breakpoint is important because this group of causes contributed more than one-fifth of all deaths even after the reduction described.

SELECTED CAUSES WITH NO BREAKPOINTS

Accidents, Poisonings, and Violence

Disregarding 1937-39, mortality from this group of causes showed little change and increased only from about 72 (based on the 1940-59 regression line) to 79 per 100,000 population in the 23 years of observation. Due to the decline of deaths from other causes, its proportion of total deaths rose from 3 to 6 percent.

Certain Diseases of Early Infancy

Important deficiencies existed for this group of causes. In the first period, there was a slight drop in the rates—from approximately 232 per 100,000 population in 1937 to 185 in 1953. Beginning with 1953, a new level of mortality was registered with great irregularities and a slight tendency to increase; these anomalies of the curve were probably due to different criteria for classification. This group of causes showed no continuing decline and probably contributed about 16 percent of all deaths.

Malignant Neoplasms

Mortality from these causes showed an uninterrupted and slight increase (b = +1.5) from 1937-59, which carried the rates from 65 to 98 per 100,000 population. In 1959 malignant neoplasms were responsible for 8 percent of the total deaths.

Vascular Lesions Affecting Central Nervous System

Selected as an indicator of the course of mortality for all cardiovascular diseases, the curve caused by this group of causes indicated a slight increase from 1937 through 1959 with rates of 42 and 59, respectively.

Other Causes of Death

Deaths in this group reached almost one-third of the total. These data do not permit adequate analysis because of deficiencies in certification or rates of low magnitude, but it should be noticed that this heterogeneous group also had a tendency to decline until 1953 with later leveling off.

EFFECT OF SELECTED CAUSES ON THE CRUDE DEATH RATE

The data collected, with all its limitations, showed that the important decline in the crude mortality rate for the period 1937-53 was fundamentally related to the decrease in mortality from a certain group of diseases of infective etiology. The total decrease was 1,061 per 100,000 population, to which these causes contributed as follows:

	Decline in rate per 100,000 population	Percent of decline
Influenza, pneumonia, and bronchitis------	318	30.0
Tuberculosis-----	187	17.6
Gastritis, duodenitis, enteritis, and colitis---------	165	15.6
Other infective and parasitic diseases--------	91	8.6

These causes showed a total reduction of 761 points for this period, which represents 72 percent of the decline in the crude rate between 1937 and 1953. Furthermore, this was an important group of causes, comprising 50 percent of all deaths registered in 1937. Mortality from tuberculosis and gastritis, duodenitis, enteritis, and colitis had an intermediate breakpoint in Period I during 1948-49, after which the decline in these rates was greatly accelerated. In fact between the years 1948-49 and 1953, the death rates for these causes dropped 245 points with b = -27.6 for tuberculosis and b = -25.8 for gastritis, duodenitis, enteritis, and colitis.

The most important fact after 1953 was the changing trend for this group of causes. Tuberculosis was the only cause that had a continuous but slow rate of decline (b = -3.7) which comprised only a small part of the total mortality (4 percent). The groups of infective diseases—influenza, pneumonia, and bronchitis and gastritis, duodenitis, enteritis, and colitis—increased slightly, and in 1959 they were responsible for 30 percent of all deaths.

On the other hand, the causes of death which had a stationary or slightly increasing course made up a larger portion of the crude death rate due to a great extent to the important decline in mortality from the group of causes just mentioned. Deaths attributed to accidents, neoplasms, diseases of early infancy, and vascular lesions affecting the central nervous system constituted 35 percent of the deaths in 1959; the latter cause was included as an indicator of the upward trend of the total deaths from cardiovascular diseases. The causes of death with stationary or increasing course during 1937-59 indicated a second factor that contributed to the leveling off of total mortality since 1953.

MORTALITY TRENDS FOR SELECTED CAUSES BY AGE GROUPS

In analyzing the course of mortality by cause for different age groups, consideration was given to those in which a recent break in the decline of the rates had been observed. The analysis was restricted to ages for which information about causes of death was available for at least 60 percent of deaths.

Under 1 Year of Age

Unfortunately, it was impossible to make an analysis of the trend of causes of death at this age, which contributed approximately one-third of all deaths in Chile, because of deficiencies in the specification of these causes in the basic data and problems of classification.

In considering the numerical importance of the group in determining the course of the crude mortality rate, figure 4 was reproduced from a study [2] which showed the course of neonatal and postneonatal mortality for 1930 and 1960. The rates were calculated per 1,000 live births with a correction for underregistration of births.

As is well known, most of the deaths during the first 28 days of life are related to pregnancy and birth. For the rest of the first year of life,

[2] Behm, H., op. cit.

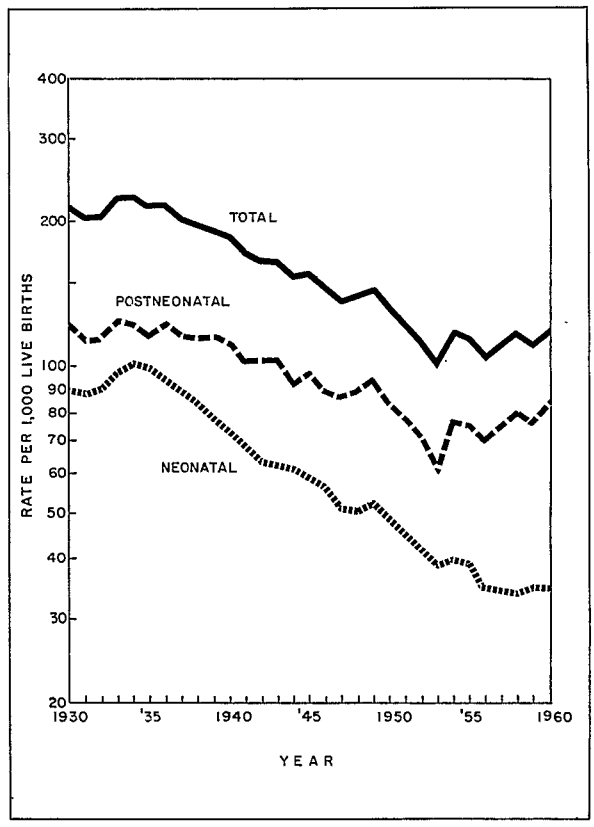

Figure 4. Infant mortality rates: Chile, 1930-60

extensive clinical and epidemiological evidence indicated that mortality occurred principally from malnutrition and enteric and respiratory infections.

A study [3] of deaths at 1-11 months with medical certification for 1957-59 gave the following distribution of the principal causes of death:

	Percent
Influenza, pneumonia, and bronchitis	33.0
Gastritis, duodenitis, enteritis, and colitis	29.7
Nutritional maladjustment	16.2
Other infective and parasitic diseases	6.4

As shown in figure 4, there was a difference between the fluctuating rates of decline in the mortality trend for the two age groups. For neonatal mortality, the decline initiated in 1934 was extended until 1956 with an average annual reduction of 3.0 per 1,000 live births, carrying the rates from approximately 100 to 35. From 1956 the rates leveled off. On the other hand, the decline in mortality at 1-11 months was less marked (b = -2.9) and was interrupted in 1953; the rates declined from approximately 120 to 70 during 1936-53. After 1953 late infant mortality increased (b = +2.1), so that the rate for 1960 (84.5 per 1,000) was similar to the one existing in Chile in 1950.

The break in the course of infant mortality in Chile must be attributed to the persistence of high mortality from malnutrition and enteric and respiratory infections.

