

AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523
BIBLIOGRAPHIC INPUT SHEET

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Batch 46

1. SUBJECT CLASSIFICATION	A. PRIMARY	TEMPORARY
	B. SECONDARY	

2. TITLE AND SUBTITLE
Patterns of mortality in childhood, report of the inter-American investigation of mortality in childhood

3. AUTHOR(S)
Puffer, R.R.; Serrano, C.V.

4. DOCUMENT DATE 1973	5. NUMBER OF PAGES 44p.	6. ARC NUMBER ARC
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7. REFERENCE ORGANIZATION NAME AND ADDRESS
PAHO

8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)
(Excerpted from Patterns of Mortality in Childhood, Report of the Inter-American Investigation of Mortality in Childhood, Scientific pub. PAHO no. 262, 1973, 480p.)

9. ABSTRACT

(HEALTH R & D)

10. CONTROL NUMBER PN-AAC-995	11. PRICE OF DOCUMENT
12. DESCRIPTORS	13. PROJECT NUMBER
	14. CONTRACT NUMBER CSD-1431 Res.
	15. TYPE OF DOCUMENT

PATTERNS OF MORTALITY IN CHILDHOOD

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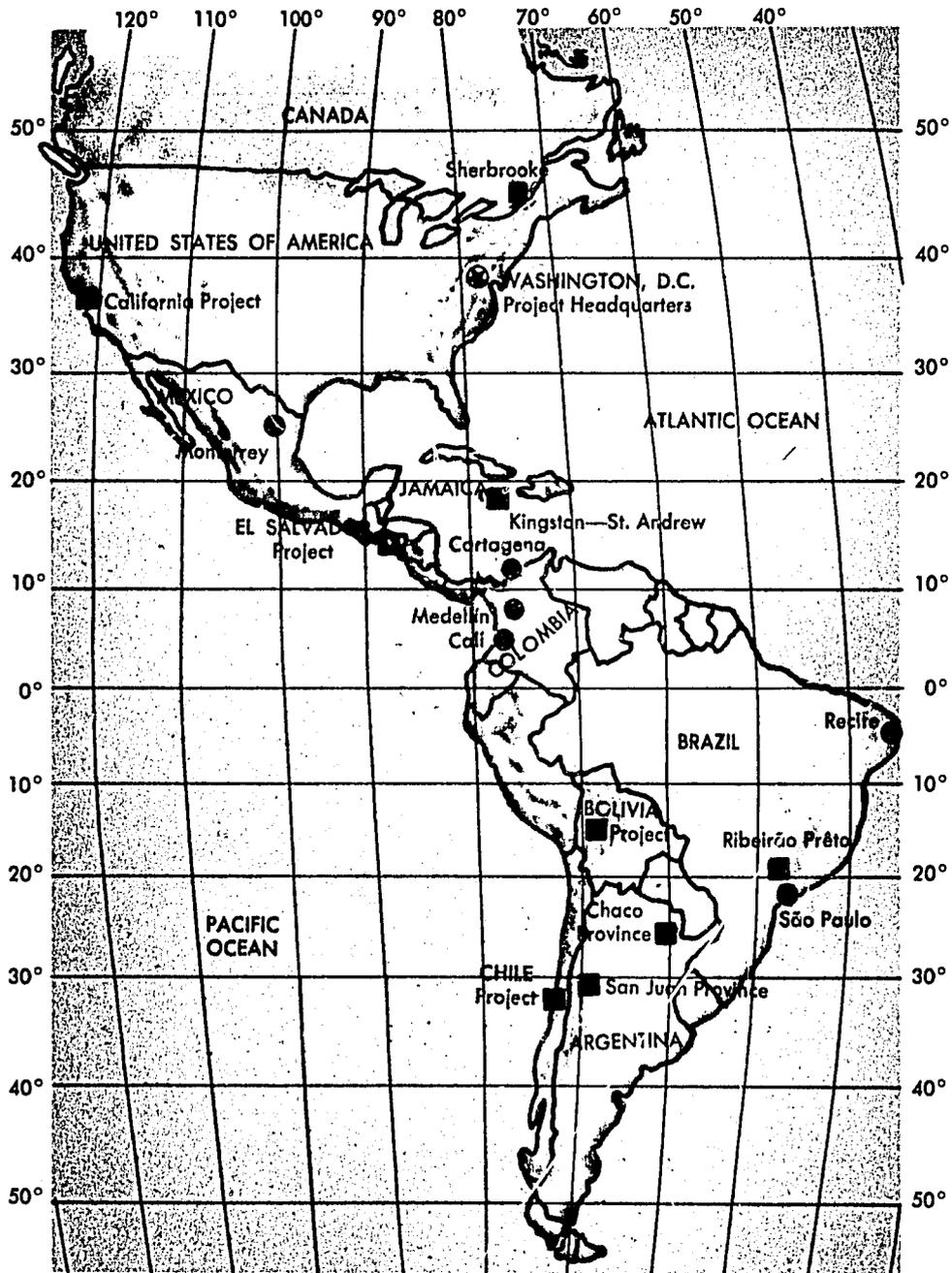


EXCERPTS

**PAN AMERICAN HEALTH ORGANIZATION
Pan American Sanitary Bureau, Regional Office of the
WORLD HEALTH ORGANIZATION**

1973

Fig. 1. Location of 15 Projects in the Inter-American Investigation of Mortality in Childhood.



All material in this pamphlet, including tables and figures, was taken from the book *Patterns of Mortality in Childhood—Report of the Inter-American Investigation of Mortality in Childhood* (Scientific Publication PAHO No. 262, 1973, 480 pp.).

PATTERNS OF MORTALITY IN CHILDHOOD

*Report of the Inter-American Investigation of Mortality in Childhood**

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*This research project was made possible by a contract between the Agency for International Development of the United States of America and the Pan American Health Organization.

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Foreword

Much remains to be learned about the natural history of health and disease in the Americas and in other Regions of the world. We do not know why diseases occur or do not occur at a given time and place. Even less do we know what conditions and circumstances cause them to spread within a country and between countries in the Hemisphere. Indeed, accurate knowledge of the etiology of a specific disease does not tell us about the sequence of events that produce it. Today we accept the fact that multiple causes are involved in the development of disease. To identify each one—in particular the causative agent—to determine how these causes interact or interfere with one another, is the task of modern epidemiology. The task is even more complex when the same disease is investigated in different societies, with a view to comparing the factors involved and their effects on morbidity and mortality, on health, and on well-being.

The last ten years have forced us all to think and act ecologically, that is, to consider the interrelationships of man and his immediate and mediate environment. In this way we can better interpret vital phenomena and many of the events of every day life and of social life. This approach is a true return to the past. In the middle of the last century Spencer, in his *Biology*, "takes for his keynote his conception of life, as having for its chief characteristic a continuous adjustment of the organism to its environment, of its internal to its external relations. So structure follows upon function and functional need, and hereditary transmission hands on to the next generation the advances that the past generation has made: life produces organization, and not organization life."*

These reflections may serve to introduce the Inter-American Investigation of Mortality in Childhood because they are pertinent to its purposes and its results. For many years we have said that mortality is due to a constellation of causes, predominant among which are infectious diseases, malnutrition, lack of basic sanitation, ignorance which often goes beyond illiteracy, and a low average family income which deprives individuals of the benefits that modern

* D'Arcy W. Thompson: "On Aristotle as a Biologist; with a Prooemion on Herbert Spencer." The Herbert Spencer Lecture delivered before the University of Oxford, 14 February 1913. In: *Toward Modern Science. Studies in Ancient and Medieval Science*, Vol. 1. Edited by Robert M. Palter. New York, The Noonday Press, 1961, page 62.

technology continues to contribute. We have pointed out that child mortality, and in particular infant mortality, is the most sensitive indicator of the degree of underdevelopment of a community. Furthermore, medical technology cannot be asked to resolve social situations on which it has no influence.

We recognize that these reflections bear on causes whose true magnitude and implications we were unable to evaluate. It was for that reason that we undertook this Investigation, the results of which we are now pleased to submit to the Governments, the universities, and students of child mortality—today the most important health problem in the Americas, where in most of the countries young persons under 15 years of age comprise no less than 40 to 50 per cent of the population, and mothers and children together, 63 per cent of the total.

Today, the Governments are aware that the progressive solution of this problem, based on its multiple causation, represents a very tangible contribution to well-being and economic development. Hence the great importance of this publication. It shows us objectively—using an ecological approach—the imperative need to analyze and to deal as a whole with the factors involved in the morbidity and mortality of mothers and children. Among the deaths analyzed nutritional deficiency appears to be the most serious health problem. When it accompanies low birth weight, the two together endanger survival and jeopardize the growth and development of the newborn child. The more serious the malnutrition of mothers, the more uncertain the future of their children. And the greater the number of offspring, the more serious the risk to the mother and her child.

This study undeniably confirms the synergism between infection and nutritional status, which highlights the priority of immunization programs against specific diseases. Moreover, breast feeding, the educational level of mothers, and the availability of water in the home directly influence the decline in the incidence of various diseases, mental retardation, and mortality. And it is only logical that there should be an inverse correlation between mortality in children and their perinatal care as well as prenatal care of mothers.

These circumstances further substantiate the need for rational family planning, founded on the parents' sense of responsibility for the well-being of their children.

As the study shows, official statistics do not completely disclose the true magnitude of health problems, a fact that is reflected in the plans, programs, and projects that are formulated. Through the training of statisticians and their auxiliaries, greater efforts should be made to improve the quality of data, to lay the foundation for the more rational use of resources, to evaluate the activities undertaken and the social effects achieved. The effectiveness of such a statistical system, however, will depend essentially on the medical profession's interest in bringing about improvement in the clinical records, through the registration of all data derived from medical diagnoses.

Once again, a significant difference is disclosed between rates of morbidity

and mortality in urban areas and rural areas, the latter being in a much more disadvantageous position. This fact should come as no surprise, for at least 37 per cent of the population do not have access to a minimum health service. There are about 100 million persons living in overcrowded conditions on the outskirts of the major cities, drawn to them by their mirage effect, or living in communities (some viable, some not) in rural areas. For the gradual solution of these problems a rational strategy has been drawn up and is set forth in the Ten-Year Health Plan for the Americas for the period 1971–1980.*

The publication of the findings of this Investigation could not be more timely because they give even greater relevance to the maternal and child health objectives the Governments have committed themselves to achieve together in this decade. What is more, the information collected and carefully analyzed will be of great importance for education in the health sciences of both professional and auxiliary health workers, in the sense of harmonizing theory and practice, with the active participation of students in the identification, elucidation, and solution of community problems.

This work represents a continuation of that devoted to the study of mortality in adults, the report on which was published in 1967 under the title *Patterns of Urban Mortality*.† Both are real studies in comparative epidemiology, essentially international in nature, whose methods have served as a model for other similar studies. Properly interpreted, the data give a truer picture of the natural history of the prevalent diseases in the Americas, in both the technologically advanced and the developing societies. They supplement the official statistics, provide guidance on the use of modern techniques and procedures, and contribute to social well-being.

We should like to express our appreciation to the Governments for their support and understanding, to the investigators who participated with such dedication in this important endeavor, and to the Agency for International Development of the United States of America, whose financial contribution made this undertaking possible.

We are confident that the valuable experience gained will serve as a basis for new studies in the Americas and in other Regions of the world, and will contribute to a reform of the teaching and learning process in the health field and to a better knowledge of actual conditions, in order that the goal of improving the well-being of mothers and children may be achieved.

ABRAHAM HORWITZ
Director, Pan American
Sanitary Bureau

* *Official Document PAHO 118* (1973).
† *Scientific Publication PAHO 151* (1967).

Chapter I

Origin and Initial Phases

One of the goals established by the nations of the Hemisphere in the Charter of Punta del Este (1961) was to reduce mortality in children under 5 years of age by one half in a 10-year period. This has proved to be a great challenge in the years since the Charter was signed.

The Inter-American Investigation of Mortality in Childhood, a collaborative research project coordinated by the Pan American Health Organization on a conti-

mental scale, has provided an excellent mechanism for exploring in depth the causes of excessive mortality in infancy and early childhood in the Americas, as well as the interrelationships of multiple causes and associated factors. The principal findings of this extensive community-centered program, carried out in the period 1968-1972, should serve as the basis for renewed efforts to improve health conditions in a major segment of the population of the countries.

OBJECTIVES

The overall objective of the Investigation was to carry out in selected communities of the Americas research projects designed to establish death rates for infancy and childhood that would be as accurate and comparable as possible, taking into account biological as well as nutritional, sociological, and environmental factors. In order to analyze both underlying and associated causes of death and to study interrelationships of diseases and other conditions, complete data were to be obtained on deaths in children under 5 years of age in accordance with standard definitions and procedures. To relate mortality to biological and other factors, considerable information was required regarding the home, the environment, the parents, practice of breast

feeding, and provision of health care.

As a basis for evaluating the many factors involved, a specific objective was to study the reproductive history of mothers, ascertaining the relationships of variables such as age of mother, birth order of deceased infant, and previous reproductive wastage.

In order to better understand and plan for the solution of problems in childhood in the Americas, one of the goals was to study mortality in rural as well as urban areas.

In keeping with the new emphasis placed by health authorities on strengthening medical research, one of the aims was to stimulate the interest of schools of medicine and public health and involve them in the studies.

THE FIFTEEN PROJECTS

The Investigation was conducted in 13 projects in Latin America during the period 1968-1971, in an additional project carried out in the United States in California in 1969-1970, and another in Canada in Québec Province in 1970 and 1971. Six of the projects were strictly urban while the other nine encompassed rural and/or suburban as well as urban areas.

The wide distribution of the 15 projects over the Americas can be seen on the map in Figure 1 (frontispiece). The Sherbrooke project in Québec Province has the northernmost location, while the Chilean project has the southernmost, lying at the other end of the Hemisphere. The six projects shown by circles are confined to cities, while the other nine shown by squares include suburban and/or rural areas.

Chapter II

Collection and Quality of Basic Data

The basic goal of obtaining mortality statistics as accurate and comparable as possible proved a far greater task than was expected. Many deficiencies in hospital records and procedures and in registration systems were uncovered. Also the lack of standardization in use of terms such as abortion, stillbirth, and live birth was found to be serious enough to invalidate many

previous comparisons of neonatal and infant mortality and likewise of life expectancy for countries of the world.

The widespread misuse of terminology indicates the need for international agencies and the medical profession in general to assume a role of greater leadership in both establishing definitions and promoting their application.

COLLECTION OF DATA

In each project the principal collaborator directed a team of medical interviewers, public health nurses or social workers, and others who assisted in the field work.

The 27-month schedule for field work was divided as follows: one month of preparatory work and trial interviewing; 24 months for collection of data on deaths and sampling of households; and two months for completion of the program. The three types of data collected were: (1) information on deaths under 5 years of age among residents of the area for 24 consecutive months, recorded on questionnaires; (2) samples of households, using questionnaires for data on families and on living children under 5 years, with two to four sampling units completed per month for the same 24 consecutive months; and (3) complete file of live births among area residents for the same two years.

Early in the program, deficiencies in registration of deaths occurring in the first day of life were noted in several projects.

Measures for evaluating the completeness of registration were introduced early in the Investigation.

The death rate of 10 per 1,000 live births served as a measure for judging completeness of inclusion of deaths occurring in the first 24 hours of life, the critical period and probably the one providing the best indicator of completeness of registration and utilization of the WHO definition of live birth.

Even though intensive efforts were exerted to secure information on all deaths in early life, provisional analyses indicated the incompleteness of the data in many projects. Additional searches were made to discover deaths that had escaped the registration process.

The analysis of neonatal mortality on the basis of birth weight provided another method of evaluating the comparability of results.

The efforts made by the staff to obtain results as complete as possible were extensive and rewarding.

In future research programs in which infant mortality is to be studied, a method of obtaining data on the outcome of each pregnancy should be introduced in the planning phase.

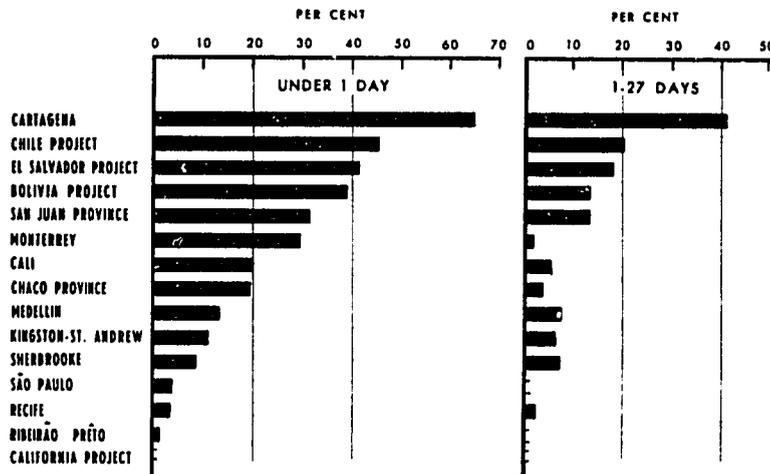
REGISTRATION OF DEATHS

For the two years of the Investigation, 35,095 deaths of infants and other children under 5 years of age were studied in the 15 projects.

