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STUDY OF MULTIPLE CAUSES OF DEATH IN THE INTER-AMERICAN
INVESTIGATION OF MORTALITY IN CHILDHOOD (1)

I. INTRODUCTION

The Inter-American Investigation of Mortality in Childhood is a continental collaborative study whose overall objective is the development of accurate and comparable rates of mortality for children under 5 years of age in 15 widely separated areas of the Americas. The aim in this current investigation is to collect information on around 35,000 deaths of children under 5 years of age using hospitals, clinics, private physicians, pathology records and family interviews as sources to determine the multiple causes of deaths occurring over a two-year period, as well as to determine relevant ecologic, socio-economic and demographic conditions.

In order to understand better the inter-relationships between disease conditions and socio-economic and ecologic factors, a probability sample of households in each community under investigation is being studied simultaneously with monthly subsamples.

The Inter-American Investigation of Mortality (2) carried out in adults during the years 1962-1967 clearly demonstrated that additional information was available in hospital and autopsy records which, when combined with clinical data, allowed a

(1) This research is being carried out by the Pan American Health Organization and is being made possible by Contract 1431 from the United States Agency for International Development and by the cooperation and support of ministries of health, local health authorities and schools of medicine and public health involved in the Investigation.

This paper was prepared by Carlos V. Serrano, M.D., for the meeting, Consultation on Multiple Cause Analysis, sponsored by the World Health Organization in Geneva, Switzerland, 13-17 October, 1969.

(2) This research project was made possible by Research Grant GM-08682 of the National Institute of General Medical Sciences of the United States Public Health Service and by the cooperation and support of ministries of health, local authorities and schools of medicine and public health in the 12 cities. The book, Patterns of Urban Mortality, Scientific Publication No. 151 of the Pan American Health Organization, gives the procedures followed and the results of the Investigation.

more precise and complete analysis of causes of death. The comparative analysis of multiple causes of death, in the ages 35-74 years in the projects of Bristol, England and San Francisco, California, U.S.A. (3) demonstrates marked differences in frequencies of the causes as well as the failure to establish the multiple causes involved when medical sections of death certificates are used as the only source of information.

The methodology being used and the large number of deaths included qualify the Inter-American Investigation of Mortality in Childhood as a unique opportunity for the study of multiple causes in the pediatric age group. For this purpose objectives have been proposed.

II. OBJECTIVES

The objectives of this study of multiple causes of death in children under 5 years in the Inter-American Investigation of Mortality in Childhood are the following:

1. To obtain a picture, as complete as possible, of the diagnoses involved in the death, as well as those associated with them which constitute a supplement to the tabulations of the single (underlying) causes of death.
2. To obtain data on the diverse associations between the diseases involved in deaths.
3. To study the effects of the coding rules in the tabulations based on the underlying cause and to examine also the possibilities of their application in the future.
4. To give special consideration to the relationship of certain causes such as nutritional deficiency, congenital anomalies and complications of pregnancy and childbirth with other causes.

III. CODING PROCEDURES*

The underlying cause of death will be coded in accordance with the procedures established in the International Classification of Diseases (Revision of 1965). In this respect any pathological state reported on the questionnaire will be taken into account if it modifies the coding and is compatible with the clinical history of the deceased.

The term associated cause is used to include those causes which are the consequences of the underlying cause, that is, the terminal and intermediate causes as well as those which contribute or the so-called contributory causes.

Also, in order to describe as completely as possible the combination of the pathological states causing death, it is considered advisable to identify the component causes of the underlying cause, particularly when the underlying cause selected is the result or consequence of another condition not possible to be considered as underlying, either because of the international rules of late effect or trivial condition or because a combination is involved and the components are not unequivocally indicated by the title of the category.

Examples of components:

a) Late effects selected as underlying cause

Components

Hydrocephalus

Any known purulent infection of cranial cavity

Cerebral palsy, infantile
etc.

Birth trauma or any other known cause

If the late effect is a specific complication of a disease for which there is a specific late effect code such as for poliomyelitis and for rickets, the acute form of the disease would not be coded also.

b) Underlying cause, rule of trivial condition

Components

Tetanus

Complication of smallpox vaccination

Bronchopneumonia

Common cold

c) Combinations not specified

Components

Accidental drowning

Accidental fall into a tank

In each of the previous examples, the underlying cause selected and the added component describes more completely and specifically the underlying cause.

*Acknowledgement is made of the use of the procedures for coding multiple causes of death given in the introduction of Vital Statistics of the United States, 1955, Supplement, National Center for Health Statistics, Washington, D.C. 1965.

In the summary of the causes of death in the questionnaire, the underlying cause is stated first followed by the associated causes in the order given below:

1. The component causes of the underlying cause, in the cases in which they can be indicated.
2. The consequences of the underlying cause, that is:
 - a. the terminal cause, first
 - b. the intermediate cause or causes
3. The contributory cause or causes.