For all of the following age groups, the regressions had 1940 as the point of origin due to the fact that during 1937-39 there were disturbing factors in the trend of some causes. In contrast with the analysis of causes for all ages, consideration is given here to the breakpoints for each group of causes in such a way that they do not coincide with the year of change of the total age-group rate. The summary tables refer to the years 1940 and 1959 and to the year in which the breakpoint was registered for the total age group. Intermediate points were added for tuberculosis and gastritis, duodenitis, enteritis, and colitis when an additional breakpoint was obvious. When the the same group of causes had a disparity in the point of union of both lines of regression, a mean of both predicted values was used for the summary table.

1-4 Years of Age

The selected causes that have been analyzed accounted for 67 to 74 percent of all deaths in this age group (table 3 and fig. 5). The total death rate declined by 1,690 points between 1940 and 1953, including the following:

	Decline in rate	Percent of total rate
Influenza, pneumonia, and bronchitis	559.0	33.1
Gastritis, duodenitis, enteritis, and colitis	444.2	26.2
Other infective and parasitic diseases	157.9	9.3
Tuberculosis	150.9	8.9

[3] Ibid.

This means that 78 percent of the total decline in the death rates from 1940 to 1953 for ages 1-4 years was attributed to these four groups of causes. The leveling off from 1953 appeared to be associated especially with the change in the trend for influenza, pneumonia, and bronchitis with a decline in the downward trend from 1940-53 (b = -44.4) to 1953-59 (-3.7); this group contributed 41 percent of the deaths in this age group. Death rates for gastritis, duodenitis, enteritis, and colitis leveled off, and deaths from infective and parasitic diseases increased (b = +6.5). In 1959 these three groups of causes were responsible for 65 percent of all deaths at ages 1-4 years.

Tuberculosis showed a great decline between 1948 and 1953 (b = -23.5). After 1953 the slight reduction was of no significance since it caused only 1.8 percent of total deaths in 1959.

5-14 Years of Age

The rate for all causes had a change in trend for this age group in 1955; the average annual reduction for the periods 1940-55 and 1955-59 was 14.4 and 0.2, respectively, as shown in table 4.

Table 4 and figure 5 are based on the mortality trend of five groups of selected causes of death that accounted for approximately 64-72 percent of all deaths for this age group. The total death rate showed a decline of 221 points between 1940 and 1955 to which the causes listed below contributed:

	Decline in rate	Percent
Tuberculosis---------	78.9	35.7
Influenza, pneumonia, and bronchitis----------	58.2	26.3
Other infective and parasitic diseases----------	29.2	13.2
Gastritis, duodenitis, enteritis, and colitis---------	5.9	2.7

The decline of the first three groups was of decisive importance—contributing 62 percent of the deaths registered in 1940 for this age group. Mortality from gastritis, duodenitis, enteritis, and colitis though in decline did not contribute to any large extent to the total death rate (2 percent).

The leveling off of mortality in 1955 at ages 5-14 years was determined in its greater part by the trend of mortality from influenza, pneumonia, and bronchitis and other infective and parasitic diseases, which no longer declined but had a rising trend. Both groups registered 44 percent of all deaths in 1959. Only tuberculosis continued to decline though at a lower rate, and its weight in the trend of mortality for this age group was relatively small. On the other hand, deaths from accidents totaled 21 percent of all deaths in 1959, and the level of mortality from this cause has remained unchanged. For this reason therefore deaths from accidents are an important factor of change in the total death rate.

15-24 Years of Age

For this age group, the rates for mortality had a breakpoint situated approximately in 1954. The decline registered up to that year was more rapid between 1948 and 1954 than in preceding years. It has been possible to analyze the causes that accounted for 61-75 percent of the deaths as can be seen in table 5 and figure 5.

The decline in the total death rate between 1940 and 1954 was 517 points, with an average annual decline of 21 points for 1940-48 and 58 points for 1948-54. This decline was clearly a result of the decrease in mortality from tuberculosis, which contributed 44 percent of the deaths in this age group in 1940. The differences between the rates for 1940 and 1954 for the selected causes are listed below.

	Decline in rate	Percent
Tuberculosis---------	285.7	55.2
Influenza, pneumonia, and bronchitis----------	71.6	13.8
Other infective and parasitic diseases--	37.9	7.3

It is evident, moreover, that the course of mortality from tuberculosis produced the change described for the total rate for 1948. Beginning

