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9. ABSTRACT This paper discusses selected results of the Inter-American Investigation of Mortality in Childhood. The findings of the study of multiple causes and factors involved indicated many fields for actions and for additional research. Also pertinent findings in the earlier investigation of mortality of adults should be utilized in planning for healthy societies. The most important underlying problem is the provision of satisfactory foods for health, in terms of quality and quantity. Prevention of immaturity, nutritional deficiency and coronary heart disease is much more realistic than treatment in terms of resources throughout the world. An awareness must be created of the relation of foods consumed to health. This publication gives nine fields in which recommendations are given in detail: registration of births and deaths; modernization of systems of registration; analyses of multiple causes of death for understanding of epidemiology of disease; studies of outcome of deliveries in hospitals; studies directed to the determination of the risks and methods of prevention of low and deficient birth weights; planning of food supplies for healthy children; maximum utilization of the results of the research programs; incorporation of methods, procedures and findings in programs of medical education as well as in teaching; and continued development of community centered research as a joint endeavor of universities and health services.		
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**INTER-AMERICAN INVESTIGATION OF MORTALITY IN CHILDHOOD (a)**  
**IN 15 PROJECTS**

**Selected Results**

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Rapid progress in improving the health of populations will depend on the introduction of preventive measures to large segments of the population - in contrast to treatment of individual cases. Such programs require an understanding of the causation of the health problems of communities. The Inter-American Investigation of Mortality in Childhood indicates the wide differences and the distinct patterns of mortality in infancy and childhood<sup>(1)</sup> and is leading to knowledge of the multiple causes and factors involved and hence to preventive programs.

The development of community-centered research as an important part of medical education is relatively recent. Fortunately research on a community basis is underway here in Trujillo by the National University of Trujillo, Peru and the development of this meeting, Primeras Jornadas Peruanas Sobre la Salud del Niño, is recognition given to the combination of medical research, teaching and actions in university education.

Coordinated international research through geographic studies is undoubtedly of fundamental importance for uncovering health problems as well as patterns and methods of spread of disease. Not only do problems need to be brought to light but also searches for causes and contributing factors must be extended in various areas of the world. Students and health workers must become aware of the need to gain the fullest possible knowledge of diseases in their own particular areas, in developing as well as developed countries. There is not uniformity in patterns and more than one cause or factor may be involved; the susceptibility of the host as well as the infectious agent and the environment may be involved in the development of disease. Here in Peru, with populations living at high altitudes as well as at sea level, in urban as well as rural areas, the opportunities for research considering these multiple factors are favorable.

(a) 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.

This paper was prepared for Primeras Jornadas Peruanas Sobre la Salud del Niño, Trujillo, Peru, 12-15 February 1975.

The two large investigations of mortality, first of adults<sup>(2)</sup>, followed by the second of infants and young children<sup>(1)</sup>, have assisted in the development of community centered research as part of the educational process in several schools of medicine and public health. With one exception the principal collaborators in the investigation of mortality in childhood were members of faculties of schools of medicine or public health and thus the research programs were conducted by those universities.

The principal collaborators served as leaders of multidisciplinary teams and more than 200 persons participated in the collection of data in the field, of which 120 were physicians and 80 were public health nurses or social workers. These leaders contributed in many ways to the success of the program and are now contributing to the implementation of the recommendations and in the development of operational research.

The two large coordinated research programs undertaken by the Pan American Health Organization have uncovered serious health problems and contributed to greater understanding of the epidemiology of diseases as the basis for health programs. Examples will be taken from the findings of the two investigations to illustrate the value of coordinated international research and to indicate how much more needs to be learned regarding causation through community-centered programs, ideally conducted by medical schools as joint endeavors of universities and health services, to safeguard the health and well-being of populations.

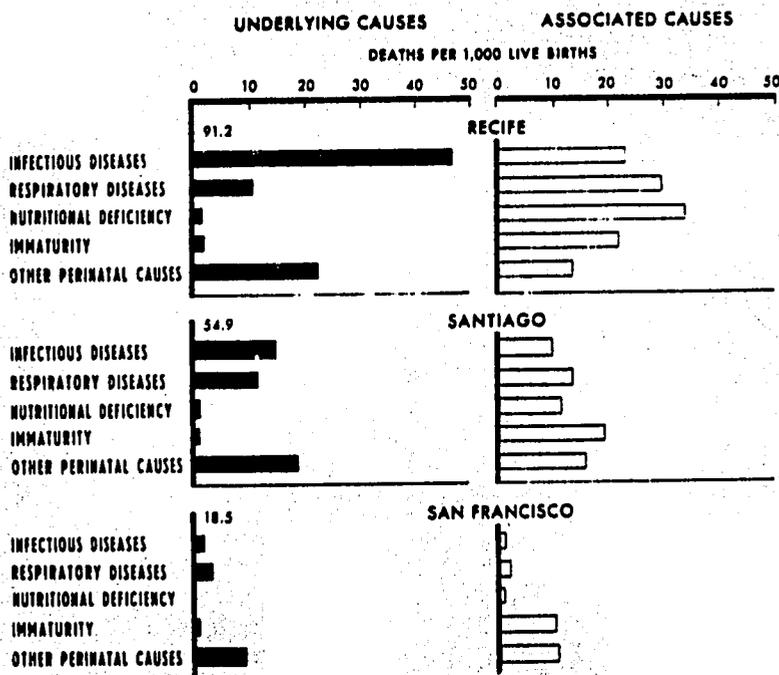
In the first investigation, medical referees assigned the underlying causes of death on the basis of all available clinical and pathological information. They found the assignment of one underlying cause difficult, if not impossible, for certain causes. Experimentation was recommended for studying the epidemiology of disease not as isolated entities but as a combination of pathological states. Thus the first investigation led to the study of multiple causes, the underlying and associated causes in the Investigation of Mortality in Childhood. Data have been selected to present at this time on multiple causes of infant mortality followed by material on multiple factors which are determinants of mortality in infancy. Since these findings indicate that planning for healthy populations in highly developed as well as in developing societies probably involves the types of food consumed beginning in infancy, selected data regarding mortality in adult life will be presented also. Planning for prevention of coronary heart disease and arterial lesions and perhaps of other diseases and conditions in adult life may properly begin early in life, that is in infancy and childhood.

#### Multiple Causes

Health problems that have remained hidden in routine analyses of mortality are revealed at least partially by the multiple cause approach. The international rules of WHO for the assignment of underlying causes were followed in the Investigation and rules were developed for the associated causes which are explained in Chapter V in Patterns of Mortality in Childhood<sup>(1)</sup>

To illustrate this method the death rates from five broad groups of underlying and associated causes of infant deaths for three cities<sup>(a)</sup> are shown in Figure 1. Infant mortality varied widely in these three cities from the high rate of 91.2 deaths per 1,000 live births in Recife, Brazil, an intermediate death rate of 54.9 in Santiago, Chile and a low rate of 18.5 in San Francisco, California in the United States. (These rates are given in the left section of the figure.) The death rates from the group of underlying causes are shown by the bars in the left section and those from associated causes in the right section.