Of the total of 35,095 deaths, 32,700 or 93.2 per cent were believed to have been registered and thus included in the official

statistics. In the thirteen Latin American projects the percentages varied from 79.8 to 99.6, with five projects having less than 90 per cent registered. Each principal collaborator uncovered deaths that had not been registered; several introduced intensive searches to find such missing deaths.

FIG. 2. Percentage of Neonatal Deaths Without Registration in Two Age Groups in 15 Projects.



In Sherbrooke 94.3 per cent of deaths were registered, and in California death certificates were the only source of information used since a search for unregistered deaths was considered unnecessary. The present report includes all deaths that were known, both registered and unregistered.

Within the neonatal period (Figure 2), deaths in the first day of life were the most seriously affected by underregistration, with those unregistered reaching 10 per cent or more in 10 projects. Of the deaths within 1-27 days, registration was lacking for 10 per cent or more in five projects.

SOURCES OF MEDICAL DATA

Efforts were made to obtain a complete record of the past history and fatal illnesses of the child, results of laboratory and other examinations, and autopsy findings in order to determine the underlying and associated causes of death, that is, the multiple causes. This approach has made it possible to establish important interrelationships as well as a precise measurement of high-risk conditions such as immaturity and nutritional deficiency.

The medical interviewers obtained information from hospitals, clinics, private physicians, and autopsy records; if no medical attention had been provided or if no satisfactory record was available, a visit was

made to the family to obtain pertinent data.

Even if the death occurred in a hospital, in certain areas some of the records had been lost or were incomplete. In contrast the quality of medical records was excellent in several projects such as those in San Juan Province, Argentina, and Cartagena, Colombia. These differences in the success of obtaining additional information, and the variation in quality of medical records, have to be taken into account in interpreting the data.

In the planning phase as well as during the course of the Investigation, emphasis was placed on the value of pediatric pathology.

Chapter III

Birth Weight

One of the intriguing findings of the Investigation in regard to neonatal mortality was the unusually high proportion of deaths of infants of low birth weight.

The evaluation of the nutritional status of infants and children must begin with their status at birth, and the most satisfactory and essential measurement is birth weight.

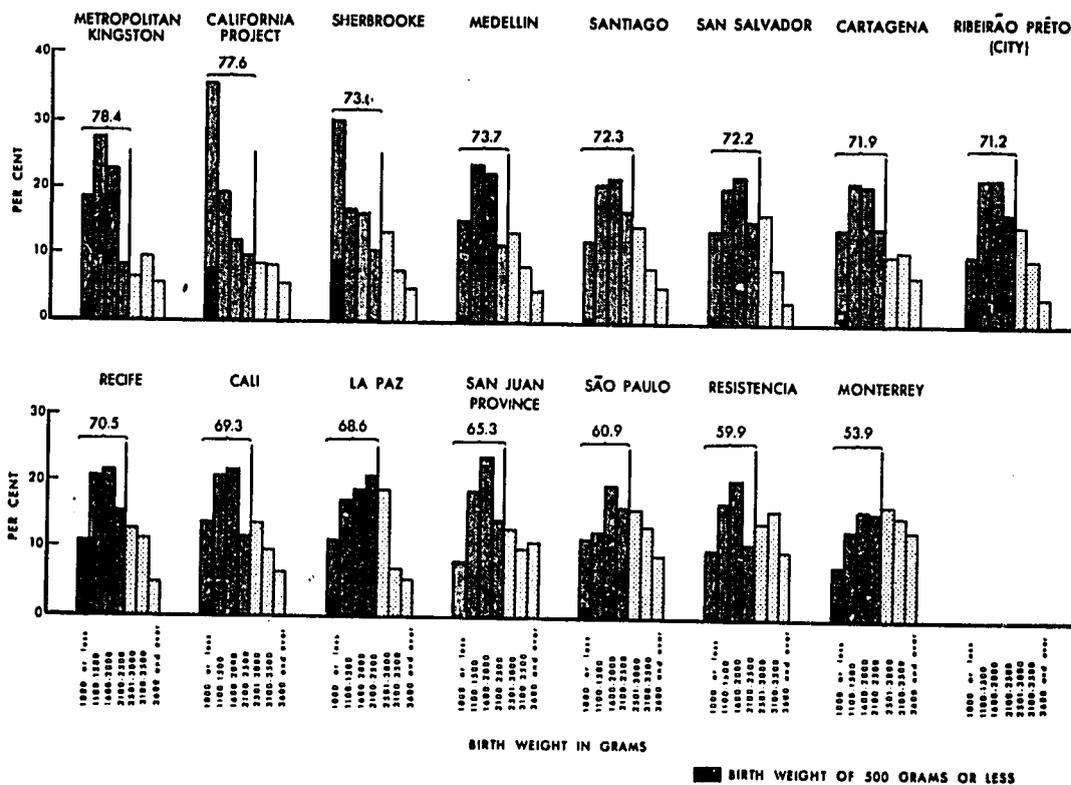
The data on birth weights in the projects, as presented in this chapter (as well as in others), are puzzling and yet indicate the

great potential value of such information. Birth weight, as an important component of the health condition of the child at birth, should be obtained routinely as it determines the chances of survival as well as the management required in terms of medical care. In the collection of data of this type the first requirement, if international comparisons are desired, is to adhere to the same definitions of a live birth and a fetal death. If true and significant differences are established, the next step is exploration in depth of the causes of such differences.

DISTRIBUTION OF NEONATAL DEATHS BY WEIGHT AT BIRTH

The distribution of neonatal deaths for seven birth-weight groups for 15 areas (Figure 3) reveals important differences. For the low-weight group of 2,500 grams or

FIG. 3. Distribution of Infants Dying in Neonatal Period Born in Hospitals, by Birth-Weight Group, in 13 Cities and Two Projects.*



* The percentages for birth weights of 2,500 grams or less are indicated above the bracketed four low-birth-weight groups.

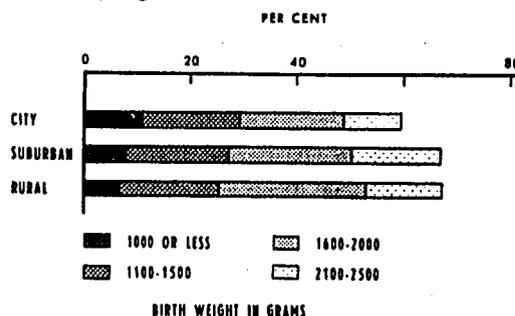
less, the variation is from 53.9 per cent in Monterrey to 78.4 per cent in Metropolitan Kingston. Figure 3 shows the percentage distributions in the 15 areas, in descending order according to the proportions falling in the low-weight group of 2,500 grams or less.

The percentages of neonatal deaths in the birth-weight groups 1,100-1,500 grams and 1,600-2,000 grams were relatively high in many Latin American projects. These distributions differed markedly from those in California and Sherbrooke. Also the relatively small numbers of neonatal deaths of infants weighing 2,501 grams or more at birth are puzzling.

The numbers of neonatal deaths in the three subdivisions of San Juan Province were sufficient to allow for consideration of differences (as is shown in Figure 4). In the rural departments, 67.1 per cent of these deaths had birth weights of 2,500 grams or less, while the figure for the city of San Juan was 59.5 per cent. In the lowest weight group (1,000 grams or less) there may be a slight deficiency in the number recorded in these rural departments, as the percentage of 6.4 was lower than in the other areas; some deaths may have been missed if the infants were born at home and death certificates were not filed. If complete data were available, the percentage of low-birth-weight infants might be even higher in the rural area.

These findings suggest that low-weight births which in turn become neonatal deaths may be more frequent in the rural area than in the city. As the facilities for saving prematures would be greater in the urban centers, these lower percentages in rural areas indicate that probably other factors could be responsible for low-weight births. As pointed out by Birch (1972) and also as has been found in the rural villages of the study in Guatemala (Lechtig *et al.*, 1972), nutritional status of the mother is one of the factors.

FIG. 4. Percentage of Neonatal Deaths with Low Birth Weight* in Three Areas of San Juan Province, Argentina.



*Births in hospitals with weight stated.

The data presented on birth weights of infants dying in the neonatal period are puzzling and indicate the need for collection and analyses of birth weights for all live births in urban and rural areas in the Hemisphere. Study of mortality could then be made taking into account factors responsible for true differences. The data indicate gaps in our knowledge and important fields for further research in Latin America.

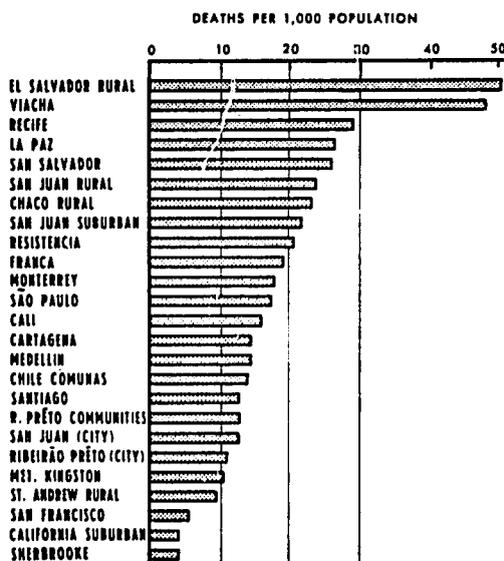
The frequency of low-weight births has been presented as background information because of the important implications of this factor in terms of the child's future growth and development, susceptibility to infection, and chances of survival. Some of these implications are considered in later chapters. Knowledge of true differences in distribution of birth weights for all births and infant deaths in cities and countries is limited at present. Also the relationship of low birth weight to other factors cannot be established because of the lack of good-quality data. Therefore continued efforts are needed so that all the important information will be recorded for each birth and death. In addition, research in this field involving rural as well as urban populations is essential in order to establish bases for sound preventive action.

Chapter IV

Mortality in Childhood

Mortality in the period from birth to 5 years of age is discussed first in general terms to illustrate the variations found in urban, suburban, and rural areas of the 15 projects. In all, there are 25 distinct areas and these are shown in Figure 5 according to size of the death rates, which

FIG. 5. Mortality Under 5 Years of Age in 25 Areas of 15 Projects.



descend from the extreme high of 50.5 per 1,000 population to the low of 4.1.

The rural *municipios* in El Salvador and Viacha in Bolivia had death rates of the order of two times those in the nearby cities. Also in San Juan Province, mortality in the rural and suburban departments was nearly double that in the city of San Juan. It is probable that in many areas of Latin America death rates in rural sectors are at least twice as high as those in cities.

The three areas with the lowest death rates under 5 years of age were those with the lowest estimated birth rates and likewise the lowest infant death rates. On the other hand, those with the highest death rates under 5 years had the highest birth rates and highest infant death rates. One explanation for part of the excessive mortality is that high birth rates imply many infants of high birth order, among whom mortality is high. Other factors (such as limited breast feeding, very little prenatal care, and lack of water supplies) which will be evaluated in this report also contribute to these wide variations.

INFANT MORTALITY

Of the 35,095 deaths under 5 years of age studied in the Investigation, 78.6 per cent (27,602) occurred in infancy, that is, in children under one year of age. The variation in these infant death rates is great—from 17.2 per 1,000 live births in the suburban counties of California to rates in excess of 100 per 1,000 in two rural areas (Viacha in Bolivia, and rural *municipios* in

El Salvador). Nearly all of this variation occurs in the postneonatal rates (28 days-11 months), which ranged from 4.5 in suburban counties of California to 83.9 in the rural *municipios* of El Salvador. This high postneonatal mortality is due principally to infectious diseases and nutritional deficiency, and it indicates the impact of those serious health problems.

TABLE 1. Distribution of Deaths by Age Group for 15 Projects Combined.

Age group	Deaths	%
Under 5 years.....	35,005	100.0
Under 1 year.....	27,602	78.6
Neonatal.....	12,674	36.1
Postneonatal.....	14,928	42.5
1-4 years.....	7,493	21.4
1 year.....	4,361	12.4
2-4 years.....	3,132	8.9

The multiple causes involved in these excessive death rates are being clarified.

Mortality in the neonatal period showed much less variation, ranging from 12.7 per 1,000 live births in suburban counties of California to rates three and four times higher—44.6 in suburban departments of San Juan Province and 49.4 in Viacha. The first four weeks of life constitute a crucial period for the child's growth and development.

COMPARISONS WITH OFFICIAL DATA

Several factors affect comparisons of the death rates obtained in the Investigation with those published in official reports. In the first place, the data of the Investigation are based on place of residence of the deceased, both for deaths (the numerator) and for live births (the denominator of infant death rates).

Death rates in infancy and early childhood for 1969 or a recent year for eight of the countries were used for comparisons. These countries vary widely in the composition of their urban and rural populations, which affects the size of the rates. Also the coverage of the registration systems needs to be considered in relation to the Investigation findings. An example of the usefulness of this type of comparison is given for El Salvador.

The infant death rates found in the Investigation in the city of San Salvador and in the rural *municipios* (Table 2) were

TABLE 2. Death Rates* Under 5 Years by Age Group in Two Areas of the Investigation in El Salvador, and Official Rate for El Salvador.

Area	Under 5 years	Under 1 year	1-4 years
Investigation			
San Salvador.....	26.4	81.7	8.0
Rural <i>municipios</i>	50.5	120.0	26.2
Official data, 1969			
El Salvador.....	24.4	63.4	13.2

* Deaths under 1 year per 1,000 live births; others per 1,000 population.

much higher than the rate for the country. The rate of 120.0 per 1,000 live births for the rural *municipios* was 47 per cent higher than that for San Salvador (81.7), which in turn was 29 per cent higher than the rate for the country in 1969 (63.4). The rural *municipios* (Apopa, Nejapa, and Quezaltepeque) are close to the city of San Salvador and do not represent the rural populations of the country since they have access to the facilities available in the capital city. Therefore, mortality in rural El Salvador may be much higher.

These comparisons of the Investigation findings with official data indicate several fields for action:

1. Procedures should be established in local areas for ensuring registration of each birth and each death.

2. For an accurate knowledge of mortality in cities, it is necessary to have data by place of residence, both for deaths and for births, since hospital facilities of cities are used by residents of other urban communities and rural areas.

3. The excessive death rates found in rural areas in the Investigation indicate the need to extend registration systems to cover such areas, or to obtain data by alternative methods such as sampling, in order to make available basic information required for the solution of serious health problems.

Chapter V

Infant Mortality

The dynamic and complex process of growth and development is the outstanding characteristic of the early life of the infant (as it is of the rest of childhood).

The interrelationships of factors affecting the mother, the fetus, delivery, and post-natal development constitute an extremely important field for analysis in the study of multiple causes and conditions responsible for morbidity and mortality.

The assignment of causes was based on all the information available for each death. The starting point was selection of the *underlying cause* of death in accordance with the definition and the rules for selection and modification set forth in the *International Classification of Diseases*. The group of associated causes comprises both the contributory and the *consequential* causes, or consequences.

The infant is at greatest risk of death in the first few hours and days of life, and mortality declines rapidly from high rates in the first day to the lowest ones later in childhood. Of the 35,095 deaths under 5

years of age subjected to thorough study of multiple causes and related factors, 27,602 or nearly four-fifths (78.6 per cent) were of infants. The infant period is divided into neonatal (0-27 days of age) and post-neonatal (28 days through 11 months). More than a third of the deaths of children under 5 years were neonatal deaths (12,674, or 36.1 per cent).

In several areas deaths under 5 years were heavily concentrated in the neonatal period, accounting for more than 60 per cent in three areas in Canada and California:

	Per cent
California, suburban counties	63.7
San Francisco	62.8
Sherbrooke	61.7

At the other extreme, the following four areas had very low percentages in the neonatal period:

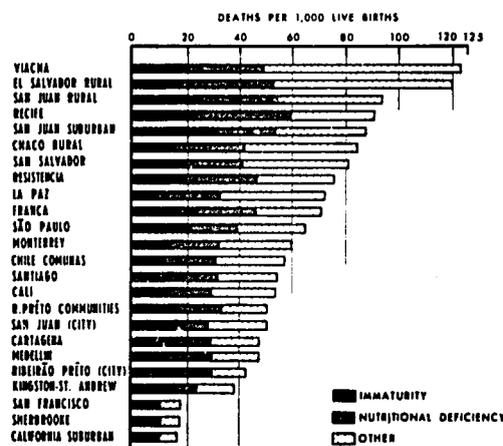
	Per cent
San Salvador	26.4
Viacha	26.1
La Paz	25.5
El Salvador, rural	18.0

ROLE OF IMMATURETY AND NUTRITIONAL DEFICIENCY

Immaturity and nutritional deficiency constitute deficits in growth and development during intrauterine and early life. The data on these causes have been processed so as to make only one assignment for each, immaturity (777) or nutritional deficiency (260-269). It is thus possible to obtain the number of infant deaths in which one of these causes is present.

