PNABE-825

65633

Working Paper # 10
September 1984

A STUDY OF POSTNEONATAL DIARRHEAL MORTALITY IN CUBA, 1969-1978: CONCEPTUAL FRAMEWORK AND METHODOLOGY

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INTRODUCTION

In most developing countries, acute diarrheal disease (ADD) and respiratory infections continue to be the two major contributors to infant mortality (1). Cuba has broken with that pattern, and, as in industrialized nations, congenital anomalies and neonatal conditions now account for the largest proportion of infant deaths (2).

In Cuba, infant mortality in the postneonatal period (28 days to 11 months of age) declined 73 percent in the years 1969-1982, dropping from 21.1 to 5.8 deaths per 1,000 live births (see Table 1). During the same period, ADD mortality in infants decreased by 85 percent, falling from first place among causes of infant deaths in the early 1960s to fifth place by 1976 (3). Although the decrease in mortality has been well documented (4), the contribution of specific interventions has not been fully investigated.

The objective of this study is to determine the contribution of specific medical and nonmedical interventions to the decline in postneonatal diarrheal mortality in nine provinces of Cuba over a 10-year period, 1969 to 1978. As a result of this analysis, models will be developed to explain the specific mechanisms responsible for the decrease in infant mortality due to diarrheal disease in Cuba.

The study is being conducted jointly by the Center for Population and Family Health, the Gertrude H. Sergievsky Center

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*This project is partially funded by the Ford Foundation, Grant No. 820-1079.

(both of Columbia University), and the Institute for Health Development of Havana.

The study consists of four distinct but interrelated components. The first is a descriptive and historical analysis of antidiarrheal programs in Cuba. This analysis will provide a detailed picture of the implementation of antidiarrheal programs as well as important information concerning many of the independent variables included in the study. It will also strengthen inference by placing the relationships found in the subsequent quantitative analysis within a conceptual framework.

The second component is an ecologic analysis of variation in postneonatal diarrheal mortality rates. This analysis will be carried out both cross-sectionally and over time, to establish relationships with variables at the district and provincial levels. This phase is indispensable, as some of the demographic and service information is available in aggregate form only at those levels.

The third part of the study is an individual analysis using the case-control method. In this analysis, all infants dying of postneonatal diarrhea during the 10-year period in the nine provinces will be compared to survivors. Background variables found to be potentially confounding in the ecologic analysis will be controlled for in this analysis.

Finally, clinical charts from the period under study will be reviewed in a sample of hospitals to ascertain secular and geographic patterns of morbidity, clinical diagnosis, and treatment modalities in both surviving and deceased infants.

CONCEPTUAL FRAMEWORK

The proposed model describes the hypothesized relationships among different factors influencing ADD mortality among infants in Cuba (see Figure 1). The model uses individual and ecologic or aggregated variables. Some variables, such as ratios of health personnel to population, will be measured at aggregate levels; others, such as birth weight, will be analyzed at both the individual and the aggregate levels.

The wide scope of the information available in Cuba offers the opportunity for testing more comprehensive explanatory models than have generally been developed in other settings. Because of the existence of an integrated health system that is well connected to other social and economic sectors of society, the information available will permit us to test a set of hypotheses encompassing independent variables from a wide variety of areas: socioeconomic, educational, biological, medical, and others.

The model is based on two main premises: a) Health care can be effective only within the context of improving socioeconomic conditions; and b) given equality in the access to and distribution of societal benefits, including health care services, not all socioeconomic changes are equally important in improving health status.

As a result of the political and economic structure of a given country, whether it has a market or a centrally planned economy, the amount of resources allocated to different socioeconomic activities, including industrial and agricultural

production, defense, education, health, housing, etc., affects the standard of living of the population. The distribution of society's burden largely determines how health effects are distributed among different population groups, with health risks among disadvantaged populations always higher than risks among those better off.

Of special interest in the Cuban case is how socioeconomic factors and preventive health services affect health status and how medical care affects the risk of death after disease develops. The interaction of the health care system and the sociopolitical and economic systems existing in Cuba, as well as their development strategies, will be part of the qualitative analysis in this study.

Socioeconomic conditions contribute significantly to modifying the biological factors leading to morbidity and mortality. In contrast, medical care, traditionally narrowly oriented toward disease-specific interventions, has little or no role in determining socioeconomic conditions.