Fig. 1 Broad Groups of Underlying and Associated Causes of Infant Mortality<sup>(a)</sup> in Three Cities



(a) The infant death rate is given in the left corner for each city.

In Recife which had a very high infant death rate, over half of the infant deaths were due to infectious diseases as the underlying causes, and the rate for this group of causes was 46.4 per 1,000 live births. This rate was much higher than the rates from respiratory diseases, nutritional deficiency and immaturity. It was over twice the death rate of 21.9 from certain perinatal causes (excluding immaturity).

The patterns of underlying causes in Santiago and San Francisco may be seen in the two lower sections. In San Francisco very few infant deaths

(a) Since data are available in tables of the published reports, figures are used to illustrate the findings.

were due to infectious diseases and over half of the infant deaths were due to perinatal causes. In Santiago the death rates from the groups of infectious diseases, respiratory diseases and other perinatal causes of 14.4, 11.3 and 18.7 per 1,000 live births respectively had a distinctly different pattern. The death rate from infectious diseases was less than one-third the rate in Recife and 10 times the rate in San Francisco.

The international rules for classification specify that immaturity is not to be assigned as an underlying cause if any other cause of perinatal mortality is reported. Thus the death rates from immaturity as an underlying cause are very small.

The patterns of associated causes of death are completely different from those of the underlying causes and death rates varied markedly in these three cities. 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 provide only one assignment for each, that is either immaturity (777) or nutritional deficiency (260-269) as an underlying or associated cause. Thus it was possible to obtain the number of infant deaths in which one of these causes of death was present. In Recife the death rate from nutritional deficiency as an associated cause of 34.0 per 1,000 live births was very high. In Santiago however, the rate of 11.4 was much lower and in fact was lower than the rates for respiratory diseases, immaturity and other perinatal causes. In San Francisco, the death rate from nutritional deficiency as an associated cause was exceedingly low (0.6) and the two principal associated causes were immaturity (9.9) and other perinatal causes (10.5).

The Investigation revealed that immaturity is a very serious problem in many areas of Latin America. The following definition of immaturity was given in the International Classification of Diseases(3), "For the purpose of this Classification an immature infant is a live born infant with a birth weight of 5 1/2 pounds (2,500 grams) or less, or specified as immature". This condition can be considered the most important factor in vulnerability to disease and death in the neonatal period. Its involvement as an underlying or associated cause of death was limited principally to that period. Neonatal mortality from immaturity as an underlying or associated cause for the 15 projects is shown in Figure 2; the associated causes are divided into those in which immaturity was classed as a contributory cause and those in which it was a consequence of a maternal or other condition in pregnancy. The rates from immaturity as an underlying or associated cause varied from 9.8 per 1,000 live births in Sherbrooke, Canada to a rate of over 20 in Recife and San Juan Province of Argentina.

The uncovering of this problem of immaturity was partly due to the discovery and inclusion of non-registered neonatal deaths. Neonatal mortality from immaturity is shown in Figure 3 according to official registration of the deaths for four Latin American cities and for San Francisco for comparison. If the non-registered deaths had not been included in Santiago the death rate due to immaturity as an underlying or associated cause would have been 12.2 while with the addition of 303 non-registered deaths found through

Fig. 2 Immaturity as Underlying or Associated Cause of Neonatal Mortality in 15 Projects

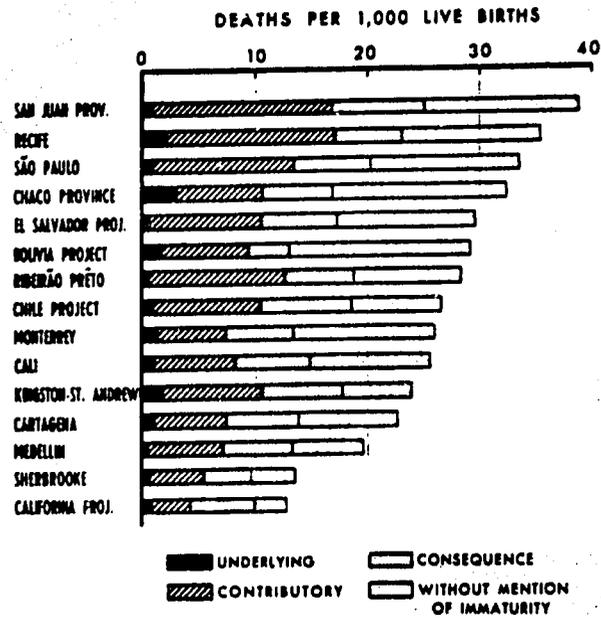
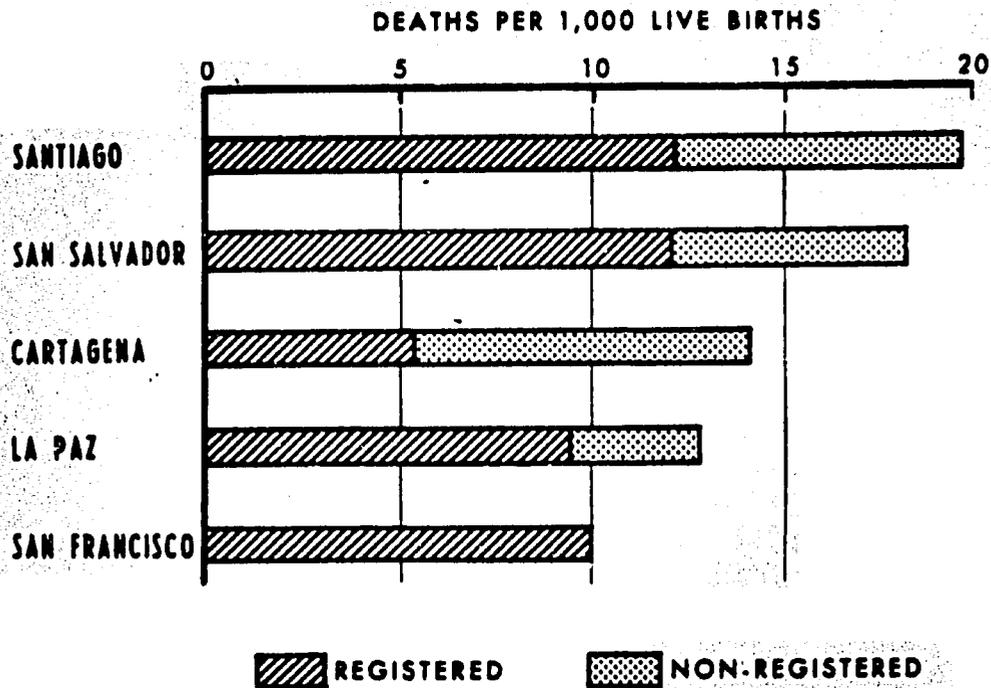


