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MORTALITY IN INFANCY AND CHILDHOOD

IN INDIA

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MORTALITY IN INFANCY AND CHILDHOOD IN INDIA*

Ruth R. Puffer, Dr P H

In 1981 a brief report on mortality in infancy and childhood in India[42] was prepared to serve as the basis for program planning with suggestions for greater in-depth study of the vital statistics essential for such planning. The purpose of the present report is to update the information in the first report, to highlight the problems uncovered in new special studies and published mortality statistics and to propose further studies and programs.

This report is divided into three sections: the first on mortality by age of death, the second on low birth weight, the important factor, and the third on causes of death. The first section indicates that death rates are excessive in the neonatal period, especially in the early neonatal period, 0-6 days of age. Also the limited data on stillbirths suggest that the loss of life is great even before and during birth. Thus studies are needed of the condition of babies at birth, which is the most important determinant for survival. A major health problem which requires solution throughout the world involves the causes and prevention of low birth weights. Recently several prospective studies of perinatal mortality[25,35,51] have been undertaken in India to extend knowledge of the size and nature of the problem and methods of reducing the excessive mortality due to the unfavorable condition of babies at birth. Some of the findings on the relation of low birth weights to mortality are included in the second section.

In the third section, the published statistics on the causes of death by the Registrar General, the Ministry of Health and Family Welfare and the Director of Health Services of Maharashtra and from special studies are used to present the distinct health problems causing mortality in infancy and childhood. These reports provide information regarding the six diseases, tuberculosis, whooping cough, diphtheria, tetanus, measles and poliomyelitis, for which immunization programs are recommended by the World Health Organization and are recognized as health problems in India. Actions are now being recommended for complete coverage.[23] Many reports and papers reveal that immaturity is a major cause of death in the neonatal period. Thus the data in all three sections indicate the basic problem of high mortality around birth due to low birth weights.

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Report prepared for USAID - India, April 1985.

A short summary of the analysis of the reports and studies follows with the important causes and factors responsible for the high rates. Also methods are proposed for collecting reliable and complete data in surveys and special studies as the basis for planning and evaluating programs.

1. Mortality by Age of Death

India has the second largest population in the world, 658,140,676 according to the 1981 census being exceeded only by China with an estimated population of 982,850,000 for Dec. 31, 1980. In 1981, 23.7 percent of the population of India lived in urban areas and thus the rural population of 76.3 percent was very large. Infants and children under 5 years of age constituted 13.8 percent of the population. This report is primarily concerned with mortality in this important segment of the population.

Table 1

Estimated Birth and Death Rates per 1000 Population in Rural and Urban Areas of India, 1983

	Total	Rural	Urban
Birth rate	33.6	35.3	28.0
Death rate	11.9	13.0	7.7

Source: Office of Registrar General.(21)

The estimated birth rate for India(21) for 1983 was 33.6 per 1000 population and the death rate 11.9. The estimated birth rates(20) varied from 33.6 to 33.9 in the five years, 1979-1983, while the estimated death rate declined from 13.0 in 1979 to 11.9 per 1000 population in 1983. Both rates were much higher in the rural area than in the urban area (Table 1).

Table 3

Deaths per 1000 Population of Children 0-4 Years of Age in Rural and Urban Areas of States of India, 1978

State	Total	Rural	Urban
Total	50.1	54.1	30.7
Andhra Pradesh	36.8	40.9	16.6
Assam	50.7	54.3	25.7
Gujarat	39.5	42.8	28.5
Haryana	33.3	35.1	20.5
Himachal Pradesh	31.8	32.4	15.2
Jammu-Kashmir	28.7	30.4	17.6
Karnataka	26.6	29.4	18.0
Kerala	12.6	13.1	10.4
Madhya Pradesh	52.8	56.5	27.7
Maharashtra	21.8	24.9	14.7
Orissa	42.7	43.9	26.1
Punjab	34.9	38.7	19.9
Rajasthan	54.9	60.8	19.9
Tamil Nadu	37.8	44.1	21.8
Uttar Pradesh	64.9	67.9	36.8

Source: Office of Registrar General.(19)

Table 2

Percentage of Total Deaths of Children 0-4 Years of Age by Sex in Rural and Urban Areas of India, 1977

Sex	Total	Rural	Urban
Total	47.0	48.6	36.0
Male	45.2	46.9	34.5
Female	48.8	50.3	37.6

Source: Padmanabha.(40)

From the Sample Registration System as reported by Padmanabha.(40,57) It was estimated that in 1977 nearly half (47 percent) of all deaths were of infants and children less than 5 years of age. The percentage in the rural area of 48.6 was 35 percent higher than that in the urban area of 36.0 (Table 2).