If the deaths from these two causes are combined (immaturity and nutritional deficiency) it can be seen that relatively high proportions of infant deaths have this important evidence of insufficient growth and development. In fact, in nine areas the number of infant deaths with these condi-

FIG. 6. Immaturity and Nutritional Deficiency as Underlying or Associated Cause in Infant Mortality in 24 Areas of 15 Projects.



tions as a cause was at least 40 per 1,000 live births. In Recife the rate was exceedingly high—59.7 per 1,000. These high rates point clearly to the need for preventive measures to combat these serious conditions.

Figure 6 shows the marked variation in infant death rates in which immaturity and nutritional deficiency were causes. Infants with such evidence of deficiency are highly susceptible to infectious diseases. It is thus

evident that action to improve the nutritional status of infants must include prevention of low birth weight as well as measures to ensure satisfactory growth after birth. In other words, prevention at the primary level should be emphasized by concentrating efforts on adequate care of women at risk of giving birth to a low-weight product.

UNDERLYING CAUSES OF NEONATAL AND POSTNEONATAL MORTALITY

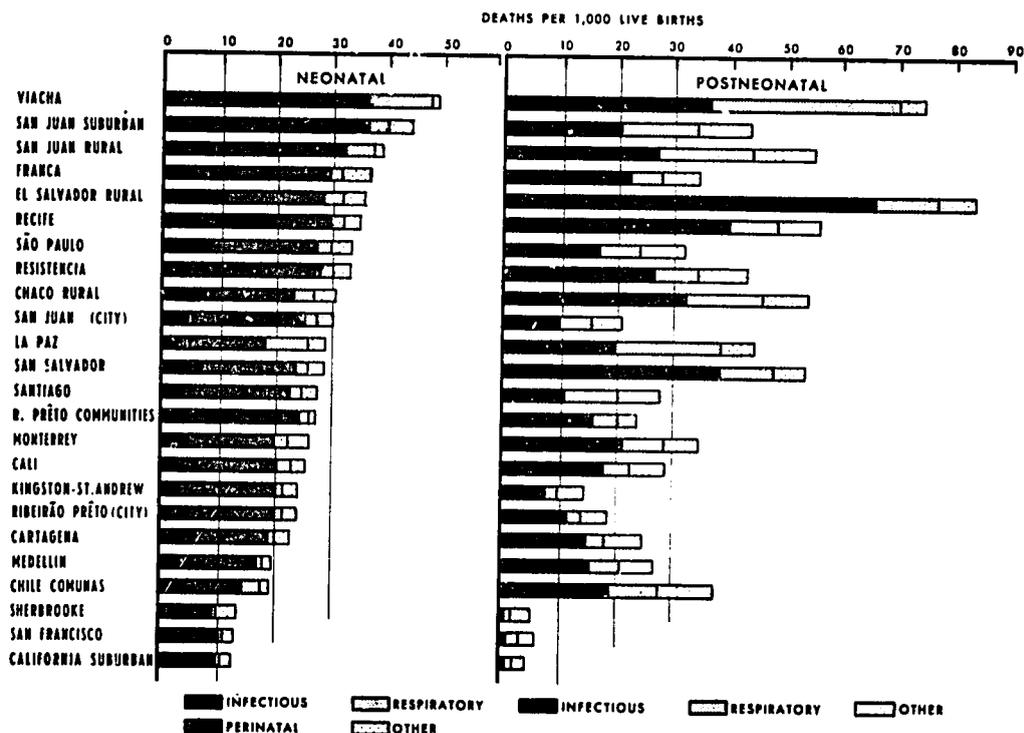
The underlying causes of death in the neonatal period are distinctly different from those in the postneonatal period. Neonatal death rates are shown in the left section of Figure 7 for 24 areas, in descending order.

For these two age groups the principal underlying causes are shown in Figure 7. In the neonatal period more than half the

deaths were included in the group of certain perinatal causes. Infectious diseases were responsible for death rates of at least 5 per 1,000 live births in eight areas.

In the postneonatal period the death rates from infectious diseases were high in many areas. Rates were in excess of 20 per 1,000 live births in four cities as well as in six other areas.

Fig. 7. Certain Causes of Neonatal and Postneonatal Mortality in 24 Areas of 15 Projects.



Chapter VI

Neonatal Mortality

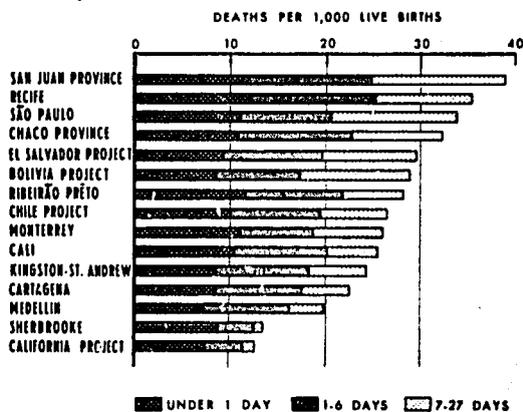
The neonatal age period encompasses the first 28 days of life. The context of neonatal morbidity and mortality is therefore highly complex, involving the action of multiple factors that may go back into pregnancy and even earlier and have health implications extending beyond the neonatal period, often through a lifetime.

The health status of the mother before and during pregnancy, as well as the risks of labor and delivery, are important determinants of the condition of the product of conception.

The study of underlying causes in the two age groups of the neonatal period (under 7 days and 7-27 days) reveals important differences (as is seen in Figure 8). As expected, the perinatal causes were found to play a predominant role in mortality in the first week of life.

Mortality in the neonatal period varied greatly. The rates per 1,000 live births ranged from 12.7 and 13.5 in the California and Sherbrooke projects to 38.8 and 35.3 in San Juan Province and Recife (Figure 8).

FIG. 8. Neonatal Mortality by Age Group in 15 Projects.



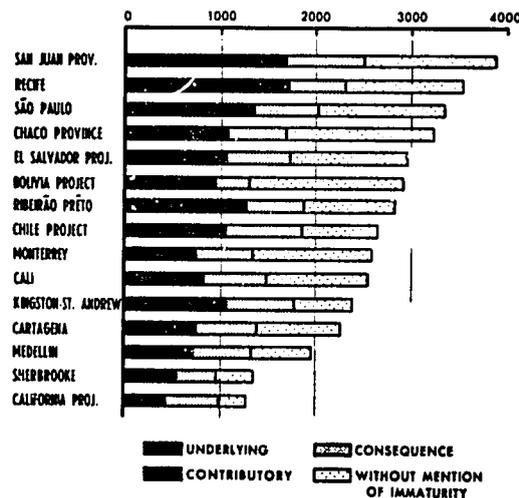
The Investigation findings revealed that *immaturity* is a very serious problem in many areas of Latin America. This condition can be considered the most important factor in vulnerability to disease and death in the neonatal period. Its involvement as

underlying or associated cause of death was found to be limited principally to that age period.

Neonatal mortality with immaturity as an underlying or an associated cause is shown in Figure 9, in which the associated causes are divided into those in which immaturity was contributory and those in which it was a consequence of maternal or other conditions in pregnancy.

The rates for immaturity as underlying or associated cause ranged from 978.2 per 100,000 live births in Sherbrooke to 2,474.3 in San Juan Province, a rate 2.5 times as high. In all the Latin American projects the rates were higher than in the Northern American projects.

FIG. 9. Immaturity as Underlying or Associated Cause of Neonatal Mortality in 15 Projects.



The reasons for these intriguing findings are not known. It is clear from the data on nutritional deficiency that this condition of high susceptibility is also frequently found as an underlying or associated cause in these same suburban and rural areas. Therefore, the possibility exists that in these areas low birth weights are more common than in urban areas of the same projects owing to the unfavorable nutritional state of mothers.

Chapter VII

Mortality in Early Childhood

The excessive mortality recorded in Latin America for early childhood (as well as infancy) led to the specific recommendations for action that were adopted by the countries in the Charter of Punta del Este (Organization of American States, 1961). The period of early childhood (age 1-4 years) is the one in which mortality can be reduced to very low levels through application of existing knowledge.

In all areas in the Latin American projects, with but two exceptions, more than half the deaths in this four-year age group were in the second year of life, that is, at one year of age. The exceptions were the

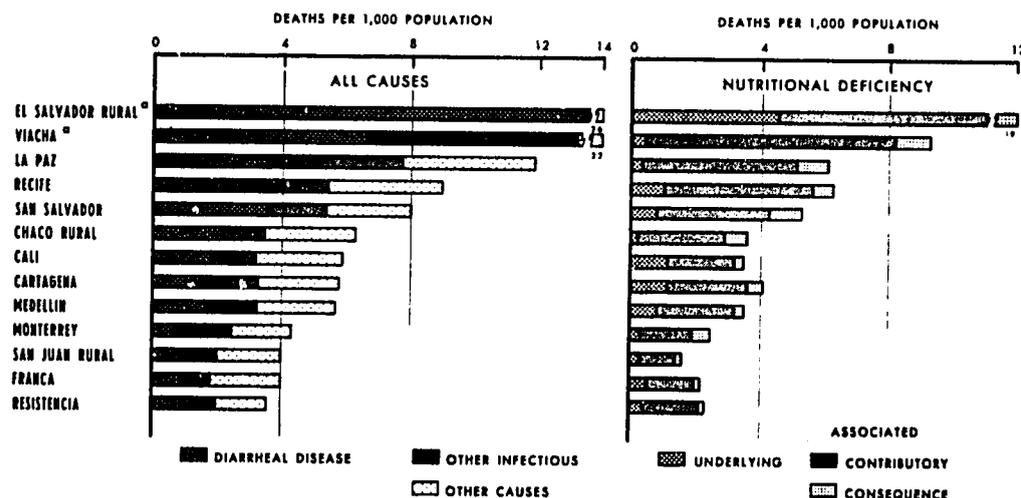
interior city of Franca (Brazil) and rural El Salvador.

When mortality was high, the group of infectious diseases usually was responsible for more than half the deaths.

In analyzing the role of infectious diseases as underlying causes in this age group, it is necessary to consider also the part played by nutritional deficiency as underlying or associated cause.

The close relationship between death rates for nutritional deficiency and those for all causes can be seen in Figure 10. Deaths from infectious diseases often occur in precisely those children who are most susceptible, i.e., those with nutritional deficiency.

Fig. 10. Mortality of Children 1-4 Years of Age from Infectious Diseases as Underlying Cause and Nutritional Deficiency as Underlying or Associated Cause in 13 Areas with Higher Rates.



* For size and divisions of very high rates for Rural El Salvador and Viacha, see Tables 66 and 67.

MORTALITY IN THE SECOND YEAR OF LIFE

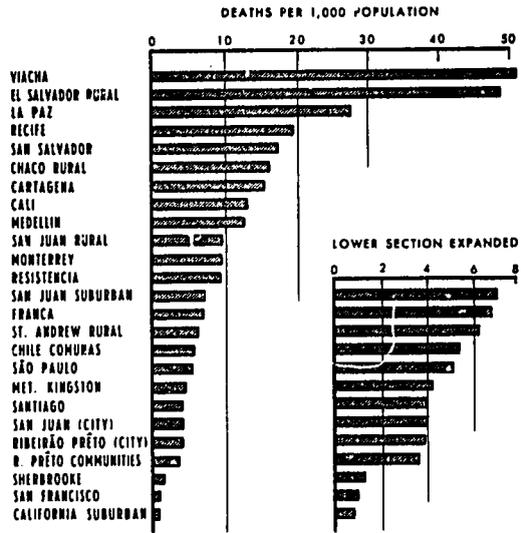
For the child who has reached the first birthday, the second year of life is the most hazardous one in early childhood. It is an especially dangerous period for those who have not attained a normal nutritional state and are therefore more vulnerable to infec-

tious diseases. Of the 7,493 deaths in the age group 1-4 years, more than half (4,361) were of children in their second year of life, that is, one year of age.

The range in death rates for these children (as is seen in Figure 11) was the greatest of all the age periods. The variations were from 0.8 per 1,000 population in the suburban California counties to 50.7 in Viacha, Bolivia. In Latin America rural and suburban areas had higher rates than those in cities in the same projects, with one exception (Ribeirão Prêto). In Argentina, Bolivia, and El Salvador the rural rates were much higher than in the cities.

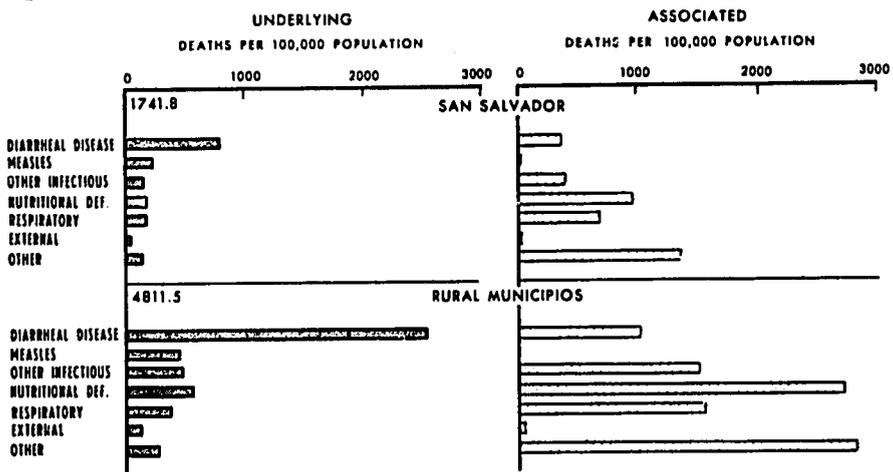
Diarrheal disease was the leading cause in both areas of El Salvador. The rate for measles (second bar in Figure 12) was higher in the rural area than in the city. The rate for nutritional deficiency (fourth bar) was high as both underlying and associated cause in the rural area, and high in the city as an associated cause. These high

FIG. 11. Mortality of Children One Year of Age from All Causes in 25 Areas of 15 Projects.



death rates for one-year-old children in the rural *municipios*, an area close to San Salvador and served by health facilities, suggest even more serious health problems in more remote rural areas.

FIG. 12. Underlying and Associated Causes of Mortality* of Children One Year of Age in Urban and Rural Areas of El Salvador Project.



* The death rate per 100,000 population is given in the left upper corner of each area.

MORTALITY IN CHILDREN 2-4 YEARS OF AGE

While total death rates of children one year of age varied from 0.8 to 50.7 per 1,000 population, in the remainder of early childhood the variation was much less, the range being from 0.7 to 18.0. Among children 2-4 years of age, mortality was

highest in two rural areas, namely, Viacha (10.7) and the *municipios* of El Salvador (18.0).

In this age period, mortality in certain Latin American areas is approaching the low rates in the Sherbrooke and California projects.

Chapter VIII

Infectious Diseases

Infectious and parasitic diseases continue to be important causes of mortality in childhood in many parts of the world. The Investigation reveals that in nearly all the projects in Latin America sizable reductions in death rates for certain of these diseases could be attained if vaccination programs were conducted and other public health measures applied. Moreover, evidence was uncovered to show that highly vulnerable infants who recover from one infectious disease often die from another.