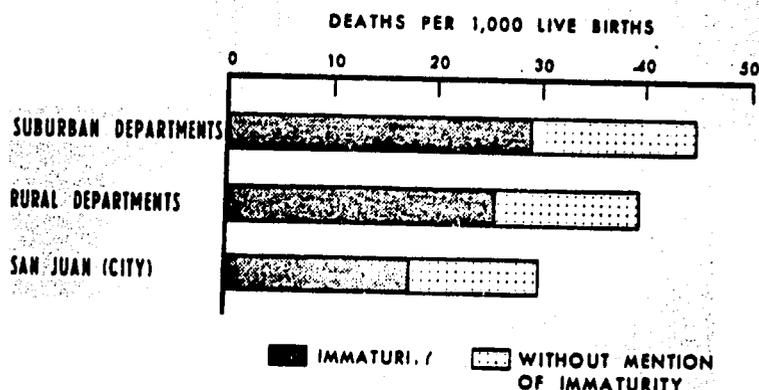
Fig. 3 Neonatal Mortality from Immaturity as Underlying or Associated Cause of Death According to Registration in Five Cities



searches of hospital records the rate was 19.7 per 1,000 live births. This rate for Santiago is nearly double the rate of 10.0 per 1,000 live births for San Francisco. As pointed out in Patterns of Mortality in Childhood, the discovery of this serious problem of immaturity was surprising. The method of analysis using multiple causes enabled calculation of death rates from immaturity. Several factors such as the frequency of low-birth-weight babies and variations in the quality of medical services could contribute to these differences.

The death rates from immaturity in the neonatal period were found to be higher in suburban and rural areas than in the neighboring cities. For example in the suburban and rural areas of San Juan Province, Argentina, the death rates due to immaturity of 29.0 and 25.4 were higher than that of 17.9 per 1,000 live births in the city of San Juan. Also differences were found in areas in the project in Ribeirão Preto, Brazil. 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 births of low-birth-weight are more common than in urban areas of the projects owing to the unfavorable nutritional state of mothers. The essential basic data on all births and deaths must be obtained for knowledge of the frequency of low-birth-weight births and of mortality from immaturity.

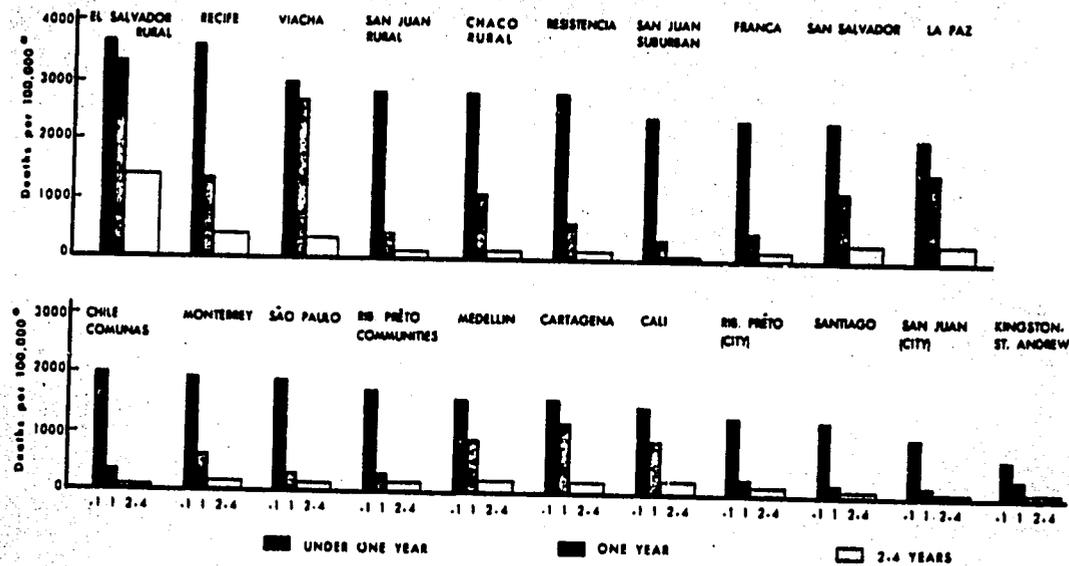
Fig. 4 Immaturity as Underlying or Associated Cause of Neonatal Mortality in Three Areas of San Juan Province



Nutritional deficiency as an underlying or associated cause of death is usually evidence of unsatisfactory growth and development commonly present after the neonatal period. Nutritional deficiency was found to be a cause of excessive mortality in the postneonatal period and in early childhood. Figure 5 shows the death rates from nutritional deficiency as an underlying or associated cause for three age groups (under 1 year, 1 year and 2-4 years)

for 21 areas of the 13 Latin American projects. In all areas death rates from nutritional deficiency were greater in the first year of life than in the other two age groups. However, very high rates in the second year of life were noted in the rural areas of Bolivia and El Salvador. Relatively high rates in the second year were also found in the cities of Recife, La Paz and San Salvador, in the three cities of Colombia and in rural Chaco Province of Argentina.

Fig. 5 Mortality from Nutritional Deficiency in Children Under 5 Years of Age for Three Age Groups in 21 Areas of Latin America

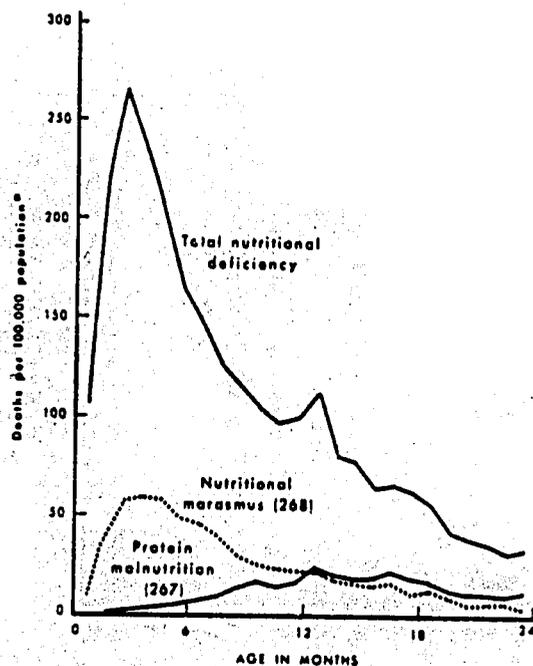


\* Under 1 year per 100,000 live births; other rates per 100,000 population.

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 while the city of San Salvador had much lower rates. The very low rates in the city of San Juan are in distinct contrast to those in rural and suburban San Juan. This evidence of higher rates in rural areas than in the neighboring cities is of key importance for health planning and for further research. Health problems such as excessive mortality from immaturity and nutritional deficiency in rural areas must be brought to light so that solutions may be sought.

For the 13 Latin American projects combined the role of the various types of nutritional deficiency as underlying or associated causes of death is shown by month of age of children under two years in Figure 6. The rates

Fig. 6 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.