The following hypothetical examples illustrate the previous:

Example 1:

A premature child of one month of age, born with hypertrophic stenosis of the pylorus and an incomplete hare-lip had violent vomiting and accelerated loss of weight; bronchopneumonia appeared as a complication and the child died.

In the international form of death certificate, this case would be expressed as follows:

- | | | | |
|-----|---------------------------------------|---|---|
| I. | a. Bronchopneumonia (terminal cause) | } | consequential causes underlying cause |
| | b. Malnutrition (intermediate cause) | | |
| | c. Congenital stenosis of the pylorus | | |
| II. | Immaturity and hare-lip | | contributory causes |

On the questionnaire, the order of the same causes will be made in the following way:

- | | | | | | |
|----|--|---|-------------------------|---|---|
| 1. | Congenital stenosis of the pylorus (underlying cause) | } | consequential causes | } | multiple causes (complete picture) |
| 2. | Malnutrition intermediate | | | | |
| 3. | Bronchopneumonia (terminal) | | | | |
| 4. | Immaturity | } | contributory causes | | |
| 5. | Hare-lip | | | | |

Example 2:

A child of five months of age who suffered a disseminated tuberculosis from a pulmonary localization followed by pulmonary collapse and death. The child was reported to be a premature at birth and malnourished at the time of death.

In the international form of death certificate, this case would be expressed in the following way:

- | | | |
|-----|---|------------------------|
| I. | a. Collapse of the lungs (terminal cause) |] consequential causes |
| | b. Disseminated tuberculosis (intermediate cause) | |
| | c. Pulmonary tuberculosis | |
| II. | Immaturity and malnutrition | contributory causes |

On the questionnaire the underlying cause is considered pulmonary tuberculosis due to the coding rule (see under 018, tuberculosis disseminated, on page 427 of Volume 1 of the International Classification of Diseases). The form and order of these causes will be the following:

- | | | | |
|----------------------------------|---------------------|---------------------|--------------------------------------|
| 1. Pulmonary tuberculosis | underlying cause |] associated causes |] multiple causes (complete picture) |
| 2. Disseminated tuberculosis | component cause | | |
| 3. Pulmonary collapse (terminal) | consequential cause | | |
| 4. Malnutrition | contributory cause | | |

IV. RULES IN DETERMINING DIAGNOSES TO BE CODED

The following general principles will serve as guides in determining the causes which are to be considered in this study of multiple causes.

RULE I: Symptoms and Ill-defined Causes (780-796)

1. The categories included in the section Ill-defined conditions (790-796) ought not to be used except when there exists in the questionnaire no other information indicative of the cause or causes of death.
2. In general, the categories included in the section Symptoms Referable to Systems or Organs (780-789) ought not to be used for coding.

This is absolute when the symptom is a usual constituent (but not a complication) of the underlying cause or also of the associated causes. For example, it will not be necessary to add cough, 783.3, tachycardia, 782.2 or fever, 788.8 when bronchopneumonia, 485, has been selected as an underlying or associated cause.

However, the important syndromes which may be a complication (but not a component) of the cause selected - underlying or associated - may be coded if the investigation of the death reveals that the syndrome had an important participation in the gravity or course of events. For example, the dehydration, 788.0, or the acidosis, 788.6, which are consequences of gastroenteritis, 009.2 would be coded. However, if by reason of space it becomes necessary to omit some of the causes selected, the symptoms, in a general way, ought not to be maintained when more defined causes can be noted.

Note: The following categories constitute examples of symptoms, which, subject to the circumstances in each case, could be coded:

Coma
Convulsions
Meningismus
Encephalopathy
Acute heart failure. undefined
Edema or dropsy
Shock
Jaundice
Ascites
Melena
Dehydration
Severe acid-base or electrolyte disorders
Pyrexia of unknown origin

RULE II, No Repetition of Codes

There will not be a repetition of any one four-digit code or any one of the three-digit codes when the Classification does not provide four-digit subcategories. For example, emphysema of the newborn, 776.2, and congenital pneumothorax, 776.2, as is clear, are both terms of the same subcategory 776.2 Respiratory distress syndrome.

However, the pathological states classifiable in the different subcategories of fourth digits of a three-digit category will be coded unless there is a conflict with some other general principle. For example, the post-maturity, 778.1, and the hemorrhagic disease of the newborn, 778.2, are coded separately even though both are subcategories of the same category of the three digits, 778, Other conditions of the fetus or newborn.

RULE II, No Repetition of Disease

No pathological state will be coded when it repeats in a less specific manner the underlying cause or some other cause already coded. For example, in the case of a ventricular septal defect, 746.3, and congenital heart disease, 746.9, this last one ought not to be coded.

Neither will a pathological state be coded when it is merely a part of another pathological state already coded. For example, in the case of juvenile neurosyphilis, 090.4, and late congenital syphilis, 090.7, it is not necessary to code the latter since the latter is indicated by the juvenile neurosyphilis which is a form of late congenital syphilis.