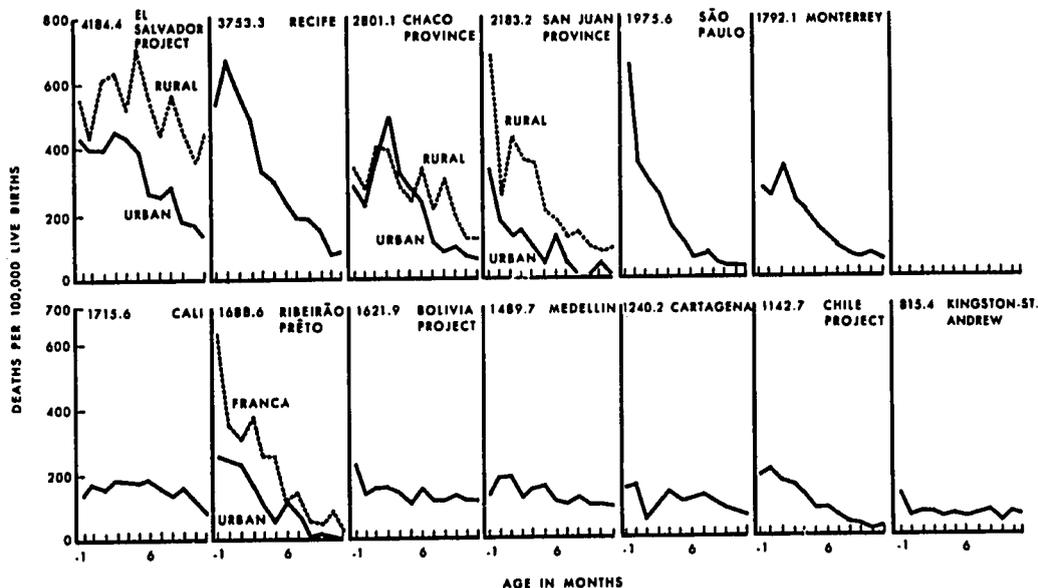
The two major infectious diseases as

underlying causes of death in the Latin American areas were diarrheal disease and measles. In only three out of 25 areas were the death rates from measles relatively unimportant (Kingston-St. Andrew, Santiago, and *comunas* of Chile)

DIARRHEAL DISEASE

Diarrheal disease, category 009 of the *International Classification of Diseases*, constitutes the major underlying cause of death for 10,052 of the 35,095 deaths of children under 5 years of age. No other single category had as many deaths.

Fig. 13. Infant Mortality from Diarrheal Disease by Month of Age in First Year of Life for 13 Projects.^a



^a The total infant death rate from diarrheal disease is shown in the upper left corner for each project.

Mortality from diarrheal disease by month of age in the first year of life differed markedly in Latin America, as can be seen in Figure 13, where thirteen projects are shown in descending order according to size of the total infant death rate, with the El Salvador project appearing first. In six projects the concentration of diarrheal disease deaths in the first six months is

clear, though there is variation. Among the cities, São Paulo had an unusually high rate in the first month, with lower rates in the remainder of infancy. In two projects, El Salvador and San Juan Province, the rates in rural areas were higher than in the cities, and in the interior city of Franca the rate was higher than in the city of Ribeirão Preto. Possible explanations for these differ-

ences are the inadequate supplies of drinking water, poor feeding practices, and insufficient medical services in the rural areas. The differences were less clear in Chaco Province. A distinctly different pattern of diarrheal disease mortality was found in the three cities of Colombia, in Bolivia, and in Kingston-St. Andrew, which had relatively low rates through the first year of life. These are areas where mothers continue breast feeding for a longer time than in the Brazilian and El Salvador areas. Although deaths in the Chile project were concentrated in early life, the death rates were low.

MEASLES

Of the 35,095 deaths under 5 years of age studied in the Investigation, 2,108 or 6.0 per cent were due to measles as underlying cause. If the neonatal period is excluded, the percentage comes to 9.4. In the second year of life measles accounted for 19.9 per cent of deaths from all causes, and in one project (Recife) for 29.7 per cent.

The highest rates for measles were in the Bolivia project (746.3 per 100,000 population for Viacha and 358.1 for La Paz), and the rate of 320.4 for Recife also indicated unusual mortality from this common disease of childhood. Measles mortality in rural areas was usually much higher than in the corresponding cities.

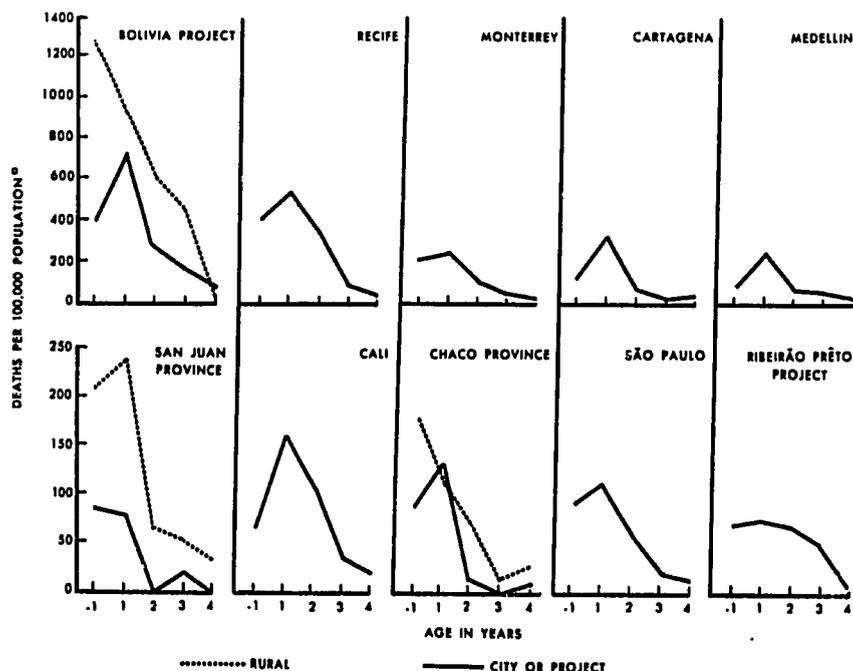
Variation in mortality in urban and rural areas are probably due to differences in susceptibility of the population.

Deaths from measles occurred early in life (as is seen in Figure 14). The highest rates were either in infancy or among one-year-old children.

In several projects (e.g. El Salvador and Monterrey) infants aged 9-11 months had the highest death rates.

Of the 674 measles deaths in the first year of life, 357 occurred before the infant reached 9 months of age. Since the vaccine is usually recommended for infants aged at least 9 months, many infants would not be protected in a vaccination campaign.

FIG. 14. Mortality from Measles for Single Years of Age Under 5 Years in 11 Projects.



*Under 1 year per 100,000 live births.

VACCINATIONS

In the interviews of families of deceased children, information was requested regarding vaccinations the children had received.

Figure 15 shows in the left section death rates from measles, diphtheria, and poliomyelitis (scales adapted to the death rates) and in the right section the percentages of the deceased children vaccinated.

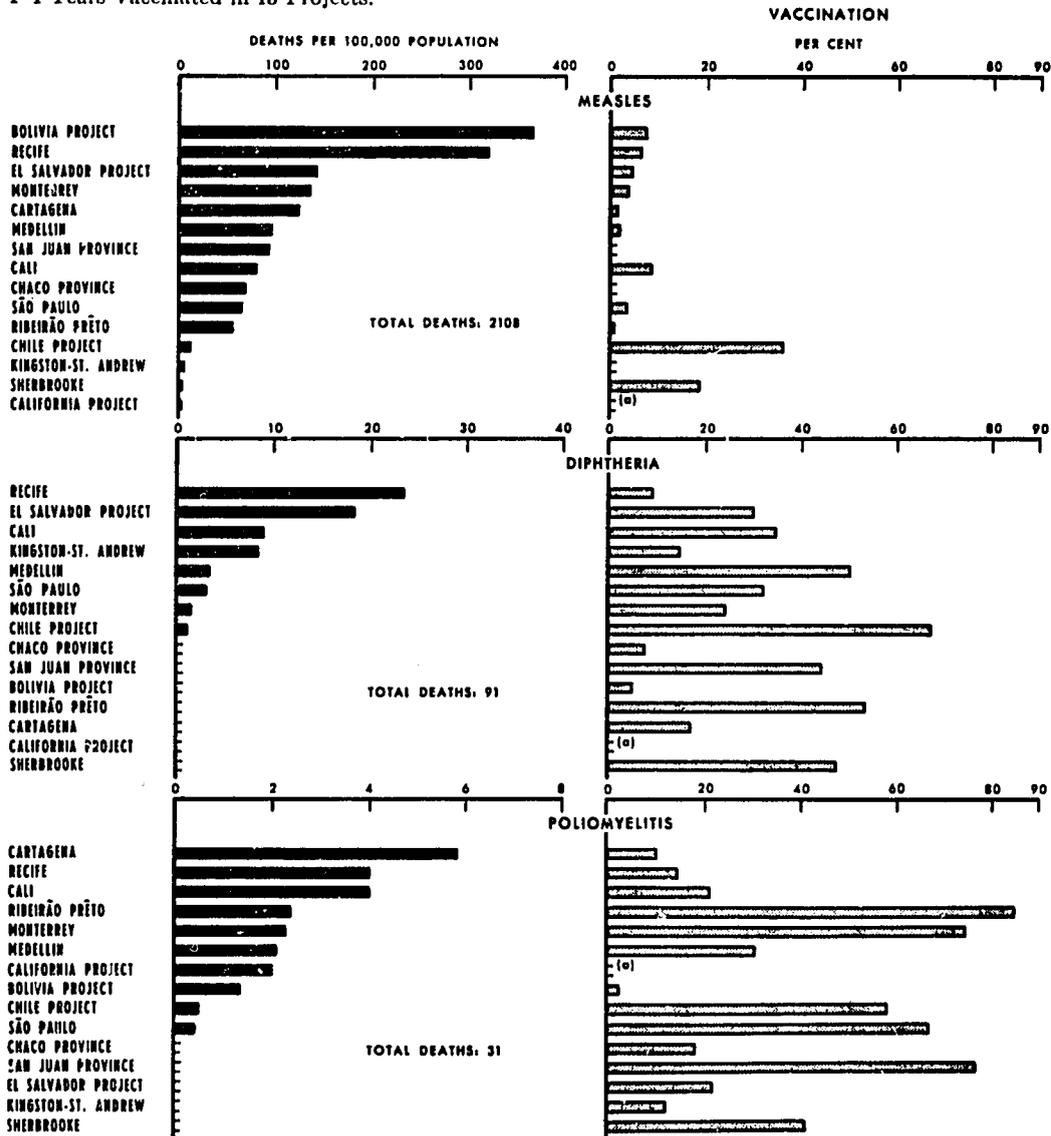
Out of fourteen projects, vaccination against measles had been carried out for a relatively large proportion of deceased children only in Chile (that project had one of the lowest death rates for measles). In La Paz and Recife measles immunization

programs were started during the period of the Investigation, but only 7.5 and 6.7 per cent, respectively, of the deceased children aged 1-4 years had been vaccinated.

The high death rates from measles in eleven projects, in contrast to the successful results achieved in Chile, indicate the great need for additional vaccination programs in the Region.

Poliomyelitis vaccine had been given to relatively high proportions of the deceased children in five projects. However, the total number of deaths (31) was too small for evaluation in relation to vaccination.

FIG. 15. Mortality from Three Diseases in Children Under 5 Years of Age and Percentage of Children 1-4 Years Vaccinated in 15 Projects.



^a Data were not obtained.

Chapter IX

Nutritional Deficiency

The findings of the Investigation are clarifying the role of nutritional deficiency in mortality of children under 5 years of age in Latin America. To measure the impact of this important health problem it is necessary to study the associated as well as the underlying causes of death in this age group.

Analysis of the interrelationships of nutritional deficiency and immaturity—both of which reflect deficits in the growth and development of the child—is essential to an understanding of the impact of these two important causes of death.

Of the 35,095 deaths under 5 years of age in the 15 projects, 19,994 or 57.0 per cent were due to these two conditions as underlying causes or associated causes. In several areas two-thirds of the deceased children had such evidence of increased vulnerability to disease and high risk of death.

AGE AT DEATH

In this section a full account is given of mortality from nutritional deficiency by age at death. This is the first time that such data for specific geographic areas have be-

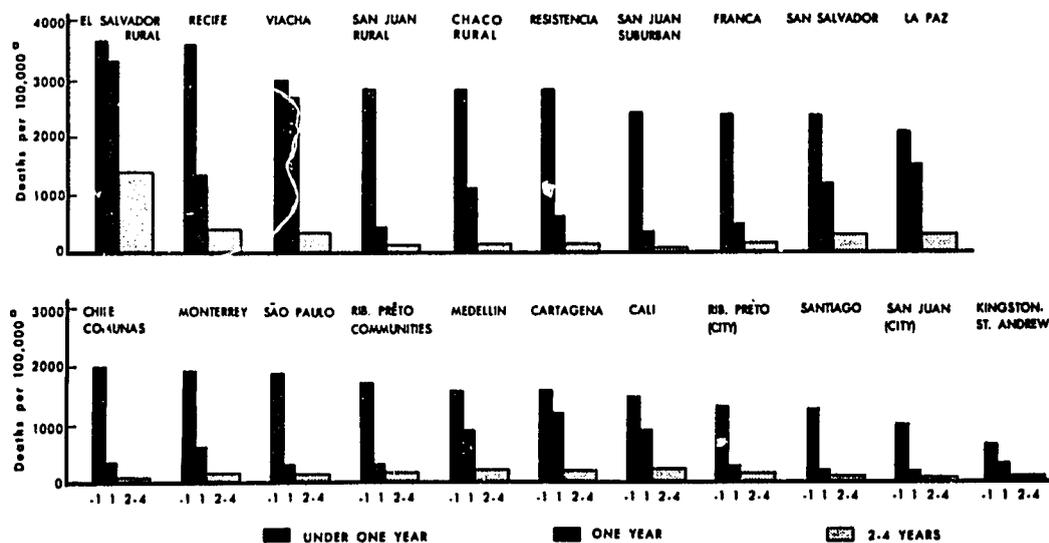
come available to permit an epidemiologic description of this important health problem. The study of deaths with this deficiency as an underlying or as an associated cause provides an excellent measure of the impact of this condition on mortality.

Of the 33,826 deaths under 5 years in the 13 Latin American projects, 11,913 or 35.2 per cent had nutritional deficiency as underlying or associated cause. This represents an overall rate of 660.3 per 100,000 population. If neonatal deaths are excluded, 11,512 deaths out of 21,951, or 52.4 per cent, had this deficiency state as a cause.

In Figure 16, childhood mortality from nutritional deficiency is shown for three age groups (under 1 year, 1 year, and 2-4 years) for 21 areas of the 13 projects. The rates for infants (as underlying or associated cause) exceeded 2,000 per 100,000 live births in 10 areas. In nine others they were in excess of 1,000. Only in the city of San Juan and in Kingston-St. Andrew were the rates less than 1,000 per 100,000 live births.

Although in all areas mortality from nu-

FIG. 16. Mortality from Nutritional Deficiency in Children Under 5 Years for Three Age Groups in 21 Areas of 13 Latin American Projects.



tritional deficiency was higher in the first year of life than in the age group 1-4 years, rates were nearly as high in the second year in the rural areas of Bolivia and El Salvador. High rates in the second year were also found in the cities of Recife, La Paz, and San Salvador, in the three cities in Colombia, and in rural Chaco Province. Rates in the group aged 2-4 years were much lower and thus further subdivision is not shown for that age group.

A comparison within projects shows that mortality was much higher in rural areas than in cities. For example, the rural *municipios* of El Salvador had the highest death rate in infancy and appear in first place in Figure 16, while the city of San Salvador (appearing ninth) had much lower rates.

The patterns of mortality from nutritional deficiency varied widely among the areas. At the same time, the evidence of higher rates in rural areas than in the neighboring cities is of key importance for health planning and for further research.

TYPES OF NUTRITIONAL DEFICIENCY

The data obtained in the Investigation make it possible, for the first time, to analyze mortality from nutritional deficiency according to type of deficiency as well as age at death. The specific types assigned as underlying or associated causes of 11,913 deaths of children under 5 years of age are given for the 13 Latin American projects combined in Table 3, in which the

TABLE 3. Mortality* from Nutritional Deficiency, by Type, in Children Under 5 Years of Age in 13 Latin American Projects Combined.

Type of deficiency	Total	Rate
Total.....	11,913	660.3
Vitamin deficiency (260-266).....	15	0.8
Protein malnutrition (267).....	1,562	80.6
Nutritional marasmus (268).....	2,544	141.0
Other deficiency (269).....	7,792	431.9

* Rates per 100,000 population.

division by type is: vitamin deficiency (260-266); protein malnutrition (267); nutritional marasmus (268); and other nutritional deficiency (269).

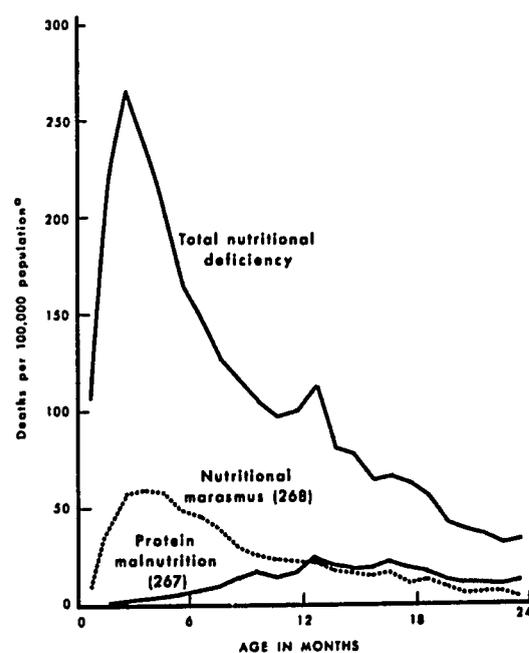
Protein malnutrition (267), or kwashiorkor, was assigned as a cause in 1,562 deaths, or 13.1 per cent of the total deaths from nutritional deficiency (11,913).