A child's survival is significantly dependent on the economic resources available in the household (5). However, when there is equitable distribution of resources, or when the society takes responsibility for the provision of social and economic necessities, child survival depends more on the resources available at the community level than on those at the household level. If even the very poor have access to education, water, electricity, housing, and health care, much of the risk resulting from poverty is eliminated. In other words, mortality differentials among classes should narrow as more equitable

distribution of societal resources diminishes class differences.

The health status of a population, including the risk of infection and host resistance/susceptibility, is in large part determined by socioeconomic status. The likelihood of developing a disease (incidence) or the likelihood of dying from the disease once it develops (case fatality) decreases when socioeconomic status improves. To lower risk even further, preventive and curative health interventions are necessary. Health status is also partly determined by factors such as genetic traits, virulence of the disease agents, and natural disasters. Although these determinants of health status are outside the scope of this study, they have been included in the model when possible.

Curative medical measures can affect disease-specific morbidity and mortality through treatment of individual cases. On a population basis, curative measures may not be able to lower mortality to desired levels, because poor socioeconomic conditions and competing causes of death may continue to cause high levels of mortality. Hence, the incidence and severity of disease and overall mortality can be most affected by curative measures only in the presence of a) improving socioeconomic conditions and b) preventive and educational measures.

Factors such as improved nutritional status are probably a necessary prerequisite for a medical intervention to be most effective. However, such factors as urbanization, higher levels of formal education, higher income, and collective provision of safe drinking water and sewage disposal may not be. In other words, mortality rates may be lowered by health care

interventions that speed up improvements in the biological conditions of the population, bypassing some socioeconomic factors that determine the standard of living.

On the basis of the above considerations, we have established a model broader than those that have previously been used. The model presented here incorporates crucial social and demographic characteristics of the population as well as the contribution of the health care system, which integrates curative and preventive elements. The proposed model includes six components. These components describe relationships at the individual as well as the aggregate level. These relationships will be quantitatively tested in our study. The model also includes more remote factors that influence the primary components and therefore play a role in determining mortality. The relationships of these factors -- A through E -- should be explored in sociologic and economic studies and are included in Figure 1 only for completeness of the model.

The model postulates the following:

1. The biological conditions of the individual are largely determined by his socioeconomic status and the status of the population in which he lives (Component 1). His status determines behavioral patterns influenced by culture, education, and material conditions.

2. Biological conditions can be modified directly, by the preventive activities of the health care system, such as immunizations and health education (Component 2), or indirectly, through changes in some of the socioeconomic conditions (Component 6a).

3. Once biological conditions are established, they determine the individual's resistance or susceptibility to the disease, risk of exposure to pathogens, and risk of infection (Component 3).