However, the complications or the consequences of a pathological state will be coded if they constitute defined clinical states even when they are classified in residual groups. For example, in perinatal mortality if a premature rupture of the membranes, 769.1, results in chorio-amnionitis, 763.9, both should be coded.

RULE III, No Repetition of Diseases: additional examples

Several examples of combinations which ought not to be shown for any death are included.

| | | |
|-------------------------------------|----------|-------------------|
| 462 Acute pharyngitis | | |
| 463 Acute tonsillitis | ... with | 034 Streptococcal |
| 464 Acute laryngitis and tracheitis | | sore throat |

4. When the underlying cause selected derives from the application of the Rule of Modification 10 relative to the late effects and the category coded does not indicate clearly the original morbid state causing the late effect, the original morbid state(s) ought to be individualized and coded as component(s) of the underlying cause.

RULE V, Adjectival modifiers

A combination term composed of the adjective form of one or more conditions modifying another condition will be coded as one cause if the International Classification provides for such classification and if the category includes only this particular combination of causes.

For example, rheumatic mitral stenosis will be coded 394.0. However if the combination is not provided for in the way described above in the Classification, each one of the conditions (specified by the adjective form and that indicated by the pathological state in question) an independent coding will be made.

For example, the diphtheritic myocarditis will be coded as diphtheria (032X) and as myocarditis, toxic (422X).

RULE VI, External Causes

1. The E-Code - In cases involving injuries from external causes, the E-code will be used in the same manner as for tabulations of underlying causes. Two or more E-codes may be necessary to describe completely the external cause with its consequences. However, when one accident comprises two events classifiable to categories E810-E823 motor vehicle accidents, the first event only will be coded. The nature of the lesion (the N code) will not be coded. However, the post operative and traumatic shock will be coded as 782.9 and the traumatic cerebral hemorrhage will be coded as 431. The other traumatic hemorrhages will not be coded.

For example, a traumatic cerebral hemorrhage (431X) is produced in a child in a collision of an automobile (E815.1) with a cement mixer, (E928). (The three codes give a complete description of the accident.)

2. Diseases resulting from the injuries. When pneumonia and similar conditions occur as a result of an injury, the disease will be coded as well as the external means of the injury. Also, when well defined diseases occur as late effects of an injury, the injury will be coded as well as the late effects.

For example, a traumatic pneumonia (486) occurs in a child (passenger) in a collision of automobiles (E812.1).

Also a second example is of an osteomyelitis of 18 months (720.2) by exposed fracture of the femur produced by the collision of automobiles two years before (E940X).

3. Surgical and Medical Complications and Misadventures.

These complications or deaths resulting from serum hepatitis (within 8 months following treatment), from excessive doses of anesthesia, from late hemorrhage, etc., will be considered as adverse effects of the medical or surgical intervention and classified to the respective subcategories of the section E930-E936.

However, the complications of operations such as embolism, the pneumonia and infection of wounds will not be considered as adverse effects and will not be coded in the subcategories of E930-E936.

RULE VII, Malignant Neoplasms and Tuberculosis

1. In the case of malignant tumors only one site will be coded giving preference to the primary site.

For example, neuroblastoma of the suprarenal glands with metastasis to the bones and nervous system will be coded 192.5, neuroblastoma of the suprarenal gland.

If two primary sites are given (which is rare) both should be coded.

2. In the case of tuberculosis, only one site will be coded giving preference to the primary location, when more than one site is given if it can be determined; otherwise, code only in disseminated tuberculosis.

For example, when tuberculosis of the liver, of spleen, of kidney, and intestines, code to 018.9, tuberculosis disseminated. The cases, however, with the presence of pulmonary tuberculosis (011), of the meninges and the nervous system (013) require the codings in accordance with a rule of the Classification to those categories.

RULE VIII, Acute and Chronic Diseases

The acute and chronic forms of the same disease ought to be coded, especially when the second is not an obvious consequence of the first.

For example, in the case of chronic nephritis (582) and acute nephritis (580), code both.

RULE IX, Hemorrhage

1. Hemorrhage of a specific organ.

The hemorrhage of a specific organ with a disease of the same organ will not be coded with the exception of the cerebral hemorrhage (which will be coded 431).

For example, a hemorrhage of the stomach in a patient with gastric ulcer will be coded only to the gastric ulcer, 531.9.

2. Hemorrhage NOS will not be coded with a tuberculosis of the lung.

V. PROVISIONAL RESULTS

In the process of selecting the causes involved in each death, use is made of all the information available. In the Investigation, the term "cause" is used to mean any disease, syndrome, morbid state, abnormal condition or factor that directly or indirectly participates in the production of death. The distinctions between the three main groups of causes: underlying, contributory and consequential (including the terminal) may be extremely difficult to establish. For example, a child with severe protein malnutrition undergoes an episode of severe diarrhea that aggravates the already existing abnormal water and electrolyte composition and dies with a superimposed terminal bronchopneumonia. In this example, the list of causes could be:

- | | |
|--|------------------|
| 1. Diarrhea | Underlying cause |
| 2. Bronchopneumonia | Terminal cause |
| 3. Severe nutritional deficiency (protein) | Contributory |

However, it is known that, in advanced states of malnutrition, diarrhea is a component of the clinical picture (a consequence) due to functional and structural changes, and a vicious cycle is established. In such a case, the severe nutritional state could be considered as the underlying cause.