Nutritional marasmus (268), which was assigned in 2,544 deaths (21.4 per cent of the total), is the result of an overall deficit in food intake or utilization and is apt to develop very early in life, that is, in the first few months.

In the 13 projects, 7,792 deaths (65.4 per cent of the total) were assigned to category 269, *other nutritional deficiency*.

For the 13 Latin American projects combined, the role of the various types of nutritional deficiency as underlying or associated cause of death in children under 2 years is shown clearly in Figure 17. The

FIG. 17. Mortality from Nutritional Deficiency, Protein Malnutrition, and Nutritional Marasmus by Month of Age in First Two Years of Life in 13 Latin American Projects Combined.



*Under 1 year of age per 100,000 live births.

rates for all types combined were highest at 2 and 3 months of age and then declined in the older groups. Protein malnutrition increased steadily until the largest numbers were recorded for children aged 12–16 months, and it decreased thereafter during the latter part of the second year of life. The death rate of 184.8 per 100,000 population for one-year-olds indicates that these children suffered the greatest mortality from this type.

INTERRELATIONSHIP OF CAUSES

The relationship of nutritional deficiency as associated cause of death to three broad groups of underlying causes in the 13 Latin American projects can be seen in Table 4; these groups are infective and parasitic diseases (divided into diarrheal disease, measles, and other), respiratory diseases, and all other causes (excluding nutritional deficiency as underlying). Neonatal deaths have been excluded since they have a distinct pattern principally involving immaturity and other conditions present at birth (perinatal causes) and thus do not contribute to this analysis of interrelationships of nutritional deficiency and other causes.

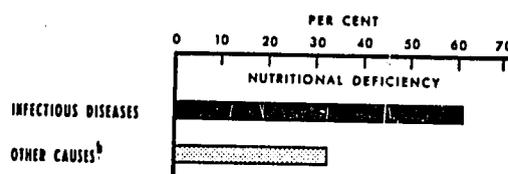
When data from all 13 Latin American projects are combined, the synergistic action of infectious diseases and nutritional de-

TABLE 4. Nutritional Deficiency as Associated Cause of Death Under 5 Years of Age (Excluding Neonatal Deaths) by Underlying Cause Group in 13 Latin American Projects Combined.

Underlying cause group	Total deaths	Nutritional deficiency as associated cause	
		No.	%
All causes.....	21,051	10,340	47.1
Infective and parasitic diseases...	12,598	7,667	60.9
Diarrheal disease.....	8,770	5,331	60.8
Measles.....	2,103	1,311	62.3
Other.....	1,725	1,025	59.4
Nutritional deficiency.....	1,163		
Diseases of respiratory system...	4,469	1,435	32.1
Other causes.....	3,721	1,247	33.5

fiency becomes evident (as is seen in Figure 18). Nutritional deficiency was associated cause in 60.9 per cent of the deaths from infectious diseases, as compared with only 32.7 per cent of deaths from all other causes. These findings are in accord with previous research indicating the importance of the nutritional state of the host in the development of disease.

FIG. 18. Nutritional Deficiency as Associated Cause of Deaths Due to Infectious Diseases and Other Causes in Children Under 5 Years of Age^a in 13 Latin American Projects Combined.



^aExcluding neonatal deaths.

^bRespiratory diseases and other causes combined.

What is now known about nutritional deficiency as well as about low birth weight and immaturity would seem to indicate that the deficient nutritional state of populations is perhaps the most important cause of excessive mortality in developing areas. A kind of vicious cycle is established whereby mothers who have been handicapped since early life by nutritional deficiency and other environmental factors give birth to low-weight infants.

When measured in terms of both mortality and reproductive wastage, the effects of inadequate nutrition on communities are exceedingly grave, especially in women who have numerous pregnancies. The consequences of this complex cycle are much more serious when the impact on the child's intelligence and adaptive capacity is taken into account.

Measures to break this vicious cycle through adequate nutrition of future mothers and their offspring and through reduction of biological wastage are mandatory in order to safeguard the health and intelligence of children.

Chapter X

Congenital Anomalies

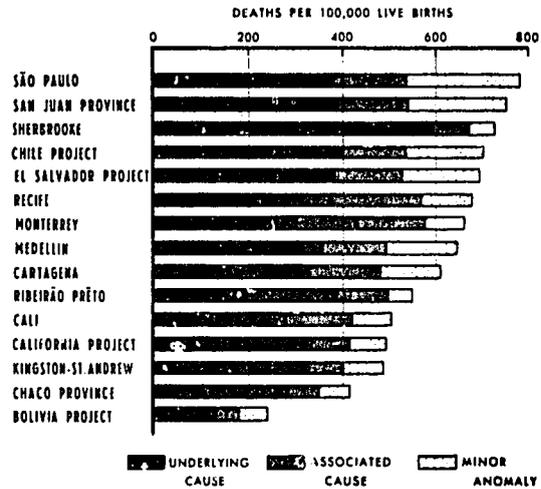
Knowledge of the geographic distribution and of the frequency of congenital anomalies is an important first step in the search for causes of these serious and often fatal abnormalities found at birth.

Of the 27,602 deceased infants, 2,873 or 10.4 per cent were found to have had at least one anomaly, which gave a rate of 606.1 per 100,000 live births. Taking into account only those with anomalies as underlying or associated causes of death, the number was 2,286, or a rate of 482.2 per 100,000 live births. Only 587 or 20.4 per cent of the 2,873 infants were classed as having minor anomalies, that is, conditions that were present but did not contribute to the sequence of events leading to death.

The variation in mortality in these infants with anomalies was much less than

that found for many causes (Figure 19)

FIG. 19. Mortality of Infants with Congenital Anomalies as Underlying or Associated Causes or as Minor Anomalies in 15 Projects.

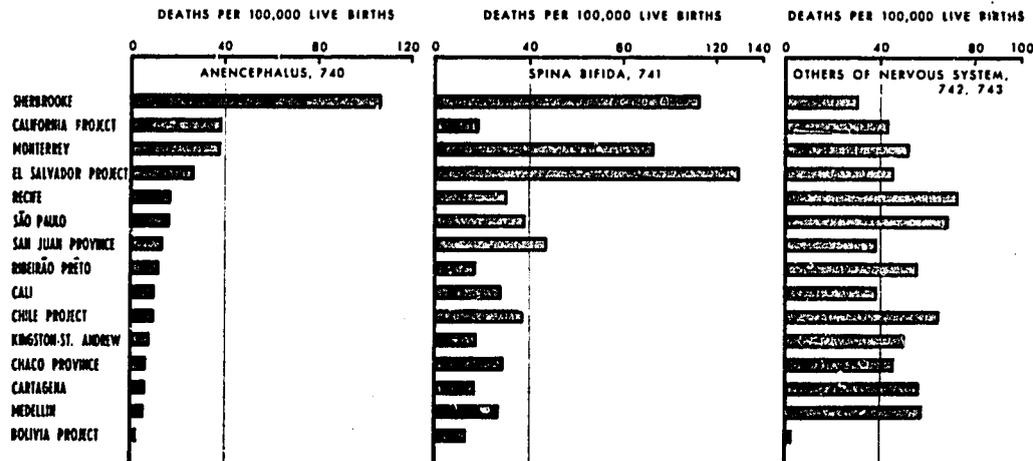


ANOMALIES OF THE NERVOUS SYSTEM

Unexpected high frequencies of anomalies of the nervous system were found in deceased infants in three projects: Sherbrooke in Canada, Monterrey in Mexico, and El

Salvador. The death rates from anencephalus (740), spina bifida (741), and other anomalies of the nervous system (742, 743) are shown in Figure 20.

FIG. 20. Mortality from Anencephalus, Spina Bifida, and Other Congenital Anomalies of Nervous System in Infants in 15 Projects.



The rate for anencephalus in Sherbrooke was 106.1 per 100,000 live births, which was almost three times the rate in the California project (38.0) and in Monterrey (37.7). The rate in El Salvador was 25.8, while for all others it was less than 20 per 100,000 live births.

For spina bifida three projects had high rates, the highest being that of 128.9 per 100,000 live births in El Salvador, followed by 112.0 in Sherbrooke and 92.4 in Monterrey. These rates were significantly higher than those in all other projects.

In the rural *municipios* of El Salvador there were 18 infants with anomalies of the nervous system, which gave a rate of 333.3 per 100,000 live births. The corresponding rate for the city of San Salvador was less than half as high—156.1—and the difference is significant. Though the numbers are small, this is a valuable clue for research into the causation of these serious anomalies. It may be, for example, that there is something lacking in the diet in the rural *municipios* and that the deficiency of that element is greater than in the city.

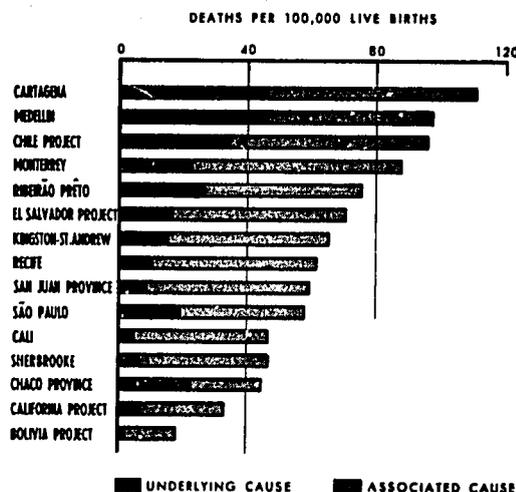
DOWN'S DISEASE

Down's disease (trisomy 21) is a severe developmental disease affecting various systems and characterized by the presence of an extra, small chromosome conventionally termed No. 21. This congenital anomaly for which methods of prevention are currently being recommended is of special interest at this time.

In the 15 projects there were 306 infant deaths due to this disease; in 86 it was underlying cause and in 220 associated cause. Consequently, as can be seen, use of the underlying cause alone would provide information on only 28.1 per cent of these deaths. The total rates in infancy varied from a low of 18.6 per 100,000 live births in the Bolivia project to 111.7 in Cartagena (Figure 21). The rates as underlying cause were highest

in the two projects with the highest total rates (Cartagena and Medellín).

FIG. 21. Mortality of Infants with Down's Disease as Underlying or Associated Cause in 15 Projects.



When the data were combined for seven projects for which the distributions of live births by age of mother were available the following death rates for Down's disease per 100,000 live births were obtained:

Under 20 years	38.8
20-24 years	28.1
25-29 years	30.9
30-34 years	77.1
35 years and over	266.6

The very high rate for infants of mothers aged 35 years and over reveals the great risk in that age group of having a child with Down's disease who dies in infancy—2.7 per 1,000 live births.

Stein and Susser (1971), in a paper on the preventability of Down's disease, recommended specific preventive measures aimed at reducing the frequency of this serious condition. There are sound bases for education of parents and for genetic counseling to prevent the birth of a child with Down's disease. The well-known relationship of the frequency of this chromosomal abnormality with increase in maternal age has been corroborated by this investigation:

Chapter XI

Other Diseases and External Causes

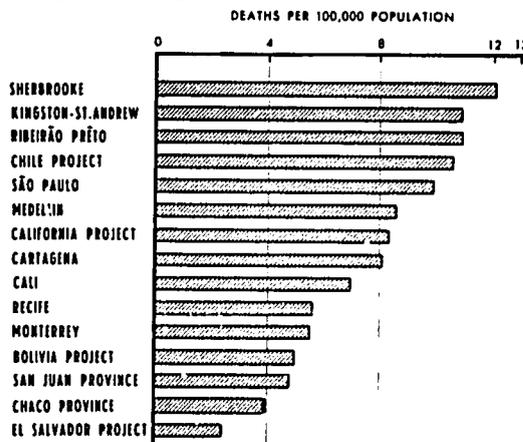
The study of mortality from several other important underlying causes contributes to an understanding of the health problems encountered in childhood. Among these are leukemia and other malignant neoplasms, external causes, and sudden death. Though the numbers of deaths from malignant neoplasms and from sudden death were relatively small in the 15 projects (163 and 280), their importance becomes clearly evident as the overall level of infant mortality is reduced. The same relative importance could be attached to the external causes, which were responsible for 847 deaths.

MALIGNANT NEOPLASMS

Of the total of 163 deaths, 80, or practically half, were caused by leukemia, and the remaining 83 by other malignant neoplasms.

In four projects the death rates for these two groups were at least 10 per 100,000 population: Sherbrooke, Chile, Kingston-St. Andrew, and Ribeirão Prêto (Figure 22).

FIG. 22. Mortality from Leukemia and Other Malignant Neoplasms in Children Under 5 Years of Age in 15 Projects.



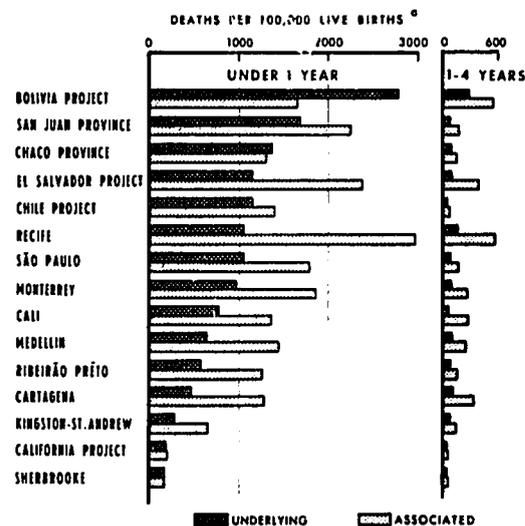
DISEASES OF RESPIRATORY SYSTEM

These morbid conditions were second to diarrheal disease as underlying cause of death in children under 5 years of age in the 15 projects. They were responsible for 5,741 deaths, with rates going from 35.1 and

40.3 per 100,000 population in the Sherbrooke and California projects up to 866.2 in the Bolivia project. In addition to this, they were assigned as associated causes in 10,298 deaths, with rates ranging from 38.4 and 53.5 in the Northern American projects to the exceedingly high rate of 1,147.6 in Recife.

Figure 23 shows graphically the rates per 100,000 live births for infant deaths and per 100,000 population for deaths of children aged 1-4 years.

FIG. 23. Mortality from Diseases of Respiratory System as Underlying or Associated Causes in Children Under 5 Years, by Age Group, in 15 Projects.



^a For 1-4 years, per 100,000 population.

MORTALITY FROM EXTERNAL CAUSES

Though the proportions of deaths due to external causes were higher in children aged 1-4 years, the rates were highest in infancy in 11 of the projects; in four others they were highest in the second year of life. Thus, very young children must be protected from external causes as well as older ones.

As mortality from infectious diseases and nutritional deficiency is reduced to low levels, external causes of death assume increasing importance in childhood.

Chapter XII

Reproductive Patterns

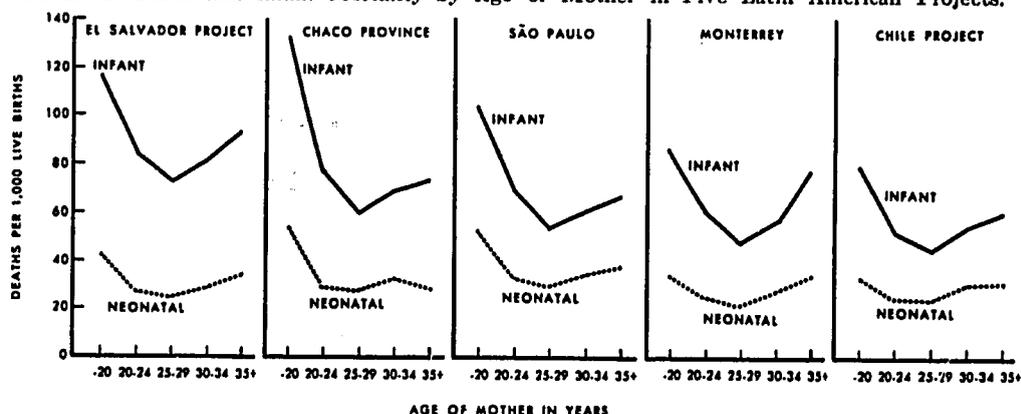
In addition to the multiple causes of infant mortality, other factors such as maternal age and infants' birth order have a direct relationship to the size of infant death rates.