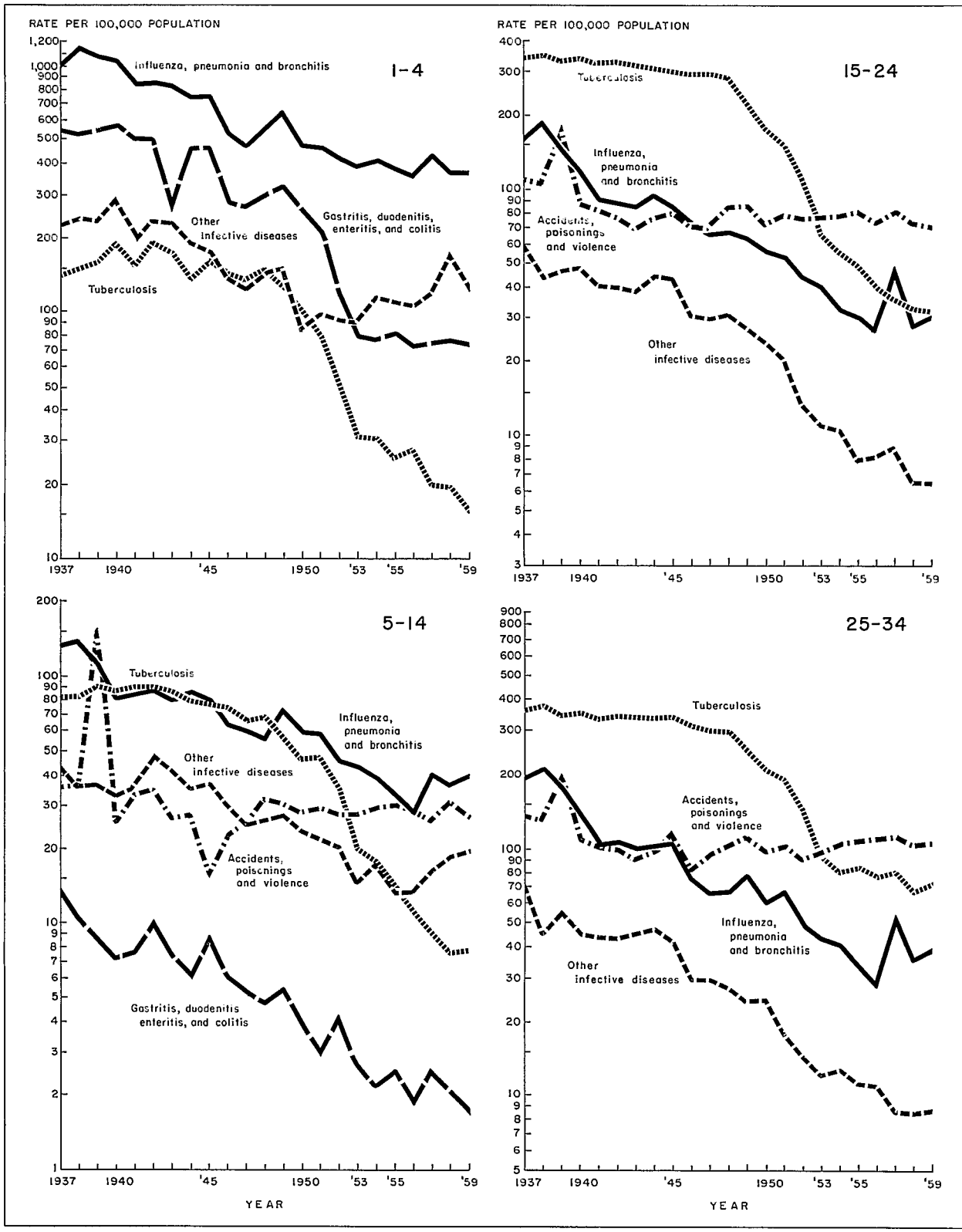

Figure 5. Death rates for selected causes by age: Chile, 1937-59

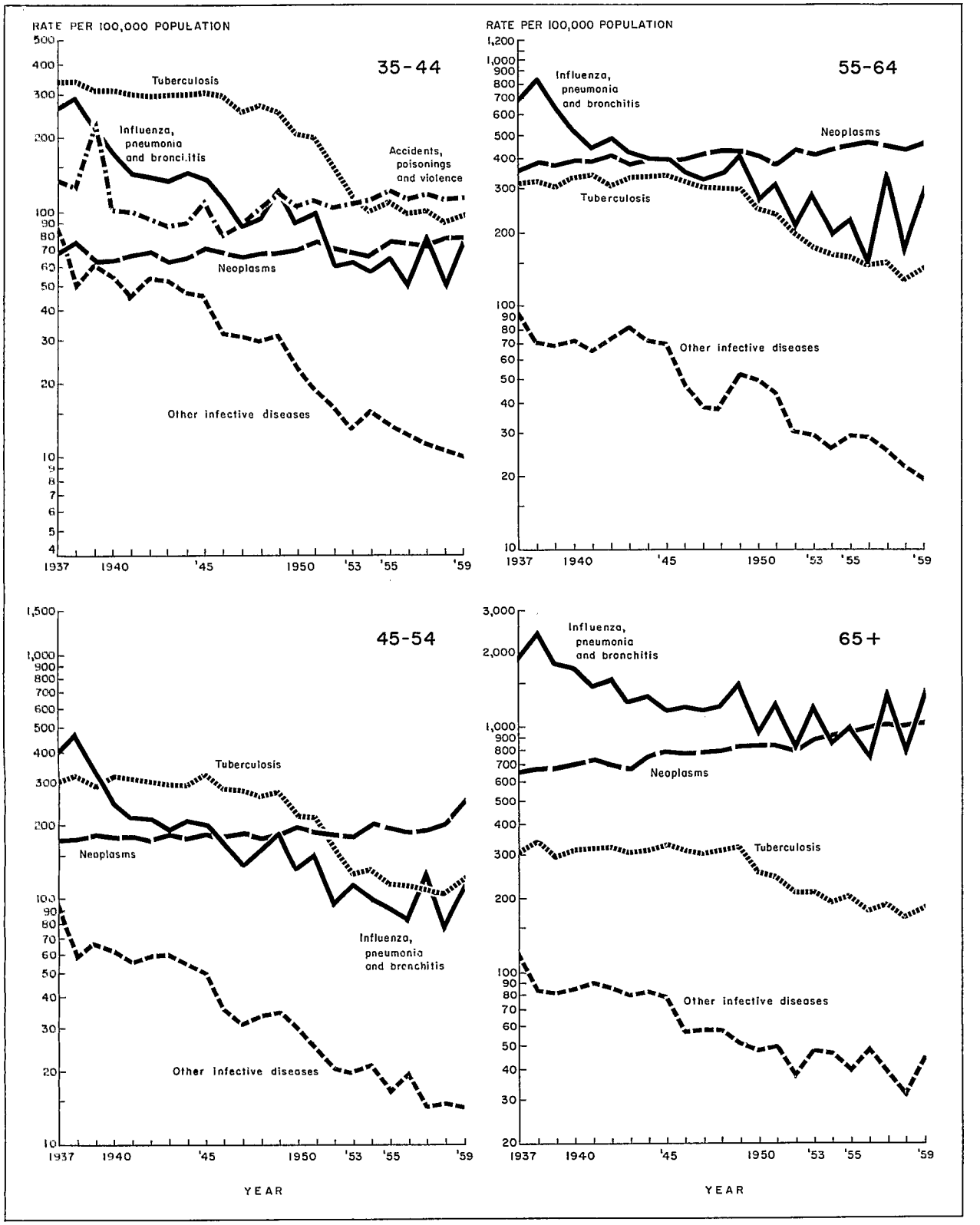

Figure 5. Death rates for selected causes by age: Chile, 1937-59—Continued

with 1954, however, the total rate leveled off following the course of mortality from influenza, pneumonia, and bronchitis, which contributed 14 percent of all deaths. Mortality from accidents became increasingly important as a consequence of the decline of tuberculosis, and in 1959 was responsible for 32 percent of all deaths at ages 15-24 years. Although the decline of mortality from tuberculosis was greatly moderated (for 1948-53, b = -41.6 and from 1953, b = -5.6), this cause was not an important factor in determining the total mortality as it contributed only 12 percent of the total deaths in 1959.

25-34 Years of Age

In this age group analysis was restricted since the causes which had been brought under study amounted to only 63 percent of the total deaths for that group in 1940 and only 55 percent in 1959 (table 6 and fig. 5). However, the general results were consistent with findings for the 15-24 age group. For the total rate, the breakpoint was in 1953. The rate of decline for the first period accelerated during 1948 so that for the period between 1940 and 1948, the mean annual decline was 29.5; it increased to 64.3 in 1948-53. In the following years, there was an evident leveling off with b = -5.3. Tuberculosis was responsible for 36 percent of all deaths at these ages at the beginning of the period under study. It was the rapid decline of this rate after 1948 that caused the breakpoint described for that year in the rate for all causes. Within a decline of 551 points in the general death rate for the years 1940-53, the weight of the following cause groups was:

	Decline in rate	Percent
Tuberculosis---------	262.1	47.6
Influenza, pneumonia, and bronchitis----------	76.2	13.8
Other infective and parasitic diseases--	37.0	6.7

These three groups of causes contributed half of the deaths for the age group 25-34 years in 1940 and were responsible for 68 percent of the difference in the rate between 1940 and 1953.

The leveling off of mortality for this age group was related to a similar leveling off of tuberculosis after 1953. In 1959 tuberculosis still caused one out of every six deaths at these ages, and therefore its change of trend was of particular importance—for 1948-53, b = -39.6; for 1953-59, b = -3.4.

Mortality from accidents was stationary during the whole period, but became progressively important through the decline of deaths of infectious etiology. In 1959 the accident group was responsible for 26 percent of the deaths in this age group.

35-44 Years of Age

As shown in table 7 and figure 5 the causes studied contributed only 54-60 percent of the total deaths for this age group. This percentage would have been higher if vascular lesions affecting the central nervous system had been considered in showing the trend of all deaths from cardiovascular diseases.

The total rate for this age group had an interruption in its declining trend about 1954. Out of a total decline of 520 points in the general death rate between 1940 and 1954, the different causes contributed as follows:

	Decline in rate	Percent
Tuberculosis---------	217.7	41.9
Influenza, pneumonia, and bronchitis----------	98.1	18.9
Other infective and parasitic diseases--	43.3	8.3

All together these causes were responsible for 69.1 percent of the total decline. Just as in the age group 25-34 years, the change in the trend for all causes was connected with the break in the decline of these causes, especially of the first two, which in 1954 caused 23 percent of the total deaths for the age group 35-44 years.

On the other hand, the causes which showed a stationary or slightly increasing trend during the whole period 1940-59 (accidents, malignant neoplasms, and vascular lesions affecting central

nervous system) comprised at least 30 percent of the deaths since 1954 and afforded another contribution to the leveling off.

45 Years and Over

The course of mortality by cause was not analyzed for these age groups. The only identified group of causes which presented any change during the period under study was influenza, pneumonia, and bronchitis. Death rates for tuberculosis tended to level off, but its importance as a cause of death in these more advanced ages was greatly reduced. Consequently, the pattern had a stationary trend or a slight decline which was not interrupted during the period 1953-55 as was that for the younger age groups (fig. 5).