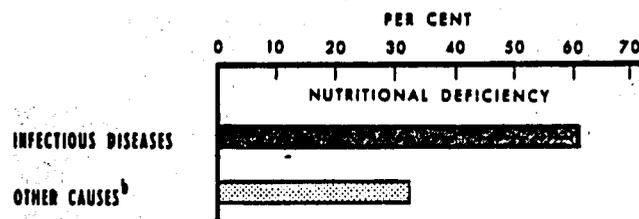
for all types combined were highest at 2 and 3 months of age and then declined in the older age groups. Protein malnutrition was diagnosed for three infants at 2 months of age, for five at 3 months and for seven at 4 months; the rates then increased steadily until the largest numbers were recorded for children aged 12-16 months, and decreased thereafter. While mortality from protein malnutrition increased to the highest rates in the second year of life, the rates for nutritional marasmus reached a peak at 2, 3, and 4 months of age and then gradually declined. Some of the survivors of nutritional marasmus probably later developed protein malnutrition and thus the damage was laid in this early period of life. It is therefore clear that preventive measures are required very early in life not only to reduce mortality from nutritional deficiency of the intermediate and marasmatic types, but to prevent protein malnutrition in the survivors as well.

Since for all forms of nutritional deficiency combined the highest mortality was in infants 2 and 3 months of age (rates of 263.4 and 235.0 per 100,000 live births, respectively), there is clear evidence of the development of severe forms in early life. This is an important finding, for in the past emphasis has been placed on deficiencies in the second year of life. Since the incidence of protein-calorie malnutrition is high at an early age when rapid growth and development take place, irreparable damage may be found in the survivors. These analyses using the multiple cause approach should lay the foundation for new and effective approaches to the study of measures for prevention of such deficiency.

The relationship of nutritional deficiency as an associated cause of deaths due to infectious diseases as the underlying cause and to other underlying causes for the 13 Latin American projects combined can be seen in Figure 7. Nutritional deficiency was an associated cause of 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 accordance with previous research indicating the importance of the nutritional state of the host in the development of disease.

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 babies. Many of these infants die from infectious diseases because of their increased vulnerability, and those who survive continue being at greater risk of the hazards of the environment and of nutritional deficiency than those born with satisfactory weight. Measures to break this vicious cycle through adequate nutrition of future mothers and their offspring and through reduction of biological wastage are mandatory to safeguard the health and intelligence of children.

Fig. 7 Nutritional Deficiency as Associated Cause of Deaths Due to Infectious Diseases and Other Causes Under 5 Years<sup>(a)</sup> in 13 Latin American Projects Combined



<sup>a</sup>Excluding neonatal deaths.

<sup>b</sup>Respiratory diseases and other causes combined

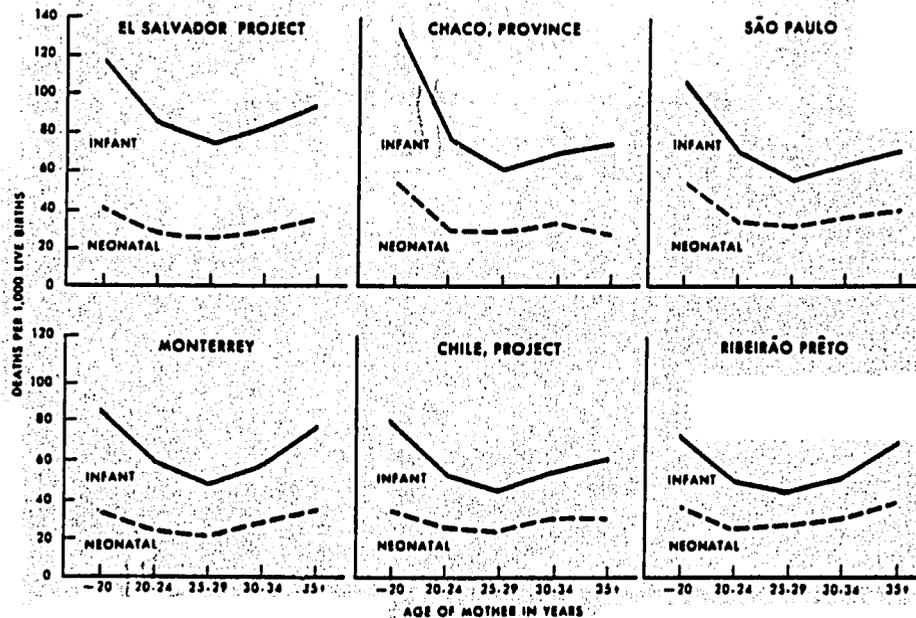
### Multiple Factors

In addition to the multiple causes of death considered in the first section of this paper, several factors such as the age of the mother at the birth of her child, the birth order and the interval from the preceding pregnancy affect the survival and condition of the infant. These factors which combine in determining the birth weight, have an important relationship to survival and are the subject of this section of the paper.

In order to analyze the risks of death in relation to these factors, the bases for death rates are essential, that is the distributions of live births by birth order, age of mother, and birth weight. Fortunately distributions of live births for the first two factors were provided for several projects and the distributions of birth weights for three projects of the investigation.

Neonatal and infant mortality is considered first for six Latin American projects according to the age group of the mother<sup>(4)</sup>. These rates shown in Figure 8 are given for the six projects in order from left to right in the two sections according to the size of the infant death rate. The rate for the El Salvador project of 88.4 per 1,000 live births was the highest while that for Ribeirão Preto of 52.6, the lowest. In these six projects the death rates for infants of young mothers under 20 years of age were very high, 133.5 per 1,000 live births in Chaco Province, 116.6 in El Salvador project and 104.1 in São Paulo. These rates were higher than in the other four age groups. The lowest death rates were for infants of mothers 25-29 years of age and thus this age period appears to be the most favorable in terms of newborns capable of surviving the hazards of infancy. The pattern of neonatal mortality was similar although the death rates were much lower.

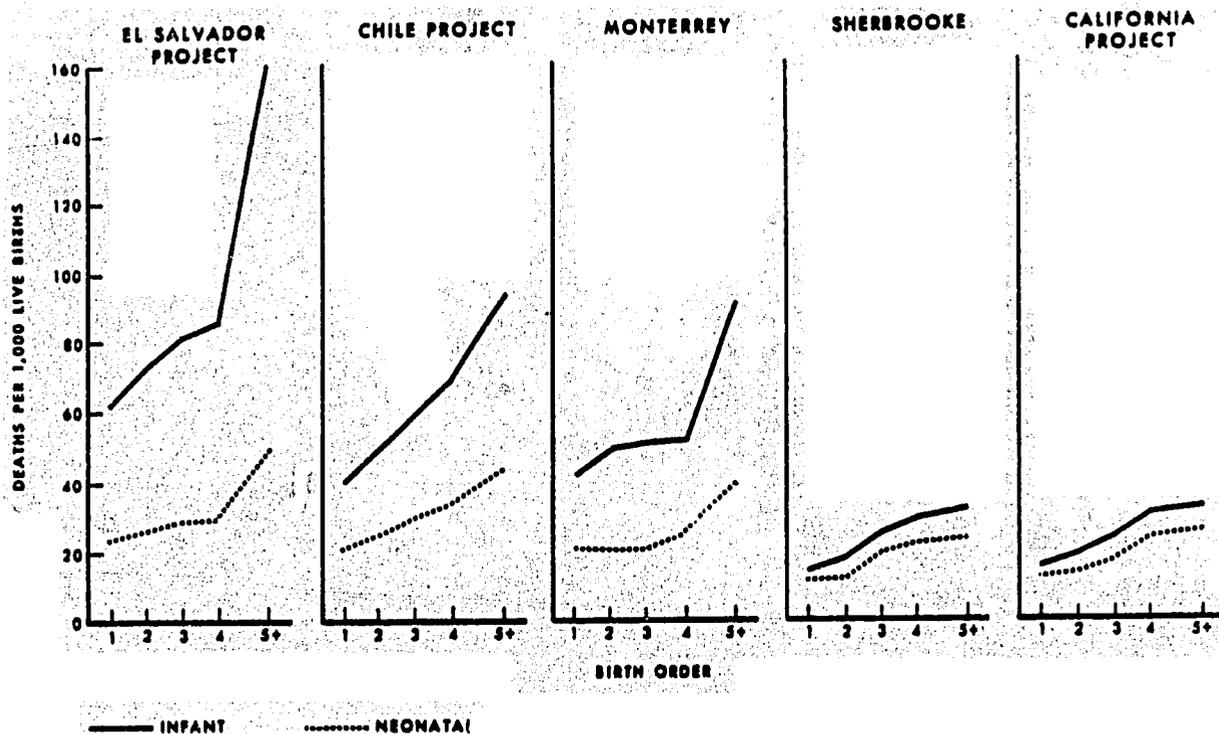
Fig. 8 Neonatal and Infant Mortality by Maternal Age Group in Six Projects