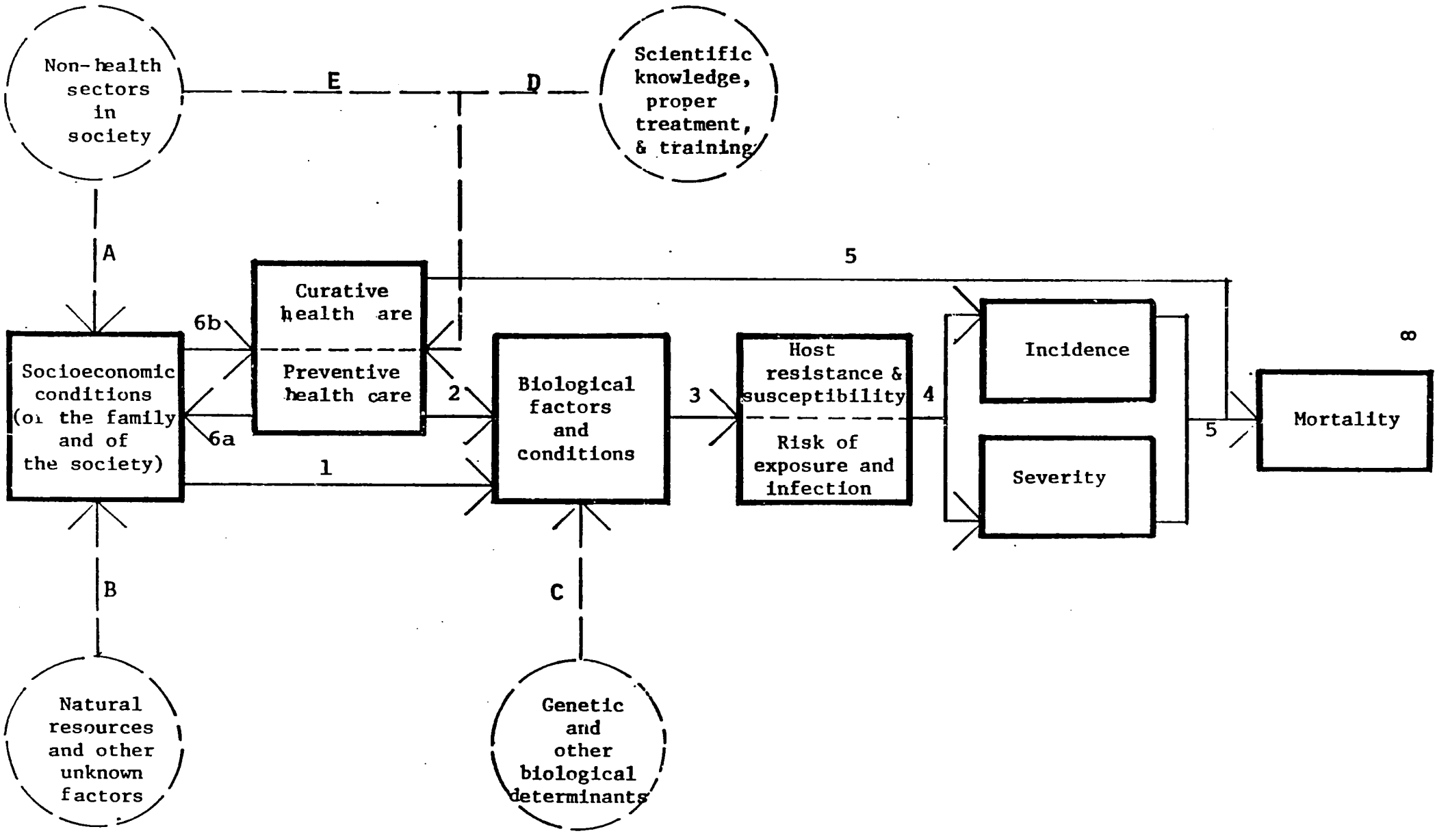
4. Inthe individual and in the population, the incidence and severity of disease are determined by both susceptibility (or immunity status) and risk of exposure to infection (Component 4).

5. The incidence and the severity of disease determine the mortality rates in the population. This mortality is affected by curative medical interventions only after clinical disease develops (Component 5).

6. The effectiveness of the health care system is determined in part by the socioeconomic status of the population and its participation in the delivery of health care (Component 6b).

Figure 1

DETERMINANTS OF MORTALITY FROM DIARRHEAL DISEASE



STUDY COMPONENTS

In this section, we describe each of the four components of the study, including the specific variables to be analyzed and the sources from which they will originate.

A. Descriptive/Historical Study

The first component of the project is the qualitative and historical analysis of antidiarrheal interventions in Cuba. Such analysis will permit us to make inferences about the processes that were responsible for bringing about changes in some of the independent variables to be included in the ecologic and case-control studies.

The opportunity rarely exists to document the development of a national program using information other than that required for statistical reports and medical care purposes. Since the leading actors in the Cuban programs are available to relate their experience, this study will also help us to interpret the quantitative results in a broader framework.

In addition, the historical analysis will help to identify activities that can be replicated or adapted in other settings and those interventions that, regardless of their effectiveness, are so intrinsically a part of Cuba's socioeconomic and political system that they would not be appropriate or useful elsewhere.

The sources for the historical information, in addition to the members of the Cuban research team, will be officials of various mass organizations and government agencies, physicians, nurses, and other health personnel, as well as other participants in the programs at the time of their implementation.

Written material, including theses and reports, pediatric standards and norms, documents related to program implementation, and interviews with key informants, will be integrated and summarized. We will examine the information over time to obtain a historical perspective on the programs in the context of the social change that took place during the period under study. The following subjects will be included in the descriptive study:

1. The formal health system, with emphasis on programs for maternal and child health, environmental health, health education, and community medicine.

2. Administrative procedures used to carry out the programs aimed at reducing diarrheal mortality.

3. Changes in the political and administrative structure of the country.

4. Participation of mass organizations in the development and implementation of health programs.

B. Ecologic Study

The ecologic study will be cross-sectional and will use timetrends (this analysis cannot be called longitudinal, since the individuals are not the same over time). Many important variables are available only at the district or provincial level, and several of them are unique in a study of this nature.