The only way to solve the problem of selection is the careful study of how the child became malnourished. If the nutritional deficiency is primary and/or secondary to an abnormal condition which has disappeared, either choice may be the acceptable one depending on the characteristics of the diarrheal disease. A third possibility may be necessary to consider if the investigation of the death reveals that the child became severely malnourished due to a long history of recurrent diarrheal episodes - a very common cause of nutritional deficiency. In this case would the nutritional deficiency be considered a consequence of the diarrheal disease? or rather a contributory cause of death? or even the underlying cause? Criteria for classification of nutritional deficiency as causes of death have been established for use in this Investigation and may be found in appendix I.

The extremely serious and important section on the perinatal morbidity and mortality is full of difficult and exciting problems concerning the relationships between maternal and fetal or child pathology throughout the gestational, delivery and postnatal periods. For example, regardless of the very important aspect of terminology, the decision of whether the so-called prematurity or immaturity should be considered a cause of death and if so as contributory or consequence may not be an easy one, unless a careful study is made of all the factors involved. But the problem may not be one of etiological relationships but one of degrees of prematurity and immaturity in relation to interval between birth and death. This and the problem of classification of nutritional status of the newborn and its repercussion on further growth and development are also treated in the appendix I.

Three very important concepts have to be considered in studies of multiple causes of morbidity and mortality in the pediatric age.

1. The most outstanding characteristic of the child (including the prenatal period) is the dynamic state of growth and development, phenomena that have very definite and crucial stages related to age periods and also, phenomena that can be affected in a reversible or irreversible manner according to the stage and previous and present states of health. A disease state, even when derived from another one, may be extremely serious over a long period of time, even through the future lifetime. This is the case of primary or secondary severe nutritional deficiencies, of prematurity and of permanent effects of some diseases of the central nervous system, etc.

2. Intimately related to the previous is the concept that disease processes are not static but highly dynamic phenomena whose effects on health depend on many factors such as age, degree of development, previous state of health, presence of concomitant or immediate abnormal conditions and their nature, etc. In the pediatric age, probably more than in adults, one finds a series of conditions such as acute otitis media, acute tonsillitis and pharyngitis, acute bronchitis, acute diarrheas and gastro-enteritis which are characterized by a great tendency for recurrences. This in itself poses a very serious and difficult problem in a study of multiple causes, particularly to establish the cause-effect relationship and hence, to draw lines between trivial and serious, between acute and chronic, between underlying, consequence and contributory causes. These repeated acute episodes may have a summation effect such that at the end, though apparently trivial, may lead to serious consequences. One single episode of acute diarrhea could not produce a severe state of nutritional deficiency of the type of pluricarential syndrome (kwashiorkor) but repeated episodes could.

3. Although the ideal trend of medical attention is maintenance of health through prevention, the recuperation through treatment still constitutes one essential, if not the major part of medical care in the developing countries, and a measure of important complications or consequences is necessary in order to provide good coverage until the primary diseases are prevented. The previous three concepts are arguments in favour of the study of all the underlying and associated causes of death (including the consequences) in the Inter-American Investigation of Mortality in Childhood.

The coexistence of two or more diseases or pathological conditions with no cause-effect relationship, as in the case of intestinal parasitosis and tuberculosis, versus the association of one disease and one or more of its known (common or not) complications, for example gastroenteritis and malnutrition, may have completely different explanations. However, the two types of associations may constitute serious public health problems. The frequency and importance of these associations and their consequences are not measurable by the concept of the single underlying cause but through the study of multiple causes using reliable sources of information.

Provisional analysis of the deaths studied in the area of Recife during the first six months of the Investigation (table 1) reveals that of a total of 346 deaths of children 6 months - 4 years of age, 153 or 44 per cent were assigned to measles as the underlying cause of death. Of the 153 children who died from measles, 109 or 71 per cent were found to have severe nutritional deficiency. For 103 of these, or 67 per cent of all measles deaths, nutritional deficiency was found to be an important contributory, pre-existing condition. Further investigation of the deaths due to measles reveals that bronchopneumonia was a severe complication in 90 per cent and diarrheal disease was a complication in 56 per cent of the deaths. In approximately one-half of the deaths, diarrhea and bronchopneumonia were present together.

Although we do not have information on survivors of measles, it seems safe to say that the complex, measles-malnutrition, is responsible for serious complications. Plans to prevent deaths due to measles in a serious endemic-epidemic region like that of Recife should consider measures such as mass immunization campaigns together with solid programs to prevent serious nutritional deficiencies and adequate health services to treat complications.