It is well known that young mothers give birth to low-birth-weight infants more frequently than do mothers in the higher age groups.\* In two projects, Ribeirão Preto and Sherbrooke the distributions of live births by the maternal age group were provided. Also data for the 1960 birth cohort of the United States(5) are available for comparison. In these three experiences 8.7 per cent of the live births weighed 2,500 grams or less in Ribeirão Preto, 7.6 per cent in Sherbrooke and 7.8 per cent in the United States. The higher percentage for Ribeirão Preto was the first evidence of an excessive frequency of immaturity of live births in a project in Latin America. The percentages of live births with weights of 2,500 grams or less for mothers under 20 years of age, that is for young mothers were higher, 11.7, 9.8 and 10.1 respectively, in Ribeirão Preto and Sherbrooke projects and in the United States.

For five projects of the Investigation infant mortality can be analyzed according to birth order. In addition to the two Northern American projects (Sherbrooke and California), the bases of live births by birth order are available for three projects, namely those in Chile, El Salvador and Monterrey. Figure 9 shows neonatal and infant death rates by birth order for these five projects.

Fig. 9 Neonatal and Infant Mortality by Birth Order in Five Projects

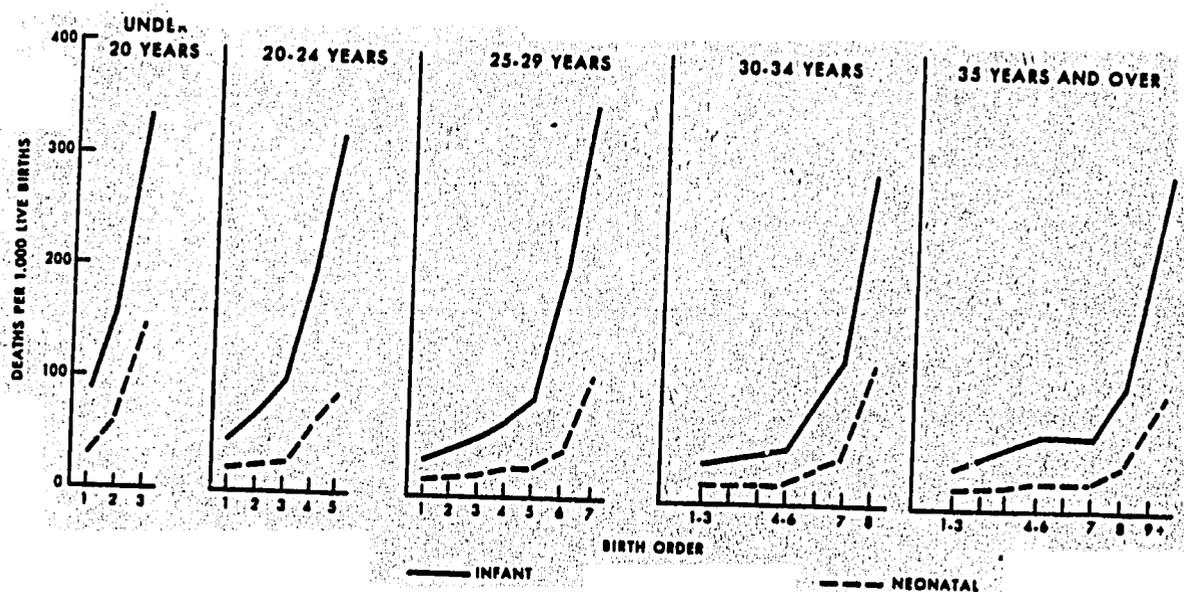


\*This statement refers to the five age groups utilized in this analysis. In the age group 35 years and over the frequency of low-birth-weight births increases with increasing age of the mother. The numbers of births in the higher age groups are small.

In general both neonatal and infant mortality increased notably with birth order. The infant death rates for those of fifth or higher birth orders were over two times the rates for those of first birth order. In the Sherbrooke and California projects the infant death rates were very low for first births (12.6 and 12.8 per 1,000 live births respectively). In these areas with very low birth rates, 40.4 per cent of the live births in the Sherbrooke project and 43.2 per cent in the California project were first births. In these two Northern American projects the infant death rates were only 36 and 38 per cent higher than the neonatal death rates. In the three Latin American projects, the postneonatal death rates were high and thus the differences in neonatal and infant death rates shown by the broken and solid lines were large. The infant death rates for the group of births of fifth or higher birth order were 90.0 per 1,000 live births for Monterrey, 90.6 for the Chile project and 160.3 for the El Salvador project.

Ideally infant mortality should be analyzed by birth order according to maternal age. Unfortunately only limited data are available at this time. For the El Salvador project the death rates by birth order are shown for five maternal age groups in Figure 10. As the bases had to be estimated utilizing cross tabulations for 1972, the rates as presented are subject to some variations due to several difficulties encountered. However, the data are sufficient to show the type of relationships. As shown in Figure 8 in the El Salvador project the death rate for infants of young mothers under 20 years of age was very high, 116.6 per 1,000 live births. As shown in Figure 10 even for first births in this maternal age group the rate was high, 89.6. The rate for second births was 161.5 and in excess of 300 per 1,000 live births for those of third birth order.