Cross-sectional analysis in approximately 75 districts will correlate postneonatal diarrheal mortality rates with an array of independent variables (shown in Table 2). The table includes a list of indices that can be used to characterize the health system. The first step in the analysis will be to ascertain the correlations of several background variables (not part of the

diarrheal interventions) with postneonatal diarrheal mortality rates. Subsequently, postneonatal diarrheal mortality rates will be standardized for the relevant background variables. Because of the different mortality levels and socioeconomic and political conditions of the two quinquennia under study, the data will be analyzed separately for each five-year period.

A second level of ecologic analysis will utilize time trends. Using 1969 as a reference year, the relationships of background variables to diarrheal mortality rates will be determined. The variable-specific mortality rates so obtained will then be applied to the distribution of background variables in each subsequent year. In this way, expected postneonatal diarrheal death rates will be generated for each province for each study year. Any differences remaining between observed and expected rates cannot then be due to changes in the distribution of the background variables.

C. Case-Control Study

In the case-control study, the cases include all postneonatal deaths from acute diarrheal disease in the years 1969-1978 in the nine provinces under study. There are two sets of controls: a) all children dying in the postneonatal period from causes other than acute diarrhea, and b) a random sample of approximately three percent of all children who survived to one year of age (see Table 3). Both groups of controls were born in the same years and provinces as the cases, but cases and controls will not be matched further. Table 4 shows the independent variables available from the death and birth certificates.

Previous work by the investigators and others confirms that the vital record is complete (6) and that birth-death linkage is feasible. The dependent variable is death or survivor status.

The initial analysis will compare cases and controls on a range of background variables. These will include both individual variables available on the birth certificates and variables assigned to each child that are derived from the ecologic analyses. (For example, infants born in a district with a large ratio of diarrhea beds to population will be assigned that ratio.)

Further analysis will cross-classify the data along strata that a priori seem important in determining susceptibility to death from diarrheal disease, such as birth weight and plurality status.

More advanced analyses will attempt to summarize cross-classified data by using multivariate methods such as the Mantel-Haenzel procedure and logistic regression analysis. In these analyses, the main focus will be to try to control for variables that are associated with diarrheal mortality and that might confound the analysis of the relationship of interventions to diarrheal mortality.

D. Hospital Survey

In order to ascertain the treatment and severity of diarrheal disease during the study period, charts of cases admitted will be reviewed in a sample of hospitals. It is important to determine whether the observed changes in mortality are due in part to changes in incidence and severity, or only to changes in mortality, resulting from (among other causes) better

medical care.

For a sample of children less than 1 year of age at admission presenting with diarrhea for the years under study, the variables to be collected are listed in the panel of Table 5. The second panel shows information that will be collected from as many hospitals as possible throughout the study period in all the provinces.

SUMMARY

This paper describes a historical study of acute diarrheal disease (ADD) among infants in Cuba, a country that has recently experienced a rapid decline in deaths from this cause (an 85 percent reduction between 1969 and 1982). The major focus of the study will be on constructing a model of the determinants of ADD mortality and on isolating the contributions of the health care system to the substantial decline in ADD mortality in contrast with contributions made by general improvements in socioeconomic status.

Four substudies constitute the research project:

1. A historical survey of the antidiarrheal programs in Cuba.

2. An ecologic analysis of geographic and secular trends in ADD mortality rates at the province and district levels.

3. A case-control study matching infants dying from ADD to survivors and to those dying from other causes.

4. A survey of samples of hospital charts to document trends in admission policies and rates and hospital procedures and treatments.

The third substudy relies on vital certificate data from nine provinces for the decade 1969-1978. Preliminary work by the study team, as well as by previous investigators, has established that the vital record is complete and that birth-death linkage is feasible. The results of this study may be relevant to Third World countries of a moderate degree of development that are trying to reduce ADD mortality rates in infants.