Table 2 shows the frequency of nutritional deficiency as underlying or associated causes of death in 665 children 6 months - 4 years of age in three areas of the Investigation. The importance of nutritional deficiency as a cause of death varies according to the area, being apparently more serious in Recife than in the other two areas. The significance of nutritional deficiency, from the point of view of mortality, is brought into clearer perspective when the deaths due to nutritional deficiency as an underlying cause are added to those in which the nutritional deficiency was a significant contributory cause. The high proportion of deaths with nutritional deficiency as an underlying or contributory cause probably indicates the existence, in one area under study, of morbid conditions able to produce significant nutritional deficits. The provisional, partial evaluation of the nutritional state of the sample of living children in Recife and Jamaica indicates the existence of a very high percentage of severe cases of nutritional deficiency (6.3 per cent) in Recife as compared to Jamaica (0.4 per cent).

The foregoing are examples of the usefulness of seeking information from multiple sources to determine the causes of morbidity and mortality. The use of sound information is the safest way to determine the multiple causes involved, as well as the most important associations. It will also be the best method to arrive at recommendations regarding modifications needed in the International Classification of Diseases to make it suitable for the coding and analysis of multiple causes.

Inter-American Investigation of Mortality in Childhood

Provisional

Table 1

Frequency of Pneumonia, Diarrhea and Nutritional Deficiency Associated with Deaths from Measles Among 346 Children 6 Months - 4 Years of Age, Recife, Brazil, July-Dec. 1968

| Associated Cause | Total | | Consequence | | Contributory | |
|------------------------|--------|----------|-------------|----------|--------------|----------|
| | Number | Per cent | Number | Per cent | Number | Per cent |
| Total measles deaths | 153 | ... | ... | ... | ... | ... |
| Pneumonia* | 138 | 90.2 | 138 | 90.2 | 0 | - |
| Diarrhea* | 90 | 58.8 | 86 | 56.2 | 4 | 2.6 |
| Nutritional deficiency | 109 | 71.2 | 6 | 3.9 | 103 | 67.3 |

* Pneumonia and diarrhea combined were associated with 75 or 49.0 per cent of the measles deaths.

Table 2

FREQUENCY OF NUTRITIONAL DEFICIENCY AS UNDERLYING OR ASSOCIATED CAUSE OF DEATH OF CHILDREN 6 MONTHS - 4 YEARS OF AGE IN THREE AREAS

| Area | Total deaths | Nutritional deficiency | | | | |
|-------------------------------|--------------|------------------------|------------------|------------------|-------------|----------------------------|
| | | Total | Underlying cause | Associated cause | | Underlying or contributory |
| | | | | Contributory | Consequence | |
| Number of deaths | | | | | | |
| Total | 665 | 372* | 55 | 228 | 90 | 282* |
| Recife, Brazil | 346 | 232 | 27 | 160 | 45 | 187 |
| Santiago, Chile | 142 | 65 | 7 | 36 | 22 | 43 |
| Kingston, St. Andrew, Jamaica | 177 | 75* | 21 | 32 | 23 | 52* |
| Percentage of total deaths | | | | | | |
| Total | ... | 55.9* | 8.3 | 34.2 | 13.5 | 42.4* |
| Recife, Brazil | ... | 67.1 | 7.8 | 46.2 | 13.0 | 54.0 |
| Santiago, Chile | ... | 45.8 | 4.9 | 25.4 | 15.5 | 30.3 |
| Kingston, St. Andrew, Jamaica | ... | 42.4* | 11.9 | 18.1 | 13.0 | 29.4* |

*Includes one death with two types of nutritional deficiency, one the underlying cause of death and the other a contributory cause.

Appendix I.

Inter-American Investigation of Mortality in Childhood

BASIC CRITERIA FOR DESIGNATION AND CLASSIFICATION OF NUTRITIONAL DEFICIENCY AND PREMATURITY AS UNDERLYING OR ASSOCIATED CAUSES OF DEATH

1. Nutritional deficiencies as underlying or associated causes of death

The poor state of nutrition found in many deceased children can be the result of one or more factors such as inadequate intake, malabsorption or sub-utilization of nutrients, increased catabolic processes or abnormal losses. When such factors are the result of any defined pathological condition, the nutritional deficiency can not be considered as an underlying cause of death regardless of the severity.

However, there are cases in which the state of severe malnutrition is aggravated by common complications, such as nonspecific infections, producing death. In such instances, the nutritional deficiency ought to be considered as the underlying cause.

Within the study of multiple causes in the Inter-American Investigation of Mortality in Childhood the following criteria are being followed for the classification of nutritional deficiencies as causes of death:

1.1 Malnutrition of degrees II and III (or their equivalents) will always be classified as underlying or associated causes of death. Malnutrition of degree I will not be considered as a cause of death.*

1.2 Whenever the terminal state of malnutrition is second (II) degree, it must be considered only as an associated (contributory or consequence) cause of death.