MORTALITY TRENDS BY SEX AND AGE GROUPS

For age groups 10-14, 15-19, and 20-24 years, mortality for females—which exceeded that for males from 1933 until about 1949—later showed a larger decline and eventually reached a lower level than that for males as in the other age groups.

Mortality of males and females due to all causes and tuberculosis and maternal mortality for females are shown in figure 6 for ages 15-24 years. It is clearly seen that the more favorable trend for females was due to the fact that tuberculosis was an important cause of death in 1937 (42 percent of total deaths), with a higher rate for females than for males but with a more marked decline. In fact, the point at which the declining mortality rate for females crosses the rate for males corresponds with that of 1948, when the notable decrease in mortality from tuberculosis began.

The course of maternal mortality was a contributory element; the rates for this cause dropped from 94.4 to 25.4 per 100,000 population between the years 1937 and 1955 with subsequent leveling off.

Trends of the rates for selected causes by sex at ages 25-34, 35-44, and 45-54 are also shown in figure 6. The main difference between mortality for males and that for females was that the leveling off of the rates was shown earlier for males than for females with a difference of 1 to 2 years in the corresponding breakpoints. A study of these figures showed that this difference was a result of the following factors: (1) Tuberculosis mortality, which remained an important cause of death for this age group, had a prolonged downward trend for females 1 or 2 years longer than did the corresponding trend of male mortality; (2) accidents, which were more important as a cause of death for males than for females, had for males, as a rule, a rise in trend; (3) for ages 35-44 and 45-54, mortality due to malignant neoplasms had a greater tendency to increase for males than for females, especially for the last 5 years.

It is evident that the decline of maternal mortality contributed to the rapid decline of female mortality during 1937-53. This factor did not affect the breakpoint of the total female rate, however, since maternal mortality had already leveled off around 1955 and was of little importance to the total mortality for that sex.

MEDICAL, SOCIAL, AND ECONOMIC FACTORS RELATED TO MORTALITY TRENDS

Since mortality is an index of the health problems of a community and these are interrelated with multiple economic and social factors of the development of the population, it is necessary to give an idea of the conditions that existed and are now prevailing in Chile. Ample evidence exists that levels of living in Chile are low in extensive groups of its population and that the country is still in an underdeveloped stage. The Chilean economic development, according to the *Corporación de Fomento de la Producción,* is characterized by slow growth and instability. From the period 1925-29 to 1956-60 the per capita value of goods and services produced has increased 1.3 percent per year, while the population has increased 1.8 percent and more recently up to 2.5 percent. In foreign commerce the country is still dependent on mineral exports. Capital investment is low, and the gross investment represents only 10 percent of the value of goods and services produced.

The average income per capita, approximately 500 dollars per year, has a very uneven

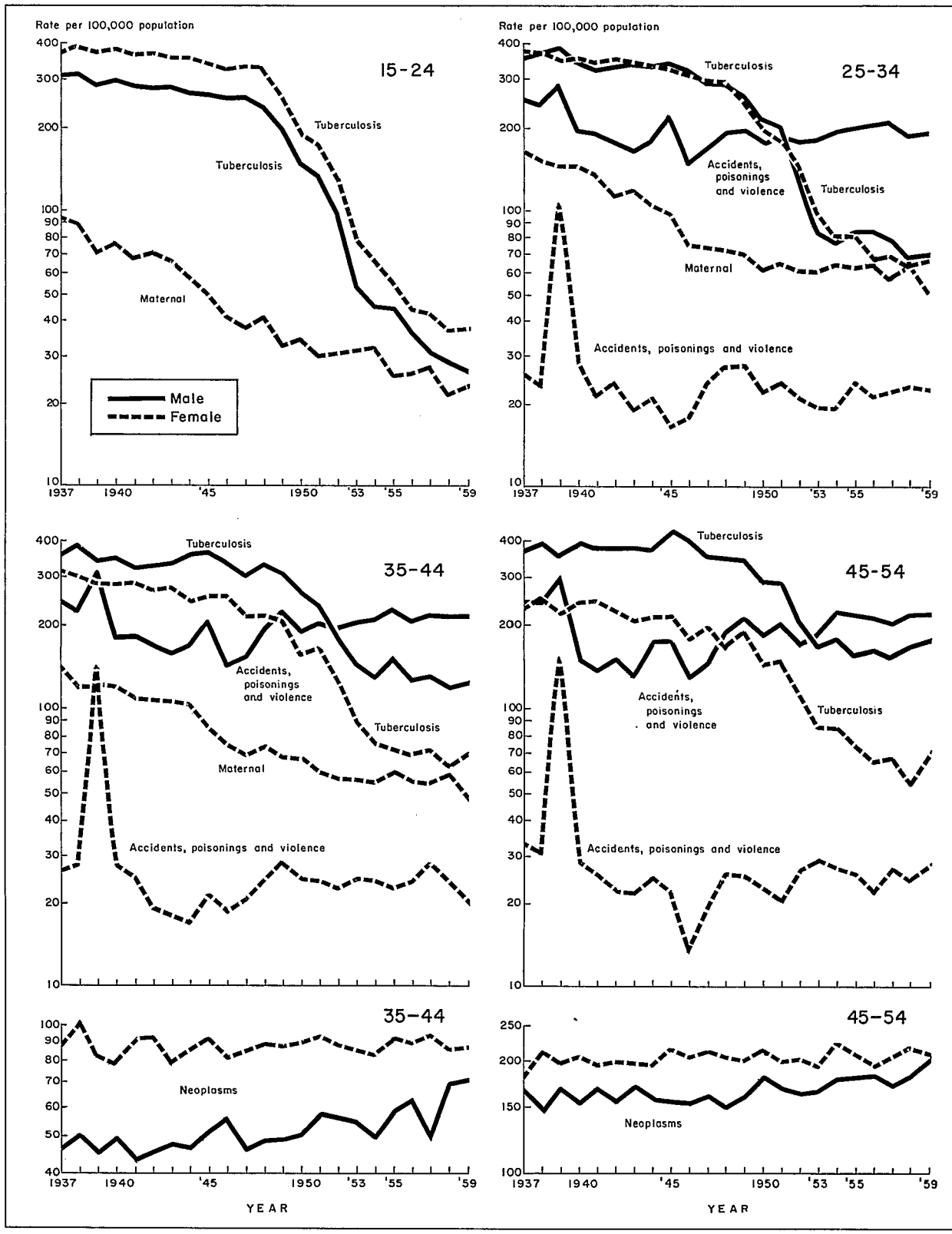

Figure 6. Death rates for selected causes by age and sex: Chile, 1937-38

distribution—3 percent of the population receive 25 percent of the national income, while 55 percent of the population get only 16 percent. The *Servicio Nacional de Salud* estimates that 80 percent of a workman's salary is necessary for his food consumption. This means that a large part of the working class is unable to solve its subsistence problem.

Agriculture is technically backward and the land is very unequally distributed—22 percent of the landowners possess 72 percent of the cultivated ground. Hence agricultural production is inadequate, and in recent years the import of agricultural products which could be produced at home has reached the amount of 50 million dollars yearly.

The remarkable growth of the population is characterized by urbanization, with great increases in the larger cities. Population of the southern zone of Santiago, for example, has increased 110 percent between 1952 and 1960. To this a serious lack of housing is added; since 1952 it has increased by 10 percent while the total population has increased by 23.5 percent. Forty percent of the population have no proper water supply, and this percentage increases to 80 percent in the rural areas. Sewerage is lacking for 45 percent of urban houses; and 50 percent of the rural population have no excreta disposal system.

The illiteracy rate is about 20 percent. It is estimated that 250,000 school-age children do not attend school. Out of those beginning grammar schools, only 36 percent reach the sixth grade. Skilled labor is scarce in spite of the advancement made in technical training. In spite of all this, the national manufacturing industry, favored by the protectionism following the 1930 crisis, has experienced a great upsurge, and its production has been four times as much during the last 20 years, thus affording 26 percent of total production. Important achievements have been made in steel, electric power, and oil.