Birth rates are declining in several areas and this trend should have a favorable effect on infant mortality. Fortunately, data were available on births by age of mother and birth order for the Province of Santiago, and these showed a shift from older to younger mothers and from high to low birth orders in a period of rapid decline in the birth rate. Infant mortality has been reduced by such changes in the pattern of re-

production. Thus in planning for healthy infants and for reduction of mortality, these factors need to be taken into account, along with the causes of death.

Moreover, the analysis made in this chapter of data on the reproductive history of mothers reveals that the excessive losses through fetal deaths and deaths of those born alive must have handicapped the families by repeated episodes of illness and mortality. To ensure survival of children from the hazards of the infant period, planning for pregnancies which are desired by the parents and which will result in healthy infants is the first essential.

Fig. 24. Neonatal and Infant Mortality by Age of Mother in Five Latin American Projects.



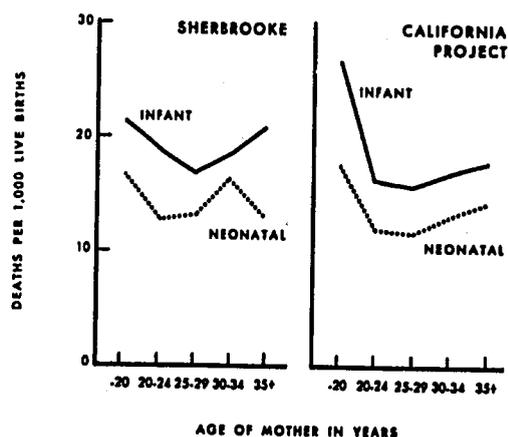
NEONATAL AND INFANT MORTALITY BY AGE OF MOTHER

Neonatal and infant mortality by age of mother in five age groups, in five projects in Latin America, is illustrated in Figure 24, in descending order of the infant death rates.

The differences in these patterns indicate that age of mother at the time of birth of child is an important determinant of the level of neonatal and infant mortality. Infants born to young mothers (under 20 years) and to the older mothers (35 years and over) experience the highest mortality.

The projects in Sherbrooke and California are shown in Figure 25 using a smaller scale, the death rates being much lower than in the five Latin American projects.

Fig. 25. Neonatal and Infant Mortality by Age of Mother in Sherbrooke and California Projects.

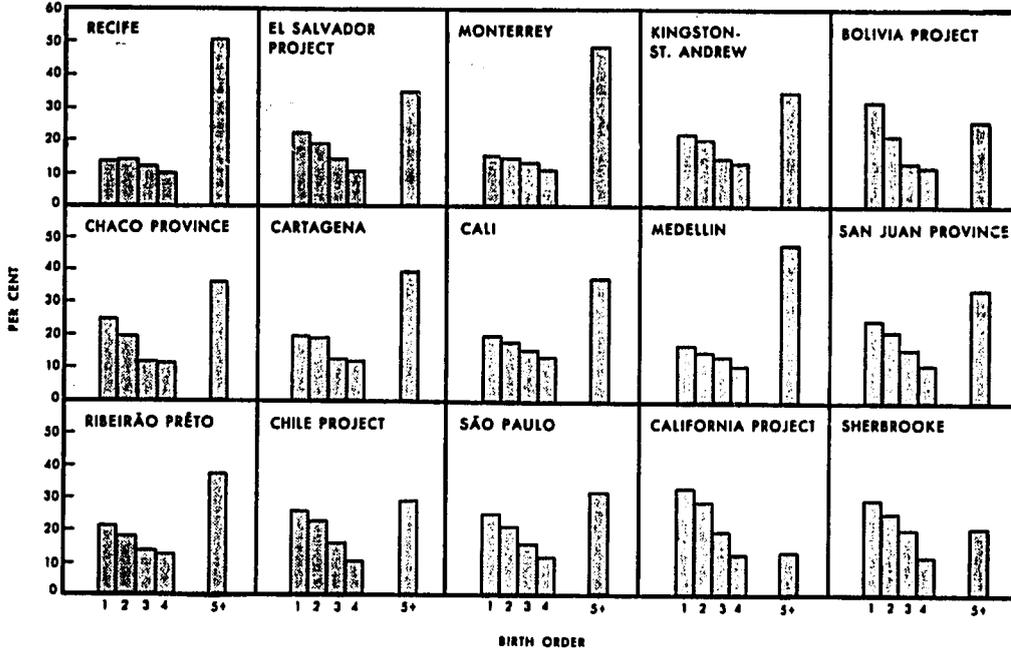


BIRTH ORDER

The percentage distributions of infant deaths by birth order are shown for the 15 projects in Figure 26, in descending order of the birth rates. In Recife, which had the

highest birth rate, more than half the deceased infants were of fifth or higher birth orders; only 13.7 per cent were first births and 13.9 per cent second births. The pattern in Monterrey was similar, with 48.6 per cent fifth or later births.

FIG. 26. Infant Deaths by Birth Order in 15 Projects.



NEONATAL AND INFANT MORTALITY BY BIRTH ORDER

Two projects in Latin America (Chile and Monterrey) had similar infant death rates for first births, 39.4 and 40.5 per 1,000 live births, and likewise excessive death rates for those of fifth and higher orders,

90.6 and 90.0, respectively (Figure 27). The infant rates in the two Northern American projects (California and Sherbrooke), shown in Figure 28 (with a smaller scale), were in general similar.

FIG. 27. Infant and Neonatal Mortality by Birth Order in Chile and Monterrey Projects.

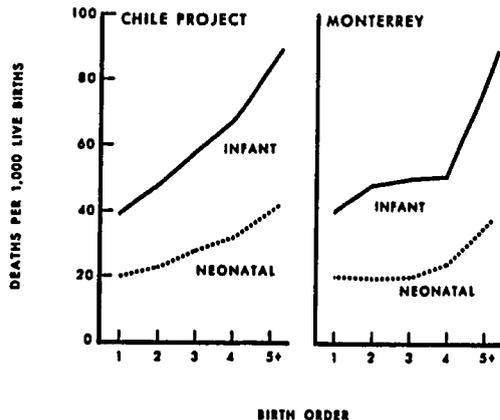
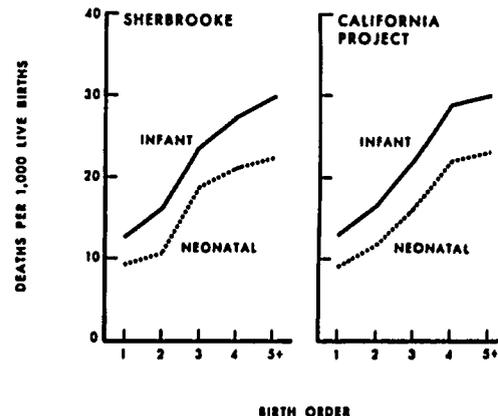


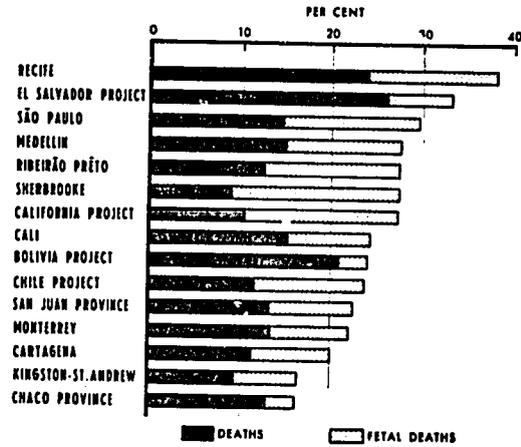
FIG. 28. Infant and Neonatal Mortality by Birth Order in Sherbrooke and California Projects.



OUTCOME OF PREVIOUS PREGNANCIES

In Figure 29 the vital losses in previous pregnancies are divided into fetal deaths and deaths of those born alive. In two projects with high death rates, Recife and El Salvador, more than 30 per cent of the products of previous pregnancies resulted in death (38.2 and 33.2 per cent, respectively). These losses represent great reproductive wastage in terms of the products, a great biological expenditure for the mother, and also a serious psychological and financial impact on the family. In these two projects more than 20 per cent of the total previous products were lost by deaths of children born alive.

FIG. 29. Mortality of Products of Previous Pregnancies of Mothers of Deceased Children in 15 Projects.



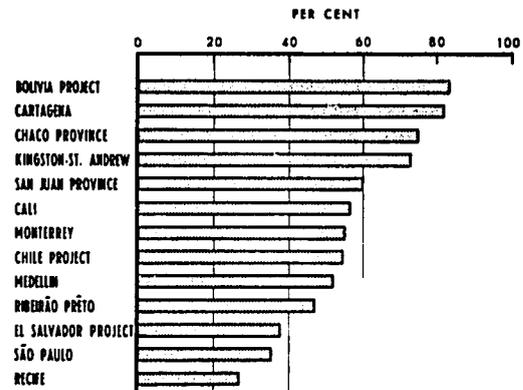
Chapter XIII

Breast Feeding

Breast feeding, because of its relationship to the child's survival, is one of the major factors to be considered in studies of infant mortality.

The wide variation in breast feeding in infancy in the Latin American projects can be seen clearly in Figure 30. The proportion of infants dying in the first year of life who had been breast fed one month or longer was over 70 per cent in four projects (Bolivia, Cartagena, Chaco Province, and Kingston-St. Andrew). In three projects (El Salvador, São Paulo, and Recife) it was less than 40 per cent, while in the other six it varied from 47.3 to 60.1 per cent.

FIG. 30. Breast Feeding for One Month or Longer of Infants Dying in Postneonatal Period in 13 Latin American Projects.



DIARRHEAL DISEASE AND BREAST FEEDING

There seems to be a general consensus that breast feeding, compared to other sources of nutrients, is accompanied by lower rates of attack by infectious diseases and that such protection is not limited to defense against infections of the intestinal tract.

The patterns of mortality from diarrheal disease in the first few months of life were found to differ markedly in the Latin American project (Chapter VIII, Figure 13). Exceedingly high death rates were noted in the first few months of life in Recife and São Paulo. These projects are in areas where breast feeding is practiced only on

a very limited scale. In contrast, the death rates in the Bolivia project, in Cartagena, and in Kingston-St. Andrew seemed to be relatively low and constant by month of age in the first year of life. These areas were found to have higher proportions of infants breast fed for at least a month.

Other factors probably affected mortality from diarrheal disease. Two of the areas with highest percentages of deaths from this cause in those breast fed and never weaned—Recife (52.8) and Chaco Province (40.8)—are areas where only small proportions of the homes are provided with water supplies.

NUTRITIONAL DEFICIENCY AND BREAST FEEDING

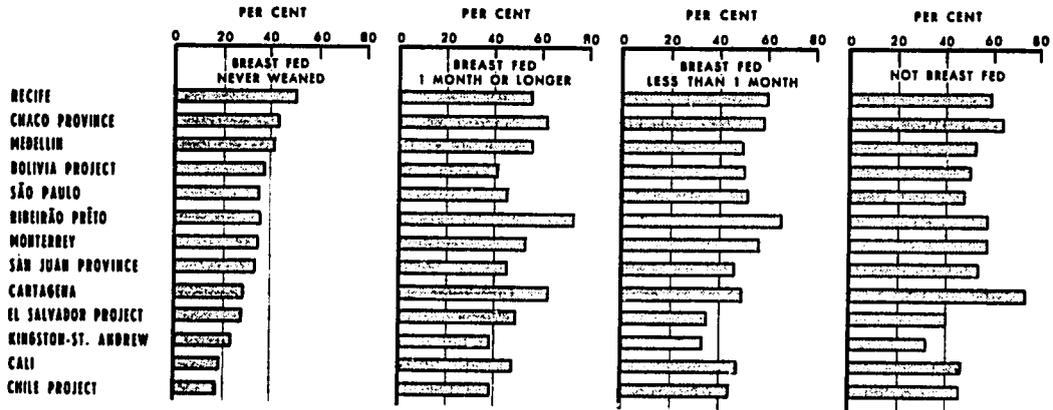
Through the protective mechanisms against infection (of which good nutrition is an important one) human milk favors a positive balance of nutrients, and hence normal growth and development.

Data on the relationship between breast feeding and nutritional deficiency as underlying or associated cause of death are pre-

sented in Figure 31 for the age group 28 days–5 months.

As can be seen in Figure 31, nutritional deficiency as underlying or associated cause was less frequent in infants breast fed and never weaned than in infants who were breast fed not at all or for only limited periods.

FIG. 31. Percentage of Infants Dying at 28 Days-5 Months of Age from Nutritional Deficiency as Underlying or Associated Cause According to Breast Feeding in 13 Latin American Projects.



In the educational programs undertaken by health personnel major emphasis should be placed on the importance of mother's milk to the health of the child. Action at the community level to encourage breast feeding, with the active participation of organized groups and of health authorities, is an

urgent need in developing areas. Mothers in those areas should be made to realize that breast feeding their young infants is vital for the child's survival, and for that reason should constitute an integral part of effective reproductive function.

Chapter XIV

Socioeconomic and Related Factors

One of the Investigation's goals was to study the interrelationships of diseases and other factors responsible for mortality.

EDUCATION OF MOTHER

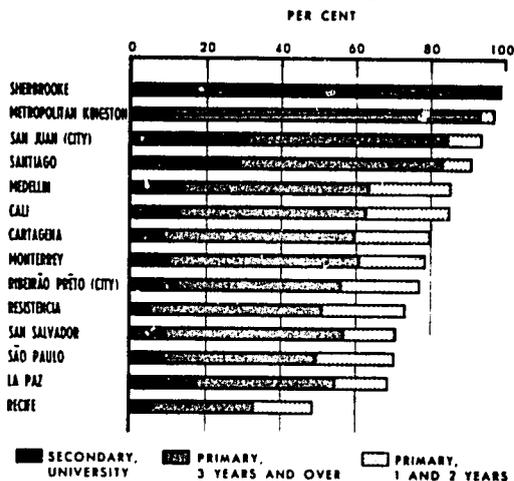
Data on years of schooling of mothers of deceased children were obtained during the home interviews in 14 projects. For the 13 Latin American projects combined, satisfactory information on this point was available for 27,606 mothers (14.7 per cent more than the number of fathers for whom occupation was stated).

Relatively small proportions of the mothers had secondary or university education in the Latin American projects (the few who had technical education were incorporated in this group). Mothers with primary education were divided into two groups: those with at least three years of schooling and those with one or two years. The final group included mothers stated to have no education and others who were considered as having no education since none was stated.

The level of education reached was lower in rural and suburban areas than in cities.

The wide variation in mother's education is illustrated first for cities (Figure 32). The Sherbrooke project had the highest proportion of mothers with at least one year of education (97.9 per cent) and also the

FIG. 32. Educational Level of Mothers of Deceased Children Under 5 Years of Age in 14 Cities.



highest with secondary or university education (60.8 per cent).

At least half of the mothers in all the cities except Recife had received at least some education. In Recife the percentage was 48.1.

In Chapter V it was pointed out that in the two projects with the lowest death rates (California and Sherbrooke) more than 60 per cent of all deaths under 5 years were neonatal deaths (63.5 and 61.7 per cent, respectively).

Figure 33 shows clearly that among the better educated mothers the proportions of

FIG. 33. Percentage of Deaths of Children Under 5 Years of Age Occurring in Neonatal Period Whose Mothers Had Secondary and University Education or No Education in 14 Projects.