1.3 When malnutrition of third (III) degree is the only cause found or when the other causes found are only common complications, it must be classified as the underlying cause. Otherwise, it is classified as a contributory or consequential cause (associated).

2. Nutritional evaluation** of the newborn;

When the weight at birth is considered in relation to length of pregnancy (term=40 \pm 2 weeks) and in relation to standard birth weight for term babies (2800-4100; mean=3400 gm.) and ignoring the very extreme cases, the following alternatives are possible:

*Degrees of malnutrition assigned according to classification of Gómez.

**This nutritional evaluation is an additional classification and is not part of the multiple cause coding.

a. Children born before term with:

- { low weight
- { standard weight

b. Children born at term with:

- { standard weight
- { low weight
- { weight above standard

Children born after term with:

- { standard weight
- { low weight
- { weight above standard

According to the definition of the World Health Organization, any child born with a weight of 2500 grams or less is a premature regardless of the length of gestation. In spite of the limitations of this definition, it has been adopted for purposes of the investigation, with the following additional criteria:

2.1 Classify as premature every child born before term with a weight of 2500 grams or less.

2.2 Classify as premature and malnourished, any child born at term with a birthweight of 2500 grams or less.

2.3 Classify as malnourished the child born at term with a birthweight above 2500 and below 3100 grams. (3100 is 90 per cent of the mean of the standard birth weight, and is the lower limit of the normal according to the scale of Gómez).

2.4 Classify as post-mature and malnourished the child born after term with low weight.

2.5 If the period of gestation is unknown, classify as premature the child born with a weight of 2500 grams or less. If his weight is above 2500 but less than 3100 grams he will be classified as malnourished.

3. Types of severe (grade III) nutritional deficiency.

For coding purposes, the code 267 of the International Classification of Diseases "protein malnutrition" ought to be used for those cases in which the nutritional history, the clinical examination and/or the anatomo-pathologic examination reveal a clear picture of the so-called pluricarential syndrome or kwashiorkor. According to observation and pathogenesis, this type is found almost exclusively in the child above 6 months of age.

The nutritional marasmus, code 268 of the Classification, must be used for those cases in which the clinical history specifies that the child was marasmatic, cachectic or emaciated and in which the weight (and height) deficit, occurring usually without edema, skin and hair changes, has been the result of an overall deficit of protein and calorie-rich nutrients. Practically all severely malnourished children under 6 months of age fall in this category.

Finally code 269.9 of the Classification should be assigned to all those cases in which second or third degree malnutrition is found, or when no information is available that permits assignment to a more specific code in case of third degree malnutrition.

4. Prematurity and immaturity as underlying or associated cause of death.

According to the rules of coding of underlying causes the diagnoses of prematurity and immaturity are not to be used as underlying causes of death when another cause(s) of perinatal mortality is mentioned (page 432 of the ICD). However, in the study of multiple causes of death, such diagnoses ought to be mentioned as associated causes if the study of the death reveals that such states contributed to the occurrence of death in a significant measure. One difficult aspect, however, is the decision of the upper age limit for prematurity or immaturity to be considered important as a factor in death. From the point of view of morbidity and mortality, it is obvious that the prognosis of prematurity depends on the birth weight and the length of gestation. Hence, the limit up to which it should be included among the multiple causes depends on these two parameters. It would seem logical to consider the diagnosis of prematurity through a period of extrauterine life equal to that period needed to complete a term gestation; for instance, if a child was born at the 30th week of gestation it should be considered premature during 10 ± 2 weeks of extrauterine life. However, it should be noted that this criterion has the important limitation of the difficulty in establishing the exact length of gestation. Also the rate of growth in the two environments is different.

For the purpose of the Investigation the following criteria have been used:

- 4.1 If the exact length of gestation is known, code prematurity as a cause of death during a period equal to carry the gestation to term.
- 4.2 If the exact gestation length is not known, code prematurity during the following periods:
 - a. For children born with weight of less than 1000 gm: first 3 months of life
 - b. For children born with weight of 1000-2000 gm: during 2 months of life
 - c. For children born with weight of 2001-2500 gm: during 1 month of life

Inter-American Investigation of Mortality in Childhood

Provisional

TYPES OF NUTRITIONAL DEFICIENCY ASSOCIATED WITH DEATHS OF CHILDREN 6 MONTHS - 4 YEARS OF AGE, IN THREE AREAS

| Type of Deficiency | Total | Recife | San- tiago | Jamaica |
|----------------------------|-------|--------|---------------|---------|
| Underlying cause | | | | |
| Total | 55 | 27 | 7 | 21 |
| Vitamin deficiency 260-266 | 1 | - | - | 1 |
| Protein deficiency 267 | 30 | 20 | 1 | 9 |
| Nutritional marasmus 268 | 22 | 7 | 5 | 10 |
| Other types 269 | 2 | - | 1 | 1 |
| Contributory cause | | | | |
| Total | 228 | 160 | 36 | 32 |
| Vitamin deficiency 260-266 | - | - | - | - |
| Protein deficiency 267 | 56 | 54 | - | 2 |
| Nutritional marasmus 268 | 45 | 36 | 6 | 3 |
| Other types 269 | 127 | 70 | 30 | 27 |
| Consequential cause | | | | |
| Total | 90 | 45 | 22 | 23 |
| Vitamin deficiency 260-266 | 1 | - | - | 1 |
| Protein deficiency 267 | 10 | 7 | 2 | 1 |
| Nutritional marasmus 268 | 30 | 17 | 6 | 7 |
| Other types 269 | 49 | 21 | 14 | 14 |