The principal agencies in charge of medical and preventive care for the population joined together to form the *Servicio Nacional de Salud* in 1952. This service is responsible for: (1) protection and promotion of health for the total population; (2) free medical care for the 70 percent of the population that constitute the laboring classes and their families and medically indigent groups; and (3) diverse economic compensations for sickness, inability to work, and so forth.

As to the work performed by the *Servicio Nacional de Salud,* available information shows that: (1) the number of registered services given has shown a continuing increase (table 8 and fig. 7); (2) the proposed aims have not been fully accomplished due to a shortage of human, material, and budget resources; as a result there was no professional care for 44 percent of the births which occurred among the working class during 1957; (3) owing to the same reasons the quality and availability of medical care are not satisfactory; and (4) levels and quality of medical care in the various provinces vary, with an excessive concentration of resources in the larger cities. Very adverse conditions prevail among 27.6 per-

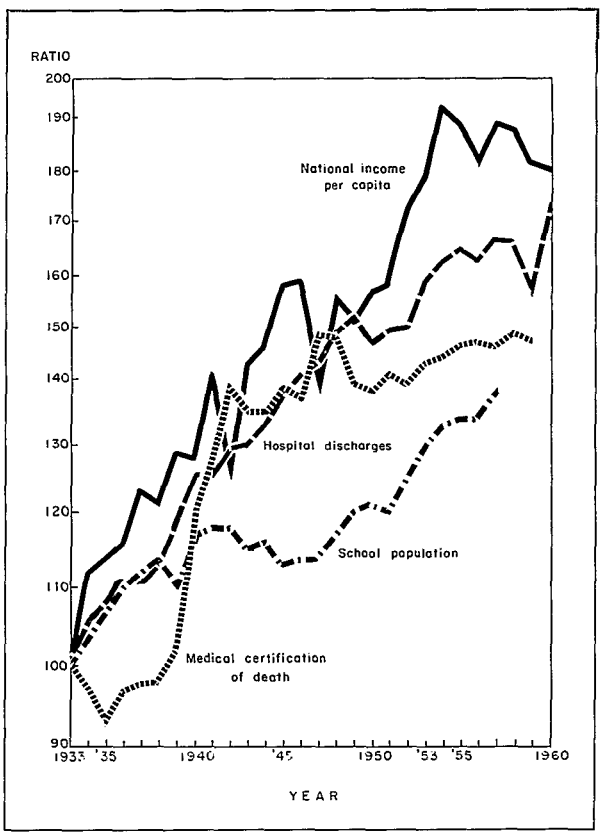

Figure 7. Selected economic, educational, and medical-care indicators: Chile, 1933-60

cent of the population living in a group of provinces that are chiefly rural, with low levels of living, fewer medical resources, and serious health problems where infant mortality varies between 107 and 151 per 1,000 live births.

These facts can be used in the interpretation of data shown in the descriptive part of this study. The remarkable decline of mortality in this country between 1933 and 1953 must be related to success in the partial control of excessive mortality of infective etiology. This success was due chiefly to the use of effective therapeutic means such as sulfa drugs and antibiotics and to health activities (particularly for children) organized as health programs even before the creation of the *Servicio Nacional de Salud* in 1952. These programs included not only medical care but also preventive and health promotion measures. Though the programs did not cover the whole population, they reached large population groups, chiefly in the urban areas.

A good example of this is shown by the slight decline in the rate for tuberculosis mortality during 1937-48. During those years a great number of tuberculosis hospitals had already been built, and there was an organized fight against the disease which included case finding and treatment for many patients. Mortality from this cause shows a stronger decline since the use of streptomycin began in 1948, and it was thus possible to greatly reduce the fatality and shorten the treatment period.

The leveling off of mortality from the group of causes registered in the years 1953-55, which determined the leveling of the total death rate curve, seems to be related to several factors. Health programs have failed to achieve an efficient level and have failed to cover the total population. Areas where medical care has been very limited and mortality very high have become a handicap for the continuation of the decline of the total death rate of the country. For example, the group of predominantly rural provinces mentioned have infant mortality rates surpassing by 75 percent the mortality of the province of Santiago which has many more resources. In some of these areas with no medical care, the infant mortality rate reaches 150 to 200 per 1,000 live births.

However, the interruption in the decline of the general mortality is also found in places like Santiago. This fact suggests a second element in this problem of general mortality in that direct medical activity is more and more restricted in its effect on all diseases which are more directly related to the socioeconomic conditions of the population and to the environment. Such is the case of respiratory and digestive infections; other infective and parasitic diseases, including tuberculosis; and malnutrition—all closely connected in their origin with the level of living of the people.

Figure 6 shows the course of some economic, educational, and medical care indices for the period 1933-60. The economic index is the national income per capita. The educational level is measured by the percentage of the school-age population registered in the schools. Medical indices are the percentage of deaths with medical certification of the cause of death and the number of hospital discharges per 1,000 population. There are several causes of error in these series as shown by some of their irregularities. But when compared with other statistical information and when taken as gross indices, they represent adequately the course of some components of the level of living and of the medical care provided in Chile.

The indices show a sustained advancement for the whole period during which death rates have been declining. While they show that health services provided have continued increasing even after 1954, the per capita income since 1953 tends to level and even to decrease. This is the period when no further progress is registered in the health control of the country.

Recently Ristori *et al.*[4] have published an epidemiological report on measles in Chile showing an increasing mortality rate that is currently five times as great as that in 1953. Their report points out the increasing frequency of fatal pulmonary and laryngeal complications which occur chiefly during the first year of life. They think that this trend is most likely related to malnutrition, which is so frequent at that age, and exposure to cold weather with early infection made possible by unfavorable living conditions, especi-

[4]Ristori, C., Boccardo, H., Borgoño, J.M., and Armijo, R.: "Medical importance of measles in Chile." *American Journal of Diseases of Children* 103:236-241, March 1962.

ally overcrowding. This situation is made worse by the rapid growth of the big city populations. So measles—a benign disease in advanced areas—has come to be associated with 50 percent of the 1960 mortality from acute infective diseases in children, and its death rate was as high as 438.8 per 100,000 population under 1 year of age.

In spite of the great efforts in food control, sanitation, and immunization, the incidence rate of typhoid fever registered in Santiago Province was 70.6 per 100,000 in 1959. By correcting the underreporting of cases, the estimated rate might be twice as high.

Especially illustrative are the results of research on infant mortality according to social classes.[5] The professional care provided at birth either by a physician or a registered midwife was used as an index to the health care received during the first year of life. Social class was established by the occupational status of the father. Both items were obtained from the birth and the death certificates; the results are summarized in the following table:

Type of mortality	Working class with:		Middle class with medical care
	No medical care	Medical care	
	Rates per 1,000 live births		
Infant	157	102	57
Neonatal	49	28	21
Postneonatal	108	74	36

These figures show clearly that even though the medical care provided is correlated with a reduction of infant mortality, the low level of living of the working class determines a high mortality compared with that of the higher socioeconomic strata. This is particularly evident for mortality at ages 1 to 11 months, which depends more directly on the socioeconomic condition of the family group in which the child was born. For the country as a whole, the infant mortality rate was 119.6 per 1,000 population in 1960 in spite of the *Servicio Nacional de Salud* devoting 27 percent of its budget, 23 percent of its hospital beds, and 48 percent of its outpatient department services to maternal and child health programs.

Progress achieved in the past in the control of mortality of infective etiology has given way to a leveling off at high endemic levels. This is because as a result of the conditions of underdevelopment in Chile: (1) the health programs have been unable to provide efficient and complete care for the whole population and (2) the low level of living among large groups of the population leads to unfavorable health conditions which still prevail.