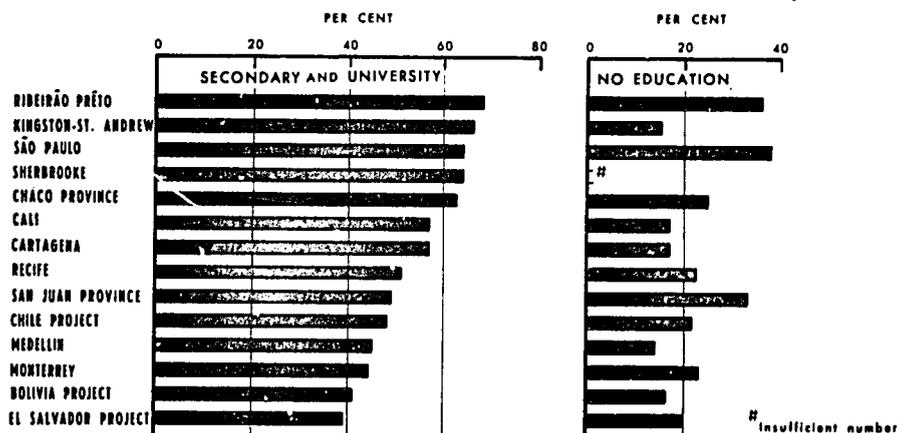
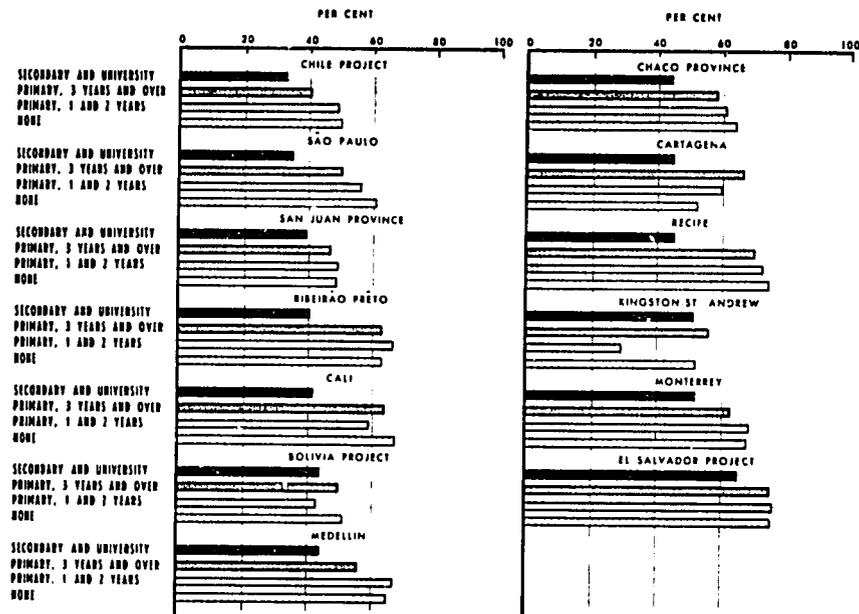


FIG. 34. Percentage of Postneonatal Deaths Due to Infectious Diseases as Underlying Causes by Educational Level of Mother in 13 Latin American Projects.



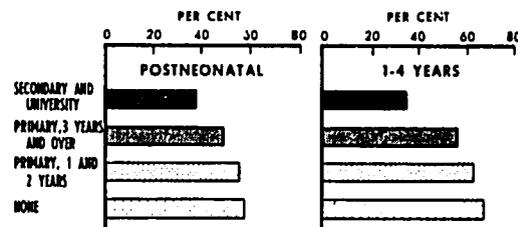
deaths under 5 years occurring in the neonatal period were much higher than in the postneonatal period in Latin American projects. In fact, in five projects the low percentages for neonatal deaths (less than 20) among uneducated mothers are evidence of the high proportions occurring in the postneonatal period and at 1-4 years, the ages at which mortality can be reduced to low levels through preventive programs. The low percentage of deaths in the neonatal period among mothers with no education (15.4) is indicative of a situation in which conditions are unfavorable and health programs are needed.

Of the postneonatal deaths, the percentages due to infectious diseases as underlying causes are shown by education of mother for 13 projects (Figure 34). In general, the proportions due to these causes were lower for mothers with secondary or university education than for those with no schooling. When high proportions of the postneonatal deaths were caused by infectious diseases, as in the El Salvador project, there was very little difference according to mother's educational level.

The data for the 13 Latin American projects combined are presented in Figure 35.

Here it can be seen clearly that the percentages of children with nutritional deficiency dying in the postneonatal period and at 1-4 years were much higher in the case of mothers with no education (57.0 and 68.3, respectively) than for those with secondary or university education (37.2 and 35.3 per cent).

FIG. 35. Deaths from Nutritional Deficiency as Underlying or Associated Cause in Children Under 5 Years, in Two Age Groups, by Educational Level of Mother in 13 Latin American Projects Combined.



Mothers without education are found more frequently in the rural areas, as the data indicate, and high proportions of their children have nutritional deficiency, which is an indication of inadequate food supplies. Education, therefore, is an appropriate measure for use in further research and also in planning health programs.

Chapter XV

Medical Attention

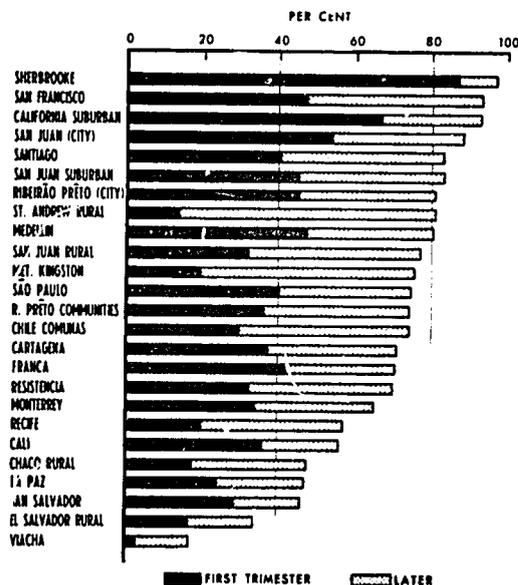
Medical attention rendered during pregnancy and delivery to mothers of deceased children, as well as that received by the children, can be studied from data collected in the interviews of families during the course of the Investigation. In many instances data obtained from hospitals and other sources complemented that information. In this report reference was made to services provided and to several parameters pertaining to deceased children and their mothers in the hope that this information will serve as a basis for action to solve the problems uncovered.

PRENATAL CARE

The data on prenatal care for mothers of deceased infants are presented for 25 areas according to the stage of pregnancy in which the care was first received. Figure 36 shows the percentages of mothers who attended a prenatal service at any time during pregnancy, and also of those who received care within the first trimester, the period which is considered most crucial.

The percentages receiving care in the first

FIG. 36. Percentage of Mothers of Deceased Infants Receiving Prenatal Care, by Stage of Pregnancy at the First Visit, in 25 Areas of 15 Projects.



trimester varied from 86.7 in Sherbrooke and 66.0 in suburban California to 2.6 in Viacha, Bolivia. In six areas of the Latin American projects at least 40 per cent of mothers had prenatal care within that period, but in six others the proportion was less than 20 per cent. In fact, more than half the mothers in the rural departments of Chaco Province, in La Paz and Viacha, and in San Salvador and rural *municipios* of El Salvador received no prenatal care at all.

The two rural areas with the lowest proportions of mothers receiving any prenatal care—namely, Viacha (16.9 per cent) and rural *municipios* of El Salvador (33.7 per cent)—had very high infant death rates (123.5 and 120.0 per 1,000 live births, respectively); and conversely, areas in which nearly all mothers received prenatal care had low death rates. Table 5 gives these percentages in descending order, along with

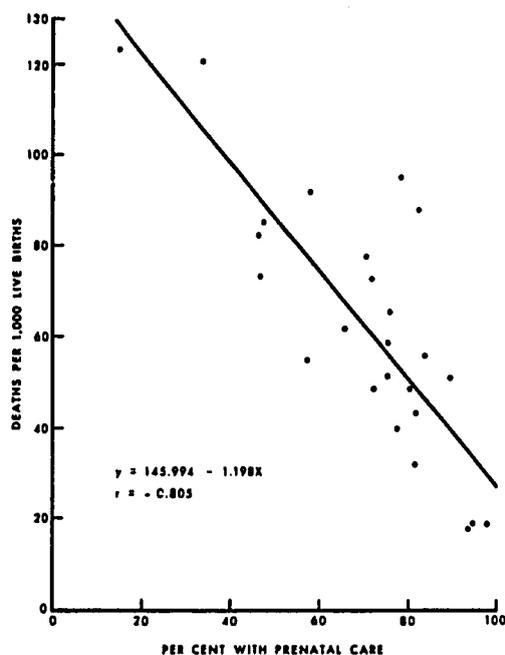
TABLE 5. Percentage of Mothers of Deceased Infants Who Received Prenatal Care, and Infant Death Rates in 25 Areas of 15 Projects.

Area	% of mothers with prenatal care	Infant death rate*
Sherbrooke	90.7	18.3
San Francisco	93.7	18.5
California, suburban	93.1	17.2
San Juan (city)	88.5	50.7
Santiago	83.0	54.9
San Juan, suburban	82.8	87.9
Ribeirão Preto (city)	81.1	43.0
St. Andrew, rural	80.8	31.6
Medellín	80.4	47.6
San Juan, rural	77.6	94.5
Metropolitan Kingston	76.2	39.5
São Paulo	74.8	65.1
Ribeirão Preto, communities	74.4	50.8
Chile, comunas	74.3	57.9
Cartagena	70.8	47.8
Franca	70.4	71.5
Resistencia	69.8	76.2
Monterrey	65.5	60.7
Recife	57.4	91.2
Cali	56.7	54.6
Chaco, rural	46.7	85.0
La Paz	46.5	73.0
San Salvador	46.2	81.7
El Salvador, rural	33.7	120.0
Viacha	16.9	123.5

* Per 1,000 live births.

the infant death rates for comparison. Figure 37 shows the inverse relation found between infant death rates and percentages of mothers receiving prenatal care in 25 areas of the 15 projects. The correlation coefficient of -0.805 was significant. Prenatal care is one of the services that must be made available to women in such areas if reductions in mortality in infancy are to be effected.

FIG. 37. Infant Death Rate and Percentage of Mothers of Deceased Infants Who Received Prenatal Care in 25 Areas of 15 Projects.



The prenatal care should start at the very earliest stage of pregnancy, and a sufficient number of visits should be planned to ensure that the expectant mother receives proper surveillance of her state of health and nutrition as well as education on safeguarding the health of her child after birth.

PLACE OF BIRTH

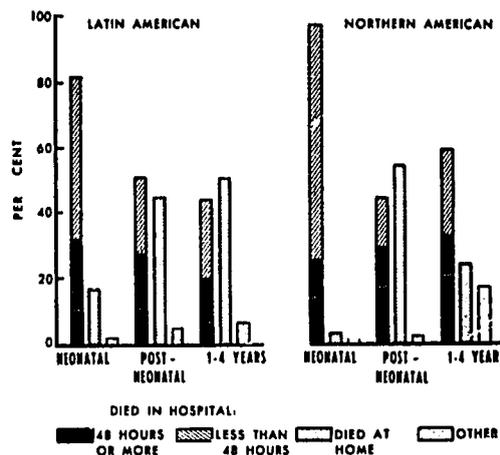
Of the infants with place of birth known, in all projects combined, 78.9 per cent of all those who died had been born in hospitals and the rest (21.1 per cent) had been born at home. Moreover, of the total number, 45 per cent were known to have

been delivered by physicians in hospitals and 25 per cent by midwives in hospitals.

PLACE OF DEATH

In the Latin American projects 60.4 per cent of all deceased children under 5 years of age (with place of death stated) died in hospitals, compared with 79.9 per cent in the Northern American projects (as shown in Figure 38). In the latter, 97.5 per cent of all neonatal deaths occurred in

FIG. 38. Place of Death of Children Under 5 Years, by Age Group, in 13 Latin American and Two Northern American Projects.



hospitals, compared with 82.1 per cent in the Latin American projects.

In the age group 1-4 years, 59.4 per cent of the deaths occurred in hospitals in the Northern American projects compared with 43.8 per cent in the Latin American ones.

Analyses of patterns of mortality by age and causes together with various other factors closely related to excessive mortality in some of the projects point to the need for providing comprehensive health services on a continuous basis.

Adequate follow-up services after birth, with continuing emphasis placed on prevention of infectious diseases and malnutrition, prompt treatment of illness, and attainment of a desirable reproductive pattern in the mother, should constitute the minimum services to safeguard the health of mother and child.

Chapter XVI

Environmental Conditions

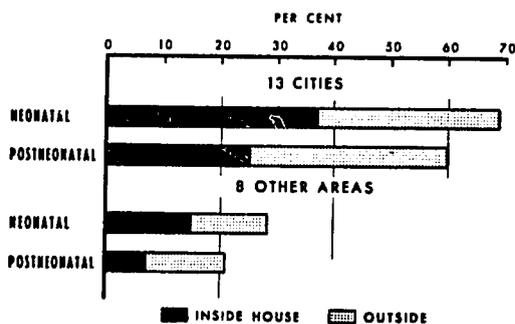
In addition to the various factors influencing the level of mortality in childhood that have been considered in previous chapters, another important group of environmental factors deserves analysis. These include conditions in the child's surroundings such as housing, water supplies, and sanitary facilities.

WATER SUPPLIES

During the interviews in the homes of deceased children, information was obtained on the type of water supply available to the family: water piped inside the house, or piped water available outside or nearby through a communal facility.

Of the homes of infants deceased in the postneonatal period, in the 13 cities combined only 60.2 per cent had piped water supplies (in contrast to 69.4 for the neonatal group), a significantly lower percentage. In the eight other areas the proportion was 28.8 per cent (compared with 21.6). Therefore, this is clear evidence that families of infants dying in the postneonatal period had less favorable conditions in regard to piped water supplies. The differences between families in the two groups are apparent for many of the areas and for the areas combined as shown in Figure 39.

FIG. 39. Percentage of Families of Infants Dying in Neonatal and Postneonatal Periods Served with Piped Water in 13 Latin American Cities and Eight Other Areas Combined, in 13 Projects.



Among families of infants in the postneonatal group the proportions with piped water inside the house were much lower. For example, in the eight other areas combined the percentage was 7.8, compared with 15.0 for the neonatal group, and in the 13 cities, 25.7 compared with 37.1.

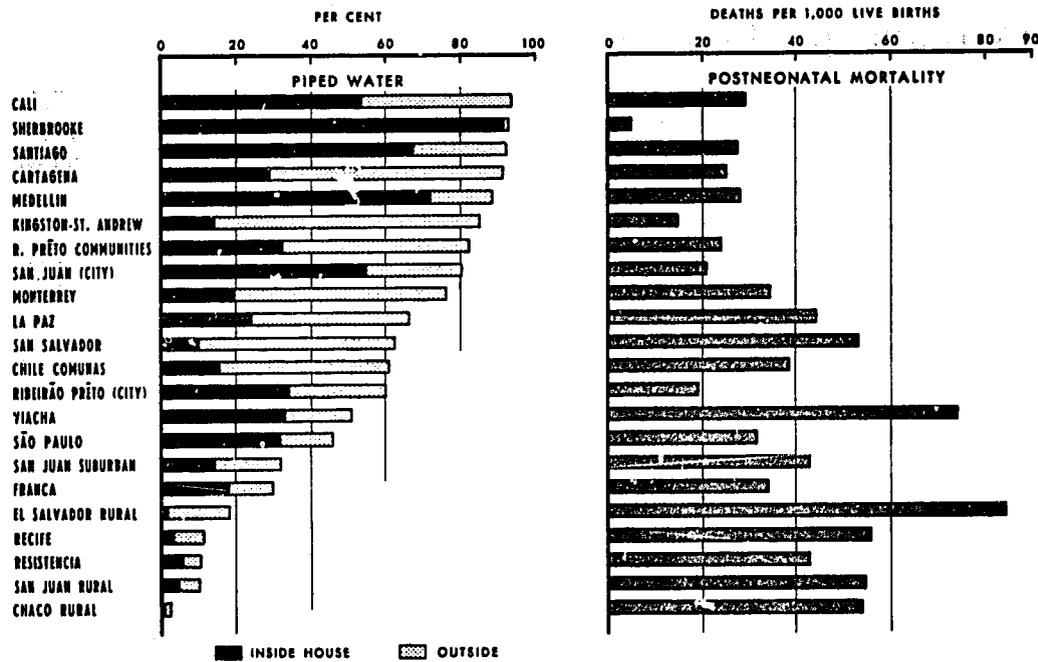
Postneonatal death rates in relation to water supplies in families of infants dying in that age period are presented in Table 6 and Figure 40. For eight areas in which piped water was available to at least 80.0 per cent of the families, the postneonatal death rate varied from a low of 4.8 per 1,000 live births (Sherbrooke) to 29.2 (Cali). In the 14 areas with lower percentages for water supplies, the death rates were in excess of 30.

TABLE 6. Availability of Piped Water in Families of Infants Dying in Postneonatal Period, and Postneonatal Mortality* in 22 Areas of 14 Projects.

Area	Percentage of houses with piped water		Post-neonatal death rate
	Total	Inside	
Cali.....	93.7	53.6	29.2
Sherbrooke.....	93.2	91.8	4.8
Santiago.....	92.6	67.5	27.7
Cartagena.....	91.0	28.4	25.4
Medellín.....	87.9	71.4	27.9
Kingston-St. Andrew.....	84.7	13.7	14.6
Ribeirão Preto, communities.....	81.9	32.5	23.7
San Juan (city).....	80.4	55.1	21.1
Monterrey.....	75.9	10.1	34.8
La Paz.....	66.1	23.3	44.6
San Salvador.....	62.6	0.3	53.6
Chile, comunas.....	61.1	15.0	38.5
Ribeirão Preto (city).....	60.0	33.8	19.0
Viecha.....	50.9	32.7	74.1
São Paulo.....	45.9	31.8	31.5
San Juan, suburban.....	31.8	14.2	43.3
Franca.....	30.1	18.2	34.6
El Salvador, rural.....	18.0	0.9	83.9
Recife.....	11.2	3.1	55.9
Resistencia.....	10.0	4.2	42.9
San Juan, rural.....	9.6	3.0	54.0
Chaco, rural.....	2.2	0.7	54.1

* Rates per 1,000 live births.