Inter-American Investigation of Mortality in Childhood

PROVISIONAL

Frequency of Nutritional Deficiency as Underlying or Associated Cause
of Death in Four Age Groups Under 5 Years of Age, for Three Areas#

| Area and age group | Number of deaths | | | | | | Percentage of total deaths | | | | |
|--------------------|------------------|------------------------|-------------------|------------------|---------------|-----------------------------|----------------------------|-------------------|------------------|------|-----------------------------|
| | Total deaths | Nutritional deficiency | | | | | Nutritional deficiency | | | | |
| | | Total | Under-lying cause | Associated cause | | Under-lying or contributory | Total | Under-lying cause | Associated cause | | Under-lying or contributory |
| | | | | Contri- butory | Conse- quence | | | Contri- butory | Conse- quence | | |
| Total | 1,874 | 638* | 77 | 332 | 230 | 408* | 34.0 | 4.1 | 17.7 | 12.3 | 21.8 |
| Santiago, Chile | 538 | 166 | 17 | 92 | 57 | 109 | 30.9 | 3.3 | 17.1 | 10.6 | 20.3 |
| Under 28 days | 184 | 10 | - | 5 | 5 | 5 | 5.4 | - | 2.7 | 2.7 | 2.7 |
| 28 days-5 months | 212 | 91 | 10 | 51 | 30 | 61 | 42.9 | 4.7 | 24.0 | 14.2 | 28.8 |
| 6-11 months | 66 | 35 | 4 | 20 | 11 | 24 | 53.0 | 6.1 | 30.3 | 16.7 | 36.4 |
| 1-4 years | 76 | 30 | 3 | 16 | 11 | 19 | 39.5 | 3.9 | 21.1 | 14.5 | 25.0 |
| Jamaica | 556 | 108* | 27 | 38 | 44 | 64* | 19.4 | 4.9 | 6.8 | 7.9 | 11.7 |
| Under 28 days | 289 | 5 | 2 | 1 | 2 | 3 | 1.7 | 0.7 | 0.3 | 0.7 | 1.0 |
| 28 days-5 months | 90 | 28 | 4 | 5 | 19 | 9 | 31.1 | 4.4 | 5.6 | 21.1 | 10.0 |
| 6-11 months | 87 | 40 | 11 | 15 | 14 | 26 | 46.0 | 12.6 | 17.2 | 16.1 | 29.9 |
| 1-4 years | 90 | 35* | 10 | 17 | 9 | 26* | 38.9 | 11.1 | 18.9 | 10.0 | 30.0 |
| Recife, Brazil | 780 | 364 | 33 | 202 | 129 | 235 | 46.6 | 4.2 | 25.9 | 16.5 | 30.1 |
| Under 28 days | 233 | 7 | - | 1 | 6 | 1 | 3.0 | - | 0.4 | 2.6 | 0.4 |
| 28 days-5 months | 201 | 125 | 6 | 41 | 78 | 47 | 62.2 | 3.0 | 20.4 | 38.8 | 23.4 |
| 6-11 months | 115 | 72 | 9 | 42 | 21 | 51 | 62.6 | 7.8 | 36.5 | 18.3 | 44.3 |
| 1-4 years | 231 | 160 | 18 | 118 | 24 | 136 | 69.3 | 7.8 | 51.1 | 10.4 | 58.9 |

*Includes one death with two types of nutritional deficiency, one the underlying cause of death and the other a contributory cause.

#Time periods: Santiago - July 1968-February 1969

Jamaica - June-December 1968

Recife - July-December, 1968

Inter-American Investigation of Mortality in Childhood

Provisional

FREQUENCY OF PREMATURITY AS UNDERLYING OR ASSOCIATED
CAUSE OF DEATH AMONG DECEASED CHILDREN UNDER
6 MONTHS OF AGE IN THREE AREAS