Fig. 10 Neonatal and Infant Mortality by Birth Order According to Maternal Age Group in El Salvador Project



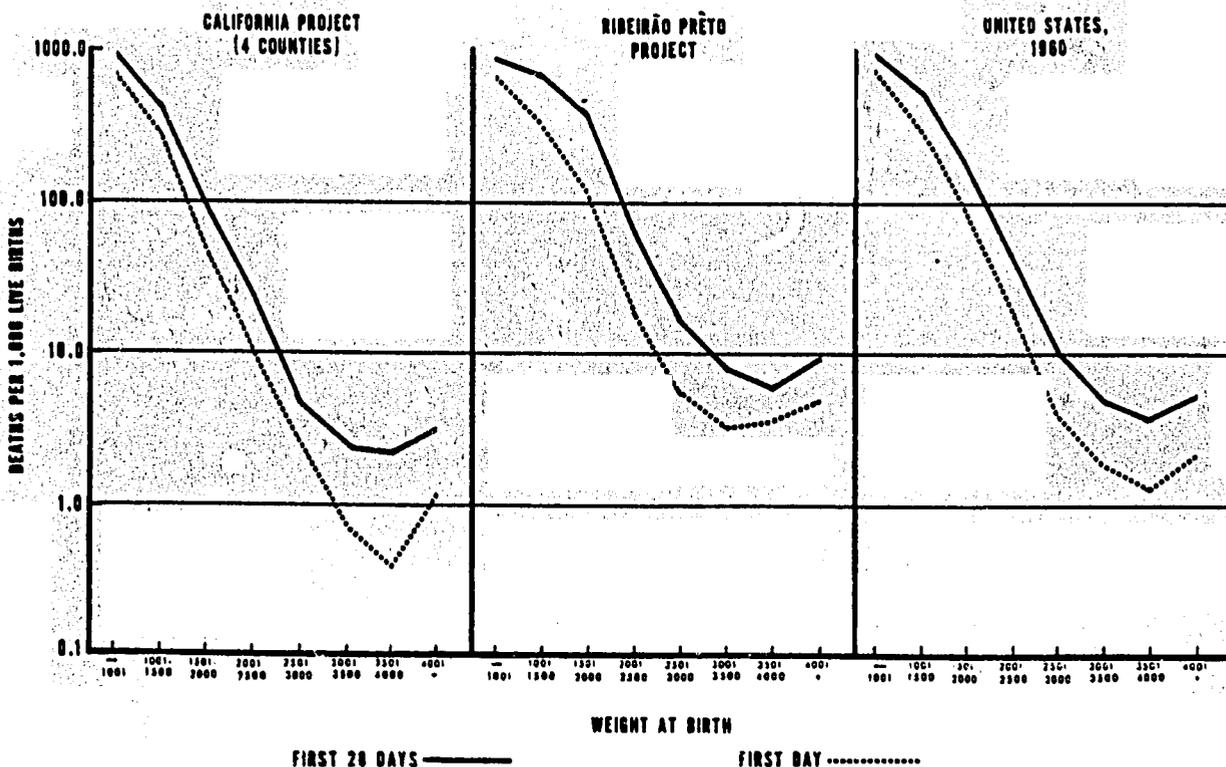
In the next age group, 20-24 years, the rate for first births was much lower, 44.0 per 1,000 live births. The rates increased for higher birth orders and for those of fifth birth order, again as in those of third birth order in the younger mothers, the infant death rate was in excess of 300.

Infant mortality was lowest for the maternal age group, 25-29 years. The death rate for first births of 30.8 was much lower than for infants of younger mothers having their first product. In this maternal age group the rates were relatively favorable for those of low birth orders but increased likewise to a rate in excess of 300 for those of seventh birth order.

In each maternal age group infant mortality increased with increasing birth order. Thus both factors are determinants of mortality. As pointed out in another report<sup>(4)</sup> the length of the interval between pregnancies has an important relationship. In maternal age groups when the birth intervals are short as for third products for mothers under 20 years of age, fifth and seventh products for those of mothers 20-24 and 25-29 years of age, mortality is excessive.

A third factor, weight at birth, is a determinant of the outcome. In only two projects of the Investigation could the base of live births by birth weight be estimated to serve for calculation of mortality by birth weight. Figure 11 shows neonatal death rates and death rates in the first day of life for the California and Ribeirão Preto projects by birth weight<sup>(6)</sup>. Similar data are included for the live-birth-cohort of United States in 1960.

Fig. 11 Mortality in First Day and First 28 Days of Life by Birth Weight in Projects of California and Ribeirão Preto and in United States 1960

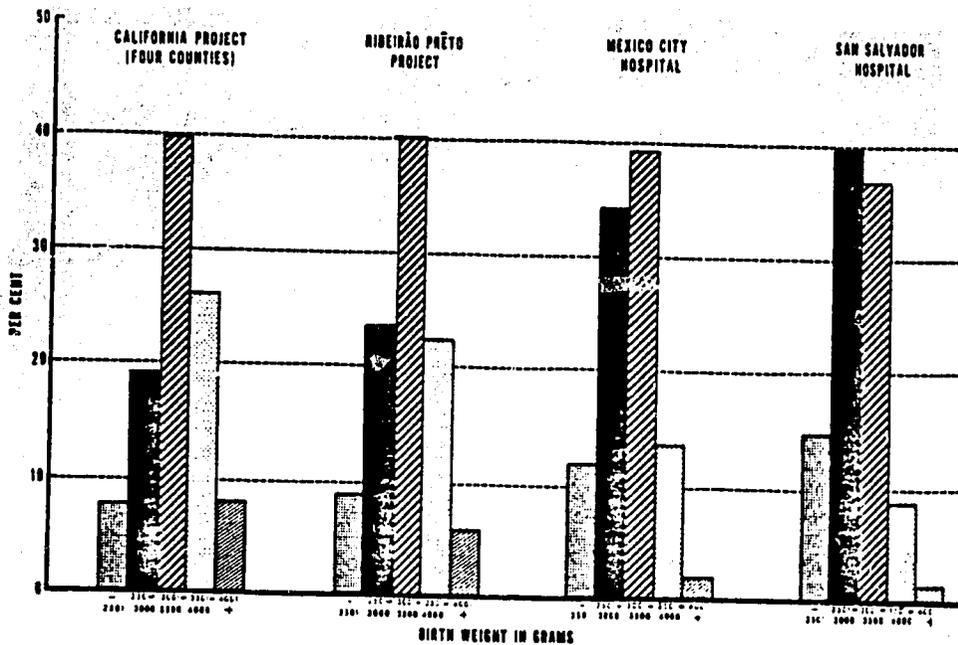


Very high proportions of babies weighing 1,000 grams or less died either in the first day or first 28 days of life. However, the fact that around 30 per cent survived the first day of life is evidence of the importance of inclusion of these very low-weight babies in studies of the outcome of pregnancies. Neonatal mortality declined as weight increased and became lowest for those weighing 3,501-4,000 grams at birth. The neonatal death rates of infants weighing 2,501-3,000 grams at birth, that is with deficient weights, was over twice the most favorable rates of those weighing 3,501-4,000 grams.

The lack of data from official registration systems has delayed understanding of the size of the problem of immaturity, that is of births of low-birth-weights, and also of the problem of births of deficient birth weights. Newborns with these weights are at great risk of death as infants from immaturity or nutritional deficiency.