In addition to existing conditions, the earthquake of May 1960 destroyed the South Central Zone. In this area levels of living were already low and the earthquake produced extensive material damages, making the health problems still worse. There was also the influenza epidemic of 1957 which affected the mortality rate for certain age groups (fig. 5).

It is quite possible that the general conditions described above may be similar to those of other countries but in different degrees of underdevelopment, and the relatively better death-registration information available in Chile has made it possible to describe it statistically.

In this respect, all the evidence gathered provides an exciting challenge to remove the fundamental causes of an excessive and avoidable mortality. It also shows the need for planning health activities as a part of the social and economic development of the country.

[5] Behm, H., op. cit.

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DETAILED TABLES

Table 1. Death rates by sex: Chile, 1933-60

[Rates per 1,000 population]

Year	Both sexes	Male	Female
1933	26.0	27.3	24.6
1934	25.7	26.6	24.8
1935	23.9	24.6	23.3
1936	24.0	24.8	23.2
1937	22.7	23.6	21.8
1938	23.1	24.1	22.2
1939	22.9	23.7	22.1
1940	21.3	22.0	20.6
1941	19.4	20.2	18.7
1942	19.9	20.8	19.0
1943	19.3	20.1	18.6
1944	18.9	20.1	17.9
1945	19.3	20.6	18.0
1946	16.6	17.7	15.5
1947	16.1	17.0	15.2
1948	16.7	17.7	15.7
1949	17.3	18.6	16.2
1950	15.0	16.2	13.8
1951	15.0	16.2	13.9
1952	13.0	13.9	12.1
1953	12.4	13.2	11.7
1954	12.8	13.9	11.8
1955	13.0	14.2	11.8
1956	12.1	13.3	11.0
1957	12.9	13.9	11.9
1958	12.2	13.3	11.1
1959	12.7	13.8	11.5
1960	12.3	13.4	11.1

Table 2. Trend of mortality from selected causes: Chile, 1937-59

[Rates per 100,000 population as read from regression lines. Rate for 1953 corresponds to line fitted to years 1953-59. Relative importance of each cause group shown as percentage of total rate]

Year	All causes[1]	Tuberculosis	Other infective and parasitic diseases	Gastritis, duodenitis, enteritis, and colitis	Influenza, pneumonia, and bronchitis	Accidents, poisonings, and violence	Neoplasms	Certain diseases of early infancy	Vascular lesions affecting central nervous system
					Rate				
1937	2,328	262	129	200	567	[2]72	65	232	42
1953	1,267	75	38	35	249	...	...	185	...
1959	1,247	52	48	44	278	79	98	204	59
					Percent				
1937	100	11	6	9	24	3	3	10	2
1953	100	6	3	3	20	...	...	15	...
1959	100	4	4	4	22	6	8	16	5
					Regression slope				
1933-53	-63.8	...	...	...	...	...	...	...	...
1937-48	...	-3.6	...	...	...	...	...	...	...
1937-49	...	...	...	-5.9	...	...	...	...	...
1937-53	...	...	-5.8	...	-20.7	...	...	...	...
1937-59	...	...	...	...	...	...	+1.5	...	+0.8
1940-59	...	...	...	...	...	+0.3	...	...	...
1948-53	...	-27.6	...	...	...	...	...	...	...
1949-53	...	...	...	-25.8	...	...	...	...	...
1953-59	-3.4	-3.7	+1.6	+1.5	+4.9	...	...	...	...

NOTE: Breakpoints for the following causes are: Tuberculosis, 217 (1948); and gastritis, duodenitis, enteritis, and colitis, 138 (1949).

[1]Percentage accumulation of causes with adequate diagnostic information on causes of death: 1959, 69; 1953, . . .; and 1937, 68.

[2]Estimated by 1940-59 regression line.

Table 3. Trend of mortality from selected causes for ages 1-4 years: Chile, 1940-59

[Rates per 100,000 population as read from regression lines]

Year	All causes[1]	Tuberculosis	Other infective and parasitic diseases	Gastritis, duodenitis, enteritis, and colitis	Influenza, pneumonia, and bronchitis
			Rate		
1940	2,607.9	183.1	259.5	546.2	934.0
1953	917.6	32.2	101.6	102.0	375.0
1959	903.9	16.1	140.7	74.1	370.6
			Percent		
1940	100.0	7.0	10.0	20.9	35.8
1953	100.0	3.5	11.1	11.1	40.9
1959	100.0	1.8	15.6	8.2	41.0
			Regression slope		
1940-48	...	-5.5	...	...	...
1940-50	...	...	-16.1	...	...
1940-53	-131.9	...	...	-32.4	-44.4
1948-53	...	-23.5	...	...	...
1950-59	...	...	+6.5	...	...
1953-59	-6.5	-2.7	...	-0.7	-3.7

NOTE: Breakpoints for the following causes are: Total (1953); tuberculosis (1948 and 1953); other infective and parasitic diseases (1950); gastritis, duodenitis, enteritis, and colitis (1953); and influenza, pneumonia, and bronchitis (1953).

[1]Percentage accumulation of causes with adequate diagnostic information on causes of death: 1959, 66.6; 1953, 66.6; 1940, 73.7.

Table 4. Trend of mortality from selected causes for ages 5-14 years: Chile, 1940-59

[Rates per 100,000 population as read from regression lines]

Year	All causes[1]	Tuberculosis	Other infective and parasitic diseases	Gastritis, duodenitis, enteritis, and colitis	Influenza, pneumonia, and bronchitis	Accidents, poisonings, and violence
			Rate			
1940--------	364.3	93.5	42.5	8.5	91.3	27.7
1955--------	143.4	14.6	13.3	2.6	33.1	28.2
1959--------	137.7	5.8	20.1	1.0	41.1	28.4
			Percent			
1940--------	100.0	25.7	11.7	2.3	25.0	7.6
1955--------	100.0	10.1	9.3	1.8	23.1	19.7
1959--------	100.0	4.2	14.6	0.7	29.8	20.6
			Regression slope			
1940-48-----	...	-3.2	...	...	...	...
1940-55-----	-14.4	...	-1.9	...	...	...
1940-56-----	...	...	...	...	-3.6	...
1940-59-----	...	...	...	-0.4	...	+0.03
1948-53-----	...	-9.0	...	...	...	...
1953-59-----	...	-2.2	...	...	...	...
1955-59-----	-0.2	...	+1.9	...	...	...
1956-59-----	...	...	...	...	+3.0	...

NOTE: Breakpoints for the following causes are: Total (1955); tuberculosis (1948 and 1953); other infective and parasitic diseases (1955); and influenza, pneumonia, and bronchitis (1956).

[1]Percentage accumulation of causes with adequate diagnostic information on causes of death: 1959, 69.9; 1955, 64.0; 1940, 72.3.

Table 5. Trend of mortality from selected causes for ages 15-24 years: Chile, 1940-59

[Rates per 100,000 population as read from regression lines]

Year	All causes[1]	Tuberculosis	Other infective and parasitic diseases	Influenza, pneumonia, and bronchitis	Accidents, poisonings, and violence
			Rate		
1940	775.3	341.1	49.4	107.0	79.9
1954	257.9	55.4	11.5	35.4	76.8
1959	235.0	27.4	6.6	33.0	75.5
			Percent		
1940	100.0	44.0	6.4	13.8	10.3
1954	100.0	21.5	4.5	13.7	29.8
1959	100.0	11.7	2.8	14.0	32.1
			Regression slope		
1940-48	-21.0	-7.0	...	...	...
1940-55	...	...	-2.7	-5.1	...
1940-59	...	...	...	...	-0.2
1948-53	...	-41.6	...	...	...
1948-54	-58.0	...	...	...	...
1953-59	...	-5.6	...	...	...
1954-59	-6.3	...	...	...	...
1955-59	...	...	-0.4	+0.2	...