| Assignment of prematurity | Total | | Recife | | Santiago | | Jamaica | |
|---------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | Num- ber | Per cent | Num- ber | Per cent | Num- ber | Per cent | Num- ber | Per cent |
| Under 6 months of age | | | | | | | | |
| Total deaths | 1209 | ... | 434 | ... | 396 | ... | 379 | ... |
| Prematurity assigned | | | | | | | | |
| As underlying cause | 38 | 3.1 | 19 | 4.4 | 3 | 0.8 | 16 | 4.2 |
| As contributory cause | 415 | 34.3 | 133 | 30.6 | 106 | 26.8 | 176 | 46.4 |
| As consequential cause | 65 | 5.4 | 15 | 3.5 | 15 | 3.8 | 35 | 9.2 |
| Under 28 days of age | | | | | | | | |
| Total deaths | 707 | ... | 233 | ... | 185 | ... | 289 | ... |
| Prematurity assigned | | | | | | | | |
| As underlying cause | 38 | 5.4 | 19 | 8.2 | 3 | 1.6 | 16 | 5.5 |
| As contributory cause | 386 | 54.6 | 125 | 53.6 | 101 | 54.6 | 160 | 55.4 |
| As consequential cause | 64 | 9.1 | 15 | 6.4 | 14 | 7.6 | 35 | 12.1 |
| Age 28 days - 5 months | | | | | | | | |
| Total deaths | 502 | ... | 201 | ... | 211 | ... | 90 | ... |
| Prematurity assigned | | | | | | | | |
| As underlying cause | - | - | - | - | - | - | - | - |
| As contributory cause | 29 | 5.8 | 8 | 4.0 | 5 | 2.4 | 16 | 17.8 |
| As consequential cause | 1 | 0.2 | - | - | 1 | 0.5 | - | - |

Inter-American Investigation of Mortality in Childhood

Provisional

FREQUENCY OF PREMATURETY ASSOCIATED WITH DEATHS OF CHILDREN
UNDER 28 DAYS OF AGE BY UNDERLYING CAUSE OF DEATH,
COMBINED DATA, RECIFE, SANTIAGO, JAMAICA

| Underlying cause | Total deaths | Prematurity | | | |
|---|-----------------|--------------|-------------|-------------|-------------|
| | | Contributory | | Consequence | |
| | | Num- ber | Per cent | Num- ber | Per cent |
| All causes | 707 | 386 | 54.6 | 64 | 9.1 |
| Diarrheal diseases 000-009 | 53 | 31 | 58.5 | - | - |
| Septicemia 038 | 27 | 25 | 92.6 | - | - |
| Congenital syphilis 090 | 4 | 3 | * | - | * |
| Diseases of endocrine glands 240-258 | 1 | 1 | * | - | * |
| Nutritional deficiency 260-269 | 2 | 2 | * | - | * |
| Congenital disorders of metabolism 270-273 | 1 | 1 | * | - | * |
| Inflammatory diseases of CNS 320-324 | 6 | 2 | * | - | * |
| Pneumonia 480-486 | 40 | 26 | 65.0 | - | - |
| Diseases of digestive system 550-577 | 5 | 1 | * | - | * |
| Infections of skin, subcutaneous tissue 680-686 | 13 | 6 | 46.2 | - | - |
| Congenital anomalies, total 740-759 | 49 | 23 | 46.9 | - | - |
| Nervous system 740-743 | 7 | 3 | * | - | * |
| Heart, circulatory system 746, 747 | 23 | 12 | 52.2 | - | - |
| Respiratory system 748 | 1 | 1 | * | - | * |
| Digestive system 749-751 | 11 | 5 | 45.5 | - | - |
| Genito-urinary system 752, 753 | 1 | - | * | - | * |
| Musculoskeletal system 754-756 | 2 | 1 | * | - | * |
| Other and unspecified anomalies 757, 758 | 1 | - | * | - | * |
| Syndromes affecting multiple sites 759 | 3 | 1 | * | - | * |
| Perinatal causes, total | 478 | 260 | 54.4 | 64 | 13.4 |
| Maternal conditions | | | | | |
| Unrelated to pregnancy 760, 761 | 13 | 4 | 30.8 | 7 | 53.8 |
| Toxemia of pregnancy 762 | 25 | 6 | 24.0 | 15 | 60.0 |
| Ante-and intrapartum infection 763 | 3 | 2 | * | - | * |
| Difficult labor 764-768 | 51 | 27 | 52.9 | - | - |
| Other complications of pregnancy and childbirth 769 | 67 | 43 | 64.2 | 19 | 28.4 |
| Conditions of placenta 770 | 23 | 1 | 4.3 | 22 | 95.7 |
| Conditions of umbilical cord 771 | 6 | 4 | * | - | * |
| Birth injury, cause unspecified 772 | 30 | 14 | 46.7 | - | - |
| Hemolytic disease of newborn 774, 775 | 11 | 6 | 54.5 | - | - |
| Anoxic, hypoxic conditions NEC 776 | 189 | 140 | 74.1 | 1 | 0.5 |
| Immaturity, unqualified 777 | 38 | - | - | - | - |
| Other conditions of newborn 778 | 22 | 13 | 59.1 | - | - |
| Other specified causes | 11 | - | - | - | - |
| Symptoms, ill-defined conditions 780-796 | 10 | 1 | 10.0 | - | - |
| External causes E800-999 | 7 | 4 | * | - | * |

*Percentage not calculated for base less than 10