Because of the evidence of the seriousness of immaturity as a health problem in the Investigation, exploratory tabulations are being made of the weights of live births in large maternities in cities of Latin America(6). Figure 12 shows the distributions of live births by birth weight in the California and Ribeirão Preto projects and in hospitals in Mexico City(7) and San Salvador. The percentages of births of low-birth-weight (2,500 grams or less) shown by the solid black bars varied from 7.6 in the California counties to 14.4 in the maternity hospital in San Salvador. Also the percentages with deficient birth weights increased from 19.1 in the California

Fig. 12 Distribution of Live Births by Birth Weight in Two Projects and Two Hospitals



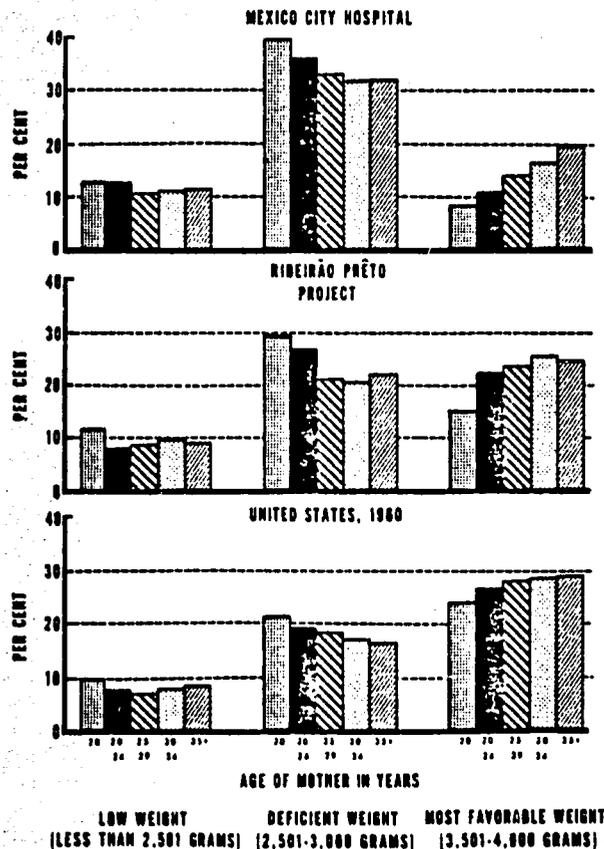
counties to 39.3 in the San Salvador hospital. Thus in the San Salvador hospital over half of the babies (53.7 per cent) had low or deficient birth weights while the comparable figure for the four California counties was 26.7 per cent.

While the percentages of births with low and deficient weights were higher in the San Salvador hospital than in the other experiences, the reverse was found for the percentages in the birth weight group of 3,501-4,000 grams, termed the most favorable in terms of mortality. The percentages in this weight group varied from a high of 26.0 in the four counties of California to 13.3 in the Mexico City hospital and 8.5 in the San Salvador hospital. As can be seen in Figure 12, very few babies in the two hospitals in Middle America weighed at least 4,001 grams.

The weight at birth depends on several factors and one of the most important is the age of the mother. In all three experiences shown in Figure 13 the young mothers under 20 years of age had higher percentages of their babies with low and deficient birth weights than did older mothers. The percentages of births in the most favorable birth weight group, 3,501-4,000 grams, increased with increasing age of the mother.

The distribution of live births in the five age groups of mothers varies dependent on the size of the birth rate and hence on the amount of family planning.

Fig. 13 Percentage of Live Births in Three Weight Groups for Five Age Groups of Mothers in a Mexico City Hospital, Ribeirão Preto Project and United States 1960



Birth order as well as maternal age group influences these frequencies. In the birth cohort of 1950 in the United States<sup>(8)</sup>, of live births to mothers under 20 years of age the frequency of low-birth-weight births increased from a low of 8.6 per cent for first births to a high of 18.3 per cent for fifth or later products. Large experiences are needed for obtaining these percentages in accordance with the three determinants, birth weight, birth order and maternal age group. Ideally official registration systems should be the source of such data. The addition of birth weight to birth certificates is recommended<sup>(9)</sup>. However, hospital data could be used as a source of information on these determinants of infant mortality. A recent paper from the Investigation<sup>(6)</sup> stresses the utilization of hospital birth weights and mortality as indicators of health problems in infancy.

In the recent study of infant mortality in the live birth cohort of 1968 in New York City by the National Academy of Sciences<sup>(10,11)</sup>, the official birth and death certificates were used as the source of data. Birth weight was provided on the birth certificate as well as birth order and age of mother. In that study infant mortality was said to be "related more closely to infant birth weight than to any other maternal or infant characteristic". One of the recommendations was to refine "risk categories and to direct the woman to appropriate services that decrease her chances of producing a low-birth weight or nonviable infant".

A research program underway in INCAP<sup>(12)</sup> in which food supplementation of 20,000 calories or more was provided to mothers indicated that such intervention resulted in a mean birth weight gain from 2,960 to 3,220 grams. Rush and co-workers<sup>(13)</sup> have shown that the prepregnancy weight and the weight gain during pregnancy are determinants of the weight at birth. The objectives of their research is to establish and then to plan strategies to prevent the occurrence of births of low-birth-weight and its sequelae.

Thus the Investigation as well as other studies are demonstrating that reductions in infant mortality require improvement in the condition of babies at birth. Emphasis should be placed on the delivery of babies with favorable birth weights and the elimination to the extent possible of delivery of babies with low and deficient birth weights. Since the age of the mother and birth order are determining factors in the weight of her child at birth, these three determinants of infant mortality deserve further study and consideration in planning for healthy infants.

These selected results indicate that multiple causes and factors are responsible for high death rates in infancy and childhood. They point to the need for actions for the prevention of immaturity and nutritional deficiency. Women in the reproductive period especially during pregnancy require sufficient food to insure healthy babies with sufficient weight to survive infancy and the hazards of infectious diseases in childhood. Evidence from Winick and Rosso<sup>(14)</sup> and others<sup>(15)</sup> suggests that nutritional deficiency of the fetus may have permanent effects on the child's intelligence and adaptive capacity. The consequences of inadequate nutrition on communities are exceedingly grave.

Thus the most important problem is food, the quality and quantity, for infants, children and women in the reproductive period. Certain results of the Inter-American Investigation of Mortality in adults may be combined with these findings as a basis for planning food supplies.

#### Selected Data from Investigation of Mortality in Adults

The wide variations in death rates from coronary heart disease in 24 countries of the world<sup>(16)</sup> and low death rates in the Latin American countries led to the Inter-American Investigation of Mortality of adults 15-74 years of age. The primary objective was to provide a comprehensive account, as accurate and complete as possible, of the causes of death of adults living in highly diverse and widely separated populations. Lima, Peru, was one of the cities included as were Bogotá and Cali in the neighboring country of Colombia. Findings from these three Latin American cities are used to illustrative differences.