NOTE: Breakpoints for the following causes are: Total (1948 and 1954); tuberculosis (1948 and 1953); other infective and parasitic diseases (1955); and influenza, pneumonia, and bronchitis (1955).

[1]Percentage accumulation of causes with adequate diagnostic information on causes of death: 1959, 60.6; 1954, 69.5; and 1940, 74.5.

Table 6. Trend of mortality from selected causes for ages 25-34 years: Chile, 1940-59

[Rates per 100,000 population as read from regression lines]

Year	All causes[1]	Tuberculosis	Other infective and parasitic diseases	Influenza, pneumonia, and bronchitis	Accidents, poisonings, and violence
			Rate		
1940	989.4	355.0	49.9	121.8	98.9
1953	438.0	92.9	12.9	45.6	102.6
1959	400.8	68.0	7.9	41.2	104.3
			Percent		
1940	100.0	35.9	5.0	12.3	10.0
1953	100.0	21.2	3.0	10.4	23.4
1959	100.0	17.0	2.0	10.3	26.0
			Regression slope		
1940-48	-29.5	-6.6	...	...	...
1940-53	...	...	-2.8	...	...
1940-56	...	...	...	-5.9	...
1940-59	...	...	...	...	+0.3
1948-53	-64.3	-39.6	...	...	...
1953-59	-5.3	-3.4	-0.8	...	...
1956-59	...	...	...	+1.6	...

NOTE: Breakpoints for the following causes are: Total, 1948 and 1953; Tuberculosis, 1948 and 1953; influenza, pneumonia, and bronchitis, 1956; and other infective and parasitic diseases, 1953.

[1]Percentage accumulation of causes with adequate diagnostic information on causes of death: 1959, 55.3; 1953, 58.0; and 1940, 63.2.

Table 7. Trend of mortality from selected causes for ages 35-44 years: Chile, 1940-59

[Rates per 100,000 population as read from regression lines]

Year	All causes[1]	Tuberculosis	Other infective and parasitic diseases	Influenza, pneumonia, and bronchitis	Accidents, poisonings, and violence	Neoplasms	Vascular lesions affecting central nervous system
				Rate			
1940--------	1,240.4	318.3	57.3	161.0	94.4	64.9	35.3
1954--------	720.2	100.6	14.0	62.9	111.8	73.3	30.2
1959--------	651.5	94.2	10.1	71.8	118.0	76.3	24.3
				Percent			
1940--------	100.0	25.7	4.6	13.0	7.6	5.2	2.9
1954--------	100.0	14.0	1.9	8.7	15.5	10.2	4.2
1959--------	100.0	14.5	1.5	11.0	18.1	11.7	3.7
				Regression slope			
1940-48-----	...	-5.2	...	...	...	...	...
1940-53-----	...	...	-3.3	...	...	...	-0.2
1940-54-----	-36.4	...	...	...	...	...	...
1940-56-----	...	...	...	-7.0	...	...	...
1940-59-----	...	...	...	...	+1.2	+0.6	...
1948-54-----	...	-30.8	...	...	...	...	...
1953-59-----	...	...	-0.8	...	...	...	-1.2
1954-59-----	-11.5	-2.4	...	...	...	...	...
1956-59-----	...	...	...	+5.0	...	...	...

NOTE: Breakpoints for the following causes are: Total, 1954; Tuberculosis, 1948 and 1954; other infective and parasitic diseases, 1953; influenza, pneumonia, and bronchitis, 1956; and vascular lesions affecting central nervous system, 1953.

[1]Percentage accumulation of causes with adequate diagnostic information on causes of death: 1959, 60.5; 1954, 54.5; and 1940, 59.0.

Table 8. Selected economic, educational, and medical-care indicators: Chile, 1933-60

Year	National income per capita[1]		Percentage school-age population registered at school[2]		Percentage of medical certification of cause of death[2]		Hospital discharges per 1,000 population[2]	
	Escudos	Ratio	Percent	Ratio	Percent	Ratio	Percent	Ratio
1933	284	100	45.3	100	48.3	100	48.9	100.0
1934	318	112	46.6	103	46.9	97	51.8	105.9
1935	325	114	48.5	107	45.0	93	52.7	107.7
1936	330	116	50.0	110	46.8	97	54.2	110.8
1937	350	123	50.6	112	47.1	98	54.4	111.2
1938	344	121	51.8	114	47.5	98	55.5	113.5
1939	352	124	49.8	110	49.4	102	58.2	119.0
1940	363	128	53.1	117	58.0	120	61.4	125.6
1941	400	141	53.5	118	62.0	128	61.3	125.4
1942	359	126	53.4	118	67.0	139	63.3	129.4
1943	407	143	52.1	115	65.0	135	63.7	130.3
1944	416	146	52.4	116	65.0	135	65.2	133.3
1945	448	158	51.2	113	67.0	139	67.5	138.0
1946	452	159	51.7	114	66.0	137	68.7	140.5
1947	394	139	51.7	114	71.8	149	70.2	143.6
1948	441	155	53.2	117	71.4	148	73.0	149.3
1949	433	152	54.3	120	67.0	139	74.5	152.4
1950	444	156	54.9	121	66.5	138	71.5	146.2
1951	449	158	54.3	120	68.1	141	73.2	149.7
1952	492	173	56.5	125	67.2	139	73.4	150.1
1953	509	179	59.1	130	69.1	143	77.4	158.3
1954	549	193	60.1	133	69.6	144	79.4	162.4
1955	533	188	60.6	134	70.6	146	80.6	164.8
1956	517	182	60.9	134	71.2	147	79.3	162.2
1957	538	189	62.4	138	70.3	146	81.4	166.5
1958	530	187	-	-	72.0	149	81.1	165.8
1959	515	181	-	-	71.1	147	76.4	156.2
1960	510	180	-	-	-	-	84.6	173.0

NOTE: 1933 equals 100.

[1]For 1933-39 based on data provided by the Economic Commission, Latin America; for 1940-60 estimate of Corporación de Fomento de la Producción. Figures refer to escudos of 1960. (1 dollar = 1.058 escudos).

[2]Information taken from Dirección de Estadística y Censos Yearbooks.

APPENDIX

POPULATION

The official data available at the *Dirección de Estadística y Censos* were midyear estimates of the total population by sex for each year from 1933 to 1960, and population distribution by sex and age from censuses taken in 1930, 1940, and 1952, as well as preliminary results of the 1960 census.

Inasmuch as these censuses showed imperfections, age pyramids were adjusted to correct for underenumeration (especially for ages under 4 years) and for preferences in declarations of age. On the basis of these corrected figures, midyear populations for each census year were estimated and apportioned by the above-mentioned official estimates. For the period 1933-51, the population by age and sex was obtained by simple linear interpolation of the corrected censuses. Estimates by age groups and sex for 1953-60 were based on the corrected census of 1952 and the corresponding live births (previously corrected for omission) and deaths.

DEATHS

Three institutions participate in the production of Chilean vital statistics: The *Servicio de Registro Civil,* which is the information collecting body, and two agencies with processing functions—the *Dirección de Estadística y Censos* and the *Servicio Nacional de Salud.*

The *Servicio de Registro Civil* has about 420 local offices which cover the national territory. Compulsory death registration has been in effect for many years in Chile (the law dates from 1884) and is believed to be almost complete. The mortality information collected in the local offices of the *Servicio de Registro Civil* is sent as individual statistical reports to the central processing agencies. The three institutions which make up the system agreed upon the text and design of the death certificate which is in accordance with the recommendations of the United Nations. The data in the statistical report are taken from the medical death certificate, which has agreed with international recommendations since 1953.