FIG. 40. Percentage of Families of Infants Dying in Postneonatal Period Served with Piped Water, and Postneonatal Mortality in 22 Areas of 14 Projects.



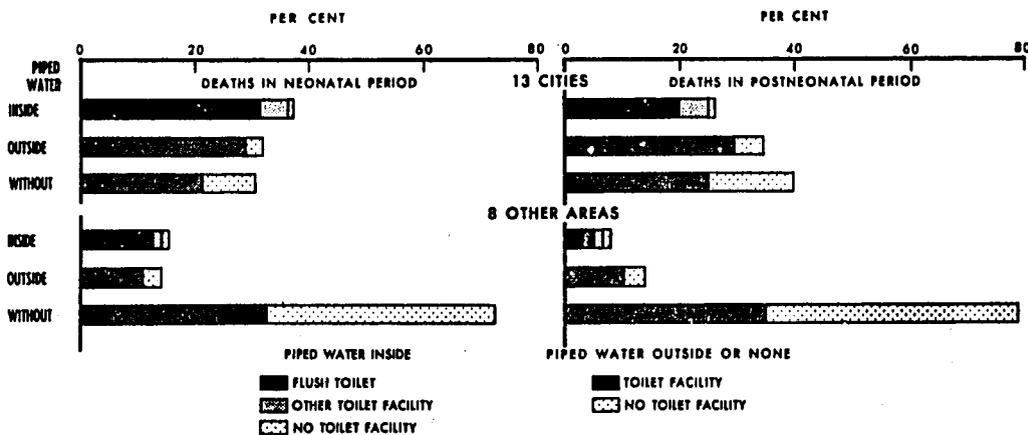
SANITARY FACILITIES

Data on the type of toilet facility used by the family (flush toilet inside house, common facility for a group of families, or other facility such as pit privy) were also obtained during the home visits by the interviewers. The data on these facilities are presented together with those on piped water in Figure 41 for 13 cities and eight other areas of the 13 Latin American pro-

jects combined, in households of infants dying in the neonatal and the postneonatal periods. Here again it can be seen that conditions were less favorable for families of infants who died in the postneonatal period.

Provision of water supplies and sanitary facilities to much higher proportions of families in many urban and rural areas is essential for bringing about major reductions in postneonatal mortality.

FIG. 41. Piped Water and Sanitary Facilities in Families of Infants Dying in Neonatal and Postneonatal Periods in 13 Cities and Eight Other Areas of 13 Latin American Projects Combined.



Chapter XVII

Changes in Assignments of Causes of Death

In this Investigation an important contribution to knowledge of causes leading to death in childhood was made by the additional clinical and pathological data obtained from hospital, clinical, and autopsy records and from interviews in the homes of deceased children.

The changes in assignments of causes of death resulting from the additional information obtained are made clear by a comparison of the final assignments with those derived from data on the death certificates.

AGREEMENT WITH UNDERLYING CAUSE FROM DEATH CERTIFICATE

As the basis for carrying out this analysis, there were 31,275 deaths, or 89.1 per cent of the total of 35,095 deaths of children under 5 years of age studied in the present Investigation. Clinical and other information in addition to death certificate was available for comparison of the classifications of 27,082 deaths, or 86.6 per cent of the 31,275. For the remainder only one type of information was found: for 2,001, the death certificate only; and for 2,192 deaths, other information only, the latter being deaths that were not registered or for which no certificates were found.

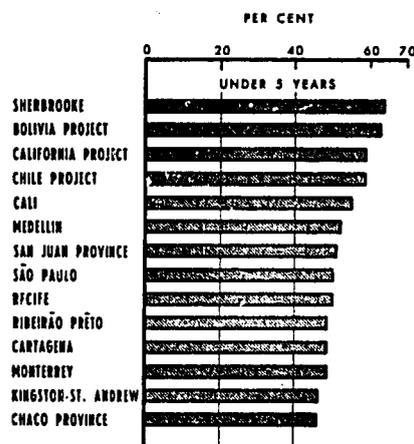
In 8,119 deaths, or nearly a third of the total, the underlying cause assigned on the death certificate was considered an associated cause on final assignment.

For slightly more than one half the deaths (52.5 per cent) the final assignment of underlying cause was in agreement with the underlying cause derived from the death certificate.

In the individual projects (as shown in Figure 42) the general agreement of underlying cause on death certificate with that on final assignment for all the deaths under

5 years of age varied from 46.3 per cent in Chaco Province to 64.3 per cent in Sherbrooke. In eight projects 50.2 per cent or more of the underlying causes were in general agreement and in the remaining six projects less than half.

FIG. 42. Agreement of Underlying Causes Based on Death Certificates with the Final Assignments in Children Under 5 Years, by Age Group, in 14 Projects.

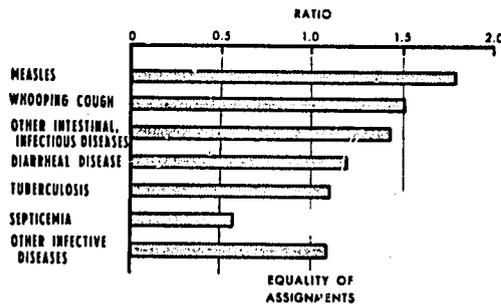


INFECTIVE AND PARASITIC DISEASES

The ratios of final assignment to death certificate assignment are shown in Figure 43 for five infectious diseases and two groups of the remaining infectious diseases. The largest increase was noted for measles (81 per cent). The increase for whooping cough of 52 per cent indicated that this communicable disease of childhood was understated as well. Increases were noted also for diarrheal disease and other intestinal infectious diseases. Of the 573 deaths assigned to septicemia from death certificates, a reduction was made to 322 on the basis of additional information on a more specific underlying cause.

With respect to measles, the assignments increased from 984 deaths on the basis of death certificates to 1,777 on final assignment. Using the death certificates alone, only 55.4 per cent of these deaths found due to measles could have been classified as measles. This indicates a serious lack of information regarding this preventable disease. In several projects the number of measles deaths was more than doubled by the additional information.

Fig. 43. Ratio of Final Assignments to Death Certificate Assignments for Infective and Parasitic Diseases as Underlying Causes in Children Under 5 Years of Age in 14 Projects Combined.



CERTAIN PERINATAL CAUSES

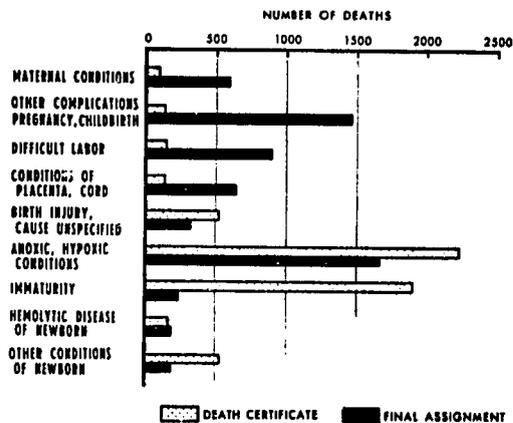
Though the size of the group as a whole differed only slightly on final assignment from that derived from death certificates, there was great variation in the specificity within the group (Figure 44). These shifts in assignment may have deep implications in terms of recognition and definition of priority problems for planning and teaching purposes. For example, 611 deaths were assigned in the Investigation to maternal conditions but only 100 were so classified on death certificates. This represents a sixfold increase, and in some projects the ratio was even higher. Knowledge of the sequence of events, including mother's condition before and during pregnancy and circumstances surrounding birth, is essential for assigning the multiple causes and for ensuring the survival and health of the product of gestation. Such relationships have been analyzed in Chapter VI.

There was a sixfold increase also in the final assignments of deaths due to difficult labor, for the 14 projects combined. In certain projects the increases were dramatic, as in Bolivia, Monterrey, Recife, and São Paulo, where the final assignments were from 12.0 to 25.3 times the numbers known from death certificates.

Other complications of pregnancy and childbirth showed a tenfold increase on final assignment as underlying causes.

Deaths attributed to conditions of placenta and cord on final assignment were more than four times the number known from death certificates.

Fig. 44. Infant Deaths from Certain Perinatal Causes as Underlying Causes Based on Death Certificates and on Final Assignments in 14 Projects Combined.



On 1,910 death certificates immaturity was the only cause given and thus the coding was made to category 777. However, for 1,681 of these deaths information available from clinical or other records was used to make a specific assignment.

These findings should bring to the attention of certifying physicians the important contribution they can make to the improvement of mortality statistics. Teaching through clinical-pathological conferences would be beneficial. Thus, complete certification of multiple causes of death becomes a problem of medical education.

Chapter XVIII

Highlights and Recommendations

Fifteen concise statements of the findings of the Investigation are given as highlights.

First. Nutritional deficiency was the most serious health problem uncovered in the Investigation, as measured by its involvement in mortality. This condition is coupled with low weight at birth, and the two conditions combined are endangering the survival and hampering the growth and development of infants and young children and probably of future mothers. Through the study of mortality by multiple causes, 57.0 per cent of the children who died under 5 years of age were found to have had immaturity or nutritional deficiency as either the underlying or an associated cause of death.

Immaturity and nutritional deficiency were found to be even more serious in rural areas than in the neighboring cities.

Second. For the first time mortality from nutritional deficiency has been analyzed by age at death and by type of deficiency.

The peak of mortality from nutritional deficiency was in infancy, as early as the third and fourth months of life, but the patterns differed markedly in the 13 projects.

Mortality from protein malnutrition increased to its peak in children 12-17 months of age, while nutritional marasmus caused high rates in infants from 2-6 months old.

Third. Analyses of associated as well as underlying causes of death were necessary in order to uncover important interrelationships such as the synergistic action of infectious diseases and nutritional deficiency, and the effects of complications of pregnancy and childbirth on products of gestation as measured by weight and condition of the newborn.

Fourth. Official mortality statistics fail to reveal the real magnitude of health problems. For the 15 projects combined, 13.2 per cent of the neonatal deaths had not been registered; in one project half had not been registered, and in two others more than one-fourth.

Only 52.5 per cent of the death certificates were in general agreement with the underlying causes that were assigned in the Investigation on the basis of additional clinical and pathological information obtained from hospital and autopsy records and during interviews conducted in the homes of deceased children.

Fifth. The role of the infectious diseases as underlying causes of death has been clarified, with diarrheal disease being found as the principal cause and measles second in importance. The death rate from infectious diseases was shown to be 23 per cent higher than could have been known from the official death certificates.

Sixth. The relationships of abnormal conditions in the mother before and during childbirth, complications of pregnancy and immaturity, and their effects on the product of conception have been measured for the first time.

Maternal conditions and difficult labor as underlying causes of death were increased sixfold by the additional information collected in the Investigation; other complications of pregnancy and childbirth were increased more than tenfold.

Surprisingly high proportions of deaths in the neonatal period were of newborn infants of low birth weight.

Seventh. The Investigation has uncovered excessive frequencies of deaths from congenital anomalies of the nervous system in three projects.

Further research into the causation of spina bifida is essential in order to determine if some type of nutritional deficiency or a toxic or environmental factor is involved.

Eighth. Marked variations in patterns of mortality were noted for certain other causes and groups of causes such as diseases of the nervous and respiratory systems, malignant neoplasms, external causes, and the sudden death syndrome.

Ninth. Child mortality in rural areas of the projects included in the Investigation was much higher than in the neighboring cities, thereby reflecting the seriousness of health problems in those sectors.

The variation in mortality was greatest for children in the second year of life, the highest rate (in a rural area) being more than 50 times the lowest (in suburban California). To reduce mortality in childhood, major attention must be given to rural areas in Latin American countries.

Tenth. Excessive reproductive wastage has been revealed through the study of mortality in products of previous pregnancies of the mothers of deceased children included in the Investigation.

In projects with high birth rates, high proportions of the deceased infants studied in the Investigation were of fifth or higher birth orders (e.g., 50.7 per cent in Recife and 48.6 per cent in Monterrey).

Planning for healthy and intelligent children is a vital and integral part of health planning. For such planning, basic data are indispensable.

Eleventh. Breast feeding for one month

or longer had been provided for only 52.5 per cent of the infants who died in the postneonatal period; also, only 18.4 per cent of those dying at 6-11 months of age had been breast fed for six months or longer. Among breast fed infants lower proportions of the deaths were due to diarrheal disease and nutritional deficiency than in those never breast fed.

Twelfth. An inverse correlation was found between infant mortality and prenatal care of mothers.

In five of the areas (three of them rural) less than half of the mothers had received any medical attention in the prenatal period.

Thirteenth. The level of education of the mother was shown to be a valuable indicator of socioeconomic status. This educational measure is therefore an appropriate one for use in health planning and in future research.

Fourteenth. The availability of piped water supplies varied markedly in the Latin American areas. In those areas a negative correlation was established between postneonatal death rates and the percentages of homes with piped water among families of infants dying in the postneonatal period.

Provision of water supplies (and sanitary facilities) to much higher proportions of families in many urban and rural areas is essential if major reductions in mortality are to be achieved.

Fifteenth. Coordinated, community-centered research has clearly been demonstrated to be a sound method of uncovering health problems and providing data needed for the establishment of effective programs.

MATERNAL AND CHILD HEALTH AND NUTRITION

It is believed that a multidisciplinary and intersectoral approach should be introduced to develop programs that will make optimum use of resources to deal with

the most serious of the multiple conditions and factors found to be responsible for mortality and morbidity. The degree of risk at the level of community, family, and

individual must be taken into account in setting the order of priorities.

A top priority is the promotion and attainment of an optimum state of nutrition for pregnant and nursing women and for the products of conception. Prevention of low weight at birth (immaturity) and of nutritional deficiency is considered a much more effective and less expensive endeavor than care of the immature infant and extended treatment of the malnourished child.

Breast feeding of sufficient duration and the timely addition of adequate foods to the diet of the weaning child should be encouraged as essential life-giving measures in developing areas. The use of these protective measures should go hand in hand with other basic actions to reduce the magnitude of the most serious health problems in developing areas: the complex of nutritional deficiency-infection.

EDUCATION IN THE HEALTH SCIENCES

The universities and in particular the schools of medicine and public health, working through the principal collaborators and their staffs, made highly significant contributions to the conduct of this Investigation.

Closer working relationships should be established between universities—which are most valuable instruments of change—and the health agencies. To this end the following recommendations are made.

First. Students at all levels in the various health disciplines should become acquainted with the status and problems of health in

the community.

Second. The planning and conduct of research and practical studies by universities in the community should involve the staffs and facilities of the health services.

Third. The experience of this Investigation could assist toward a better definition of methods for teaching the disciplines related to maternal and child health.

Continuing education in maternal and child health disciplines, using the facilities of health services as well as university resources, is essential.

DEVELOPMENT AND IMPROVEMENT OF BASIC HEALTH DATA AND STATISTICS

For geographic studies of diseases it is necessary to have available or develop basic data from different areas.

The first and most important recommendation is that the outcome of each pregnancy be recorded with as much information as possible.

These recommendations can be carried out readily in hospitals and health centers. Midwives and nurses as well as obstetricians and pediatricians can contribute to the complete recording of such vital data.

For calculating death rates in a given

area, essential data on infant's birth weight and on age and parity of mother must be provided for both the numerator (infant or neonatal deaths) and the denominator (live births); and the proper distinction must be made between mothers who are residents of the area and those who are non-residents. The leadership of the medical profession in establishing procedures in hospitals, health centers, and vital statistics systems is important so that the data needed for health programs and for research will become available.

EPIDEMIOLOGIC RESEARCH

The policy of combining epidemiologic and community-centered research with preventive actions is the sound and logical approach. The Investigation has demonstrated clearly the great diversity of patterns of mortality in widely separated areas of the Hemisphere. In medical education programs, students should be made aware of the importance of continuing the search for greater knowledge of diseases and for clues to their etiology.

The gravity and complexity of the combined effects of immaturity-nutritional deficiency are clear, and methods to break this vicious cycle must be found. However, only through longitudinal research will it be pos-

sible to demonstrate conclusively the full effects of nutritional deficiency on the future mothers and on their products. Such comparative studies on the outcome of pregnancies, taking into account biological factors in the mother such as age, nutritional state, and reproductive history as well as social and environmental factors, would be of great value for understanding differences in patterns of reproduction and for planning health programs.

Future epidemiologic research on diseases and on methods for their prevention should be directed toward elucidating the roles of the host, the specific agent, and the environment, and all the interrelationships of the multiple factors involved.