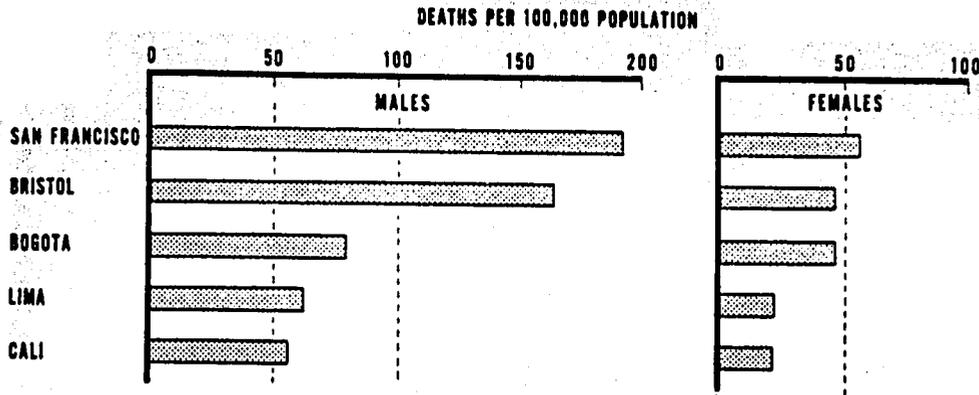
The Investigation showed that there are large and real differences in mortality from arteriosclerotic heart disease, principally affecting males. The age adjusted death rates from arteriosclerotic heart disease for these three cities of Latin America and for comparison of San Francisco in the United States and Bristol in England are shown in Figure 14. The death rates for males of 191.2 and 162.8 per 100,000 population in San Francisco and Bristol were two to three times the low rates of 78.0, 60.6 and 54.7 in Bogotá, Lima and Cali. Low death rates were noted for females and the rate for Bogotá was the same as that for Bristol.

Large differences in death rates for males were found even in young adults, with higher rates in Bristol and San Francisco than in Lima, Bogotá and Cali. Figure 15 shows these death rates (on semi-log scale) for the 40 year age period, 35-75 years, for these five cities.

Analysis of the findings of the Investigation<sup>(17)</sup> by social class revealed that the proportion of deaths due to arteriosclerotic heart disease was high in the professional class in the Latin American cities while the proportions were high in all three social classes in San Francisco and Bristol.

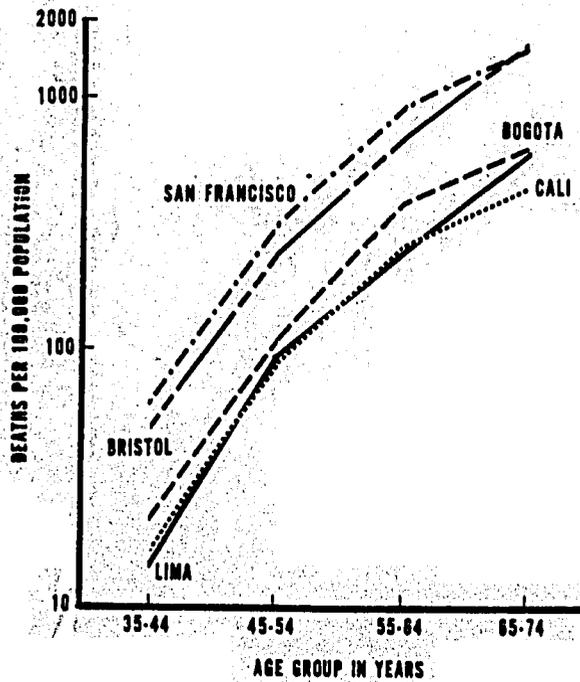
Epstein<sup>(18)</sup> pointed out that it is likely that "major geographic differences in coronary heart disease frequency are mostly due to differences in the consumption of saturated fats but that a high intake of sucrose, coupled with a high saturated fat intake, excess of calories and lack of exercise, have an added detrimental effect". It may be that the consumption of sucrose and highly saturated fats is greater for individuals of the professional class than in the other classes in Latin American cities. As food patterns change with economic development and in planning for prevention of immaturity and nutritional deficiency it is important to prevent the so-called "epidemics of coronary heart disease" now occurring in countries of Europe and Northern America.

Fig. 14 Annual Age-Adjusted Death Rates from Arteriosclerotic Heart Disease, by Sex, 15-74 Years of Age, in Five Cities, 1962-1964



(a) SOURCE: Patterns of Urban Mortality<sup>(2)</sup>

Fig. 15 Annual Death Rates from Arteriosclerotic Heart Disease of Males 25-74 Years of Age, in Five Cities, 1962-1964



SOURCE: Patterns of Urban Mortality<sup>(2)</sup>

At the same time that the Inter-American Investigation of Mortality in adults was being conducted another investigation which was recommended also by the Study Group on the Classification of Atherosclerosis Lesions of WHO<sup>(19)</sup> was underway. The large research project termed International Atherosclerosis Project<sup>(20)</sup> was conducted by McGill and co-workers, principally pathologists in 15 cities of which 13 were in the Americas. Lima, Bogotá and Cali were included. In that investigation raised atherosclerotic lesions in the coronary artery were found early in life in the European City of Oslo, Norway and in the United States City of New Orleans. The percentages were much lower throughout life in Lima, Bogotá and Cali being exceedingly low in young adults 25-34 years. One of the possible explanations is the higher fat intake in diets in Oslo and New Orleans. Thus in planning for satisfactory diets for mothers, infants, and children foods which may result in an increased risk for arterial lesions and for coronary heart disease in adult life should be avoided. The mistakes of highly developed countries should not be copied.

## DISCUSSION

The findings of the Investigation of Mortality through the study of multiple causes and factors involved indicated many fields for actions and for additional research. Also pertinent findings in the earlier investigation of mortality of adults should be utilized in planning for healthy societies.

The most important underlying problem is the provision of satisfactory foods for health - in terms of quality and quantity. Prevention of immaturity, nutritional deficiency and coronary heart disease is much more realistic than treatment in terms of resources throughout the world. An awareness must be created of the relation of foods consumed to health. This involves many agencies in addition to those involved in health, such as agriculture and economics. In a recent publication<sup>(21)</sup> Alan Berg, an economist, emphasized the relationship of malnutrition to economic development and stated "If governments deem it important to eradicate major nutritional deficiencies, they must take actions of broad consequence". The task ahead to improve the health of our populations is a tremendous one and geographic studies such as investigations of mortality assist by uncovering serious health problems and by laying foundations for planning actions and for further research.

The evidence from these selected findings from the Investigation indicates the urgent need for actions directed to solutions of the main problems uncovered. Nine fields in which recommendations are given in detail in the publications are listed.

1. Registration of births and deaths in accordance with the definitions of WHO.
2. Modernization of systems of registration with responsibility on hospitals and health personnel; inclusion of birth weight, birth order and age of mother in birth certificates.

3. Analyses of multiple causes of death for understanding of epidemiology of disease, especially the role of host, specific agent and the environment.
4. Studies of outcome of deliveries in hospitals for knowledge of birth weights and mortality in the first day of life and their relation to birth order and maternal age group.
5. Studies directed to the determination of the risks and methods of prevention of low and deficient birth weights, and nutritional deficiency.
6. Planning of food supplies for healthy infancy and childhood and also for prevention of disease in adult life.
7. Maximum utilization of the results of the research programs for improvements and reorientation of health programs.
8. Incorporation of methods, procedures and findings in programs of medical education as well as in teaching of other health sciences and related disciplines.
9. Continued development of community-centered research as a joint endeavor of universities and health services to safeguard the health and well-being of populations.

The discussions in the second session on mortality in childhood will be focussed on actions to implement these recommendations. The three subjects will be actions indicated, operational research and educational programs. The success of our research depends on the maximum utilization of results in these three fields.

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