The numbers of deaths utilized in this study were officially published by the *Dirección de Estadística y Censos,* with the exception of those for the year 1960; the only available data for this year were supplied by the *Servicio Nacional de Salud.* Preference was also given to official data because they were offered in longer statistical series and with better detailed classification.

Although the vital statistics system provides complete information under most headings, several deficiencies exist concerning statistics for causes of death. Such deficiencies can be attributed to various factors. Not all the deaths are accredited by a medical certificate. The percentage of medical certification in Chile reached 72 percent in 1958. This figure varies in the different regions of the country—95 percent in Santiago Province, where the capital of the country is situated, and only 31 percent in Chiloe, a province with a large rural population. For the cases with no medical certification, the law demands assurance of the death from two lay witnesses. These witnesses usually do not have sufficient knowledge to give adequate information on the cause of death.

Medical certification of causes of death is not always correct. Different studies carried out in Chile have shown errors due to the fact that

the certifying doctor does not always follow official recommendations.[6]

The rules employed for the codification and classification of causes of death have changed during the course of years. Up to 1949, the *Dirección de Estadística y Censos* applied the Fifth Revision of the International Statistical Classification. From 1950 to 1952, a national classification was used, and only in 1953 was there a return to the International Classification (Sixth and Seventh Revisions).

Unfortunately for the purposes of this study, the change of classification in 1953 occurred precisely when the mortality trend was changing. In spite of efforts to obtain comparability in the study of causes, difficulties which could not be overcome caused elimination from the study of some important groups of causes (e.g., cardiovascular diseases). This group was limited to vascular lesions affecting central nervous system because it did not apparently show distortion in classification.

The changes of classification criteria have still another origin in the diversity of criteria used by different officials in applying the rules throughout the years.

Quality of basic information is different for various groups of causes. For example, hypertension has 98-percent medical certification in contrast with other diseases which show 20- to 30-percent certification. This fact brought about the decision to select groups of causes with more than 50-percent medical certification. This reduced the study of specific causes to a portion comprising around 68 percent of the total number of deaths; discarded causes were grouped in a residual category. Moreover, some causes originally selected had to be separately grouped or eliminated because their trend revealed irregularities brought about by changes of criteria previously mentioned.

The percent of medical certification of causes of death in 1959 for the groups under study is the following:

	Percent
Total	71.1
Tuberculosis	82.3
Other infective and parasitic diseases	72.6
Neoplasms	83.5
Vascular lesions CNS	85.5
Influenza, pneumonia, and bronchitis	47.7
Gastritis, duodenitis, enteritis, and colitis	81.3
Maternal deaths	80.8
Early infancy	73.1
Accidents, poisonings, and violence	95.7
All other causes	73.7

In order to have an additional check on the trend of causes of death, these were studied for the provinces of Santiago and Valparaiso, which have more reliable information because of their higher percentage of medical certification with fewer defective certificates. These two provinces register 35 percent of the total deaths in the country. This analysis revealed that the trend of the causes of death which have been studied follow the general trend observed in the country as a whole.

MORTALITY TRENDS FOR SELECTED CAUSES

Cardiovascular Diseases

This group was to include items B22, 24, 25, 26, 27, 28, and 29 of the Abbreviated List of the International Classification of Diseases (Seventh Revision, 1955); rheumatic fever was excluded because of its infrequency and low medical certification as a cause of death. The trend of the group showed little change, with a rate of about 220 per 100,000 population for 1937-50 followed by a decline until 1954, when rates leveled off. This course does not agree with the expected trend of mortality from cardiovascular diseases in Chile.

[6] Pereda, E.: "Estudio de la exactitud de los datos estadísticos de causas de defunción y los procedimientos para perfeccionarlos." A medical student's report to Facultad de Medicina. Universidad de Chile. 1956. (unpublished)

Behm, H., Reyes, A., Taucher, E., and Zenteno, T.: "Problemas de nomenclatura en la clasificación de las defunciones por trastornos nutritivos del lactante." Comunicación al Seminario Internacional de Clasificación de Enfermedades. Caracas, Venezuela. 1957.

A similar situation was observed when the trend was studied for the same causes of death in the provinces of Santiago and Valparaíso, where basic data are of better quality. The analysis of the course of the components of the group showed that although mortality produced by vascular lesions affecting the central nervous system (B22) has a slight and sustained increase in 1937-59, the other disease entities showed the same irregularities as described in the group rate. Furthermore, the figures produced by the *Servicio Nacional de Salud* and the *Dirección de Estadística y Censos* were checked with each other and several inconsistencies were found. Most of these differences were related to changing criteria in the application of the International Classification and the use of a national classification during the years 1950-52.

Consequently, this group, in spite of its numerical importance, had to be excluded from the study. Data referring to the deaths included in B22 had fewer irregularities and might be considered as an index of mortality from cardiovascular diseases.

Certain Diseases of Early Infancy (B42,43, and 44)

For the country as a whole as well as in the provinces of Santiago and Valparaíso, the curve for this group showed a slow decline in the rates of about 50 points up to 1950; a progressive increase was observed afterwards. This trend had no relation to the general curve of total infant mortality in spite of the fact that it was an important cause of this mortality. In order to analyze this disagreement, the three components were studied separately. Birth injuries, postnatal asphyxia, and atelectasis (B42) showed a slight increase which did not appear to be real because the proportion of births under professional care had been increasing during this period. Infections of the newborn (B43) showed a sudden increase in 1950 which coincided with a decrease of similar magnitude in the group of other diseases peculiar to early infancy (B44). Evidently this was due to modifications in the criteria applied in classifying under these headings, which, nevertheless, would not affect the total of the group.

Changes of criteria in codification which might explain the anomalous course of the total curve for 1955 have been analyzed in a study carried out at that time.[7] This study showed that an important part of acute enteric infections, diagnosed as "dyspepsia" by pediatricians, was erroneously attributed to B44. On the other hand, deaths from gastritis, duodenitis, enteritis, and colitis (B36) presented a marked decline beginning in 1949, which can be only partially explained by the introduction of antibiotics at that time. On the basis of the factors previously discussed, it seemed probable that part of this decline was due to the fact that deaths actually belonging to group B36 have been assigned to "nutritional maladjustment" (category 772), and thus mortality classified in group B44 had been artificially increased.

For the purpose of comparison, data originating with the *Servicio Nacional de Salud* were studied, resulting in a curve which generally revealed a trend similar to that of the *Dirección de Estadística y Censos*.

Since the available information had several sources of error, it was obvious that only rough changes should be described. Nevertheless, the overall picture of mortality was consistent with other evidence.

Gastritis, Duodenitis, Enteritis, and Colitis (B36)

The curve for this group showed an initial level of approximately 200 deaths per 100,000 inhabitants, a rate which remained more or less stable up to 1945. Beginning with this year, an irregular decline was initiated, and it was especially stressed in the years 1951 and 1953, after which little change was evident. The level of this last period was a rate of about 40 per 100,000 population. The knowledge of the health conditions of the country especially in relation to deficient

[7] Behm, Reyes, Taucher, and Zenteno, op. cit.

sanitation and high infant mortality rate, a part of the latter being due to this group of causes, made the accuracy of the actual rate doubtful.

The comparative study of these data with those of the *Servicio Nacional de Salud* showed an important difference in the number of deaths. Classification rules were followed more carefully at the *Servicio Nacional de Salud* for this group of causes, suggesting that their figures presented a truer picture. Unfortunately, the series published by this service were too short for this study. However, there was evident leveling off of the trend in recent years at a rate of approximately 80 per 100,000 population.

Other Causes

This heading covered the remaining groups of causes, some of which had numeric importance but the quality of cause certification did not permit analysis. This group amounted to 32 percent in 1937 and 31 percent in 1959 and was another factor which limited analysis of causes of death in Chile.

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