Table 1

INFANT, POSTNEONATAL, AND DIARRHEAL MORTALITY RATES, AND PERCENTAGE OF LOW BIRTH WEIGHT, CUBA, 1969-1982

Year	Infant Mortality	Postneonatal Mortality	Infant Diarrheal Mortality	% LBW
1969	46.7	21.1	6.7	u
1970	38.7	15.0	5.5	10.3
1971	36.5	14.1	5.1	9.9
1972	28.7	9.6	2.9	9.8
1973	29.6	10.2	3.0	10.4
1974	29.3	10.4	u	11.7
1975	27.5	10.1	2.5	11.4
1976	23.3	8.2	2.0	10.8
1977	25.0	9.6	2.6	10.6
1978	22.3	7.8	1.6	10.4
1979	19.3	6.1	1.0	10.2
1980	19.6	6.5	1.6	9.7
1981	18.5	6.0	1.3	9.5
1982	17.3	5.8	1.0	8.7

u = unavailable

Source: Ministerio de Salud Publica (MINSAP) Annual Reports, Havana, 1978 and 1982.

Table 2

ECOLOGIC ANALYSIS: AGGREGATE VARIABLES

A. Independent Variables

1. Health system measures

Group I: Outpatient care indices

pediatric visits
well-baby visits
prenatal visits
home visits and educational sessions carried out by health personnel and mass organizations
gestational age at onset of prenatal care

Group II: Hospital activities and facilities

number or percentage of deliveries in hospital of different care levels
rates of births and deaths taking place outside hospitals
rates of pediatric admission for diarrhea
number of beds for acute diarrheal diseases
number of beds for respiratory diseases
number of beds in maternity homes
utilization, vacancy rates, etc., for diarrheal and respiratory beds
ratio of health personnel to population

Group III: Qualitative evaluation of health services

evaluation of hospital services and units
rehydration protocols, use of intravenous solutions and appropriateness of antibiotics
changes in the type, quantity, and distribution of equipment and supplies

2. Health and biological variables of cases

birth weight distribution
nutritional status
infant feeding practices
pathogens detected in fecal analyses

Table 2 (Continued)

3. Socioeconomic status of the population

literacy rates
school dropout rates
percentage of children in school
availability of potable water
housing conditions
rural/urban residence
changes in food rations
changes in food consumption
changes in disposable income

B. Dependent variables

number of reported diarrhea cases
case fatality rates
case-, age-, and sex-specific mortality rates

Table 3

NUMBER OF CASES AND CONTROLS FOR THE NINE PROVINCES UNDER STUDY

	CASES	CONTROLS	
Year	All deaths from ADD*	All deaths from other causes	3% sample of survivors
1969	946	2,321	4,600
1970	812	1,579	4,542
1971	722	1,399	5,107
1972	396	1,114	4,989
1973	423	1,069	4,474
1974	326	1,047	3,983
1975	228	898	3,747
1976	177	721	3,635
1977	196	731	3,260
1978	117	592	2,875
Total	4,343	11,471	41,212

*Acute Diarrheal Disease

Source: MINSAP; data provided by the National Bureau of Statistics.

Table 4

CASE-CONTROL STUDY: INDIVIDUAL VARIABLES

A. Birth Certificate

1. Biological characteristics of the child

   birth weight
   gestational age
   singleton or multiple birth
   sex

2. Fertility pattern of parents

   birth order
   parity
   number of surviving children
   number of abortions
   number of stillbirths
   ages of mother and father

3. Socioeconomic status of parents

   education of mother and father
   occupation of mother and father
   parents living together or apart
   availability of potable water

4. Measures of the health system

   type of health facility (if any) at which birth took place
   who assisted in the delivery
   distance from residence to nearest health facility

5. Identification

   date of birth
   place of birth

Table 4 (Continued)

B. Death Certificate

1. Dependent variables

   age at death
   cause(s) of death (altered after consideration of autopsy findings)

2. Identification

   date of death
   place of death

3. Measures of the health system

   facility (if any) at which death took place
   presence of attending physician at death

Table 5

HOSPITAL SURVEY: INDIVIDUAL AND AGGREGATE VARIABLES

A. Individual Variables

1. Name
2. Date of birth
3. Sex
4. Age at admission
5. Diagnoses
6. Severity of disease (degree of dehydration)
7. Weight and height at admission
8. Nutritional status at admission
9. Length of stay in the hospital
10. Discharge disposition (released home, died)
11. Date of release or death

B. Aggregate Variables

1. Utilization rates of pediatric and diarrheal beds
2. Case fatality rates
3. Evaluationsof diarrheal wards during the yearsunder study (use, quality)
4. Referral patterns for infants

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