The death rates for the age group 0-4 years for the states of India were

published in the report of the Survey of Infant and Childhood Mortality, 1979.[19] For India, the death rate was 50.1 per 1000 population; the rate in the rural area was 76 percent higher than in the urban area. The variation in the death rates was great, from 12.6 in Kerala to 64.9 per 1000 population in Uttar Pradesh. The four neighboring states of Uttar Pradesh, Rajasthan, Madhya Pradesh and Orissa as well as Assam had the highest death rates. Excessive mortality in infancy was in part responsible for the high rates for this age period. As mortality is reduced more rapidly by health programs for children 1-4 years of age than for infants, the death rates for children 1-4 years of age would be useful in assessing mortality in early life. From rough estimates , the death rate for children 1-4 years of age appears to be relatively low for Kerala. Maharashtra has the second lowest rate for the group 0-4 years and probably has a low death rate for children 1-4 years of age. The impact of immunization, oral rehydration and nutrition programs could be evaluated by death rates for children in this age group.

Table 4

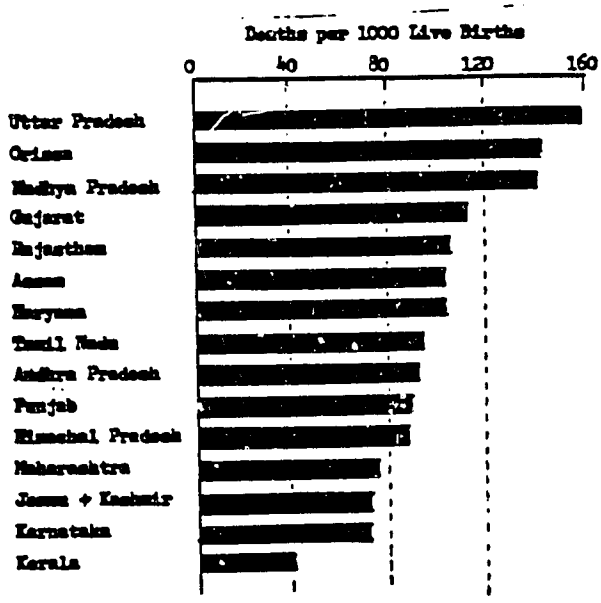
Infant Death Rates per 1000 Live Births for Rural and Urban Areas of States, India, 1980

State	Total	Rural	Urban
Total	114	124	65
Andhra Pradesh	92	103	40
Assam	103	105	64
Gujarat	113	119	94
Haryana	103	111	53
Himachal Pradesh	87	88	62
Jammu + Kashmir	72	76	45
Karnataka	71	79	45
Kerala	40	41	34
Madhya Pradesh	142	152	80
Maharashtra	75	84	52
Orissa	143	150	62
Punjab	89	96	58
Rajasthan	105	115	50
Tamil Nadu	93	103	64
Uttar Pradesh	159	167	99

Source: Office of Registrar General.[20]

Figure 1

Infant Deaths per 1000 Live Births for States of India, 1980



The infant death rate in 1980 of 114 per 1000 live births was lower than the rates in the 1970's. The rates from 1970 to 1979 fluctuated from 125 to 140 per 1000 live births.[19] The infant death rates of the Office of the Registrar General are given in Table 4 for the rural and urban areas of 15 states of India in 1980.

The rural infant death rate of 124 per 1000 live births for India was nearly double the urban rate of

65 per 1000 live births. The variation in these infant death rates was from 40 in Kerala to a rate nearly four times as high of 159 per 1000 live births in Uttar Pradesh (Figure 1).

The most critical period for survival of the infant and likewise for obtaining the facts regarding the birth and death is the first 24 hours of life. Throughout the world special attention needs to be directed to the condition of the infant at birth and to current registration or reporting of all births and deaths in early life in accordance with international definitions.(62)

Table 5

Estimated Neonatal and Postneonatal Deaths per 1000 Live Births in Rural and Urban Areas of India, 1974 and 1980

Period	Total		Rural		Urban	
	1974	1980	1974	1980	1974	1980
Infant	126	114	136	124	74	65
Neonatal	70	69	76	76	41	39
Postneonatal	56	45	60	48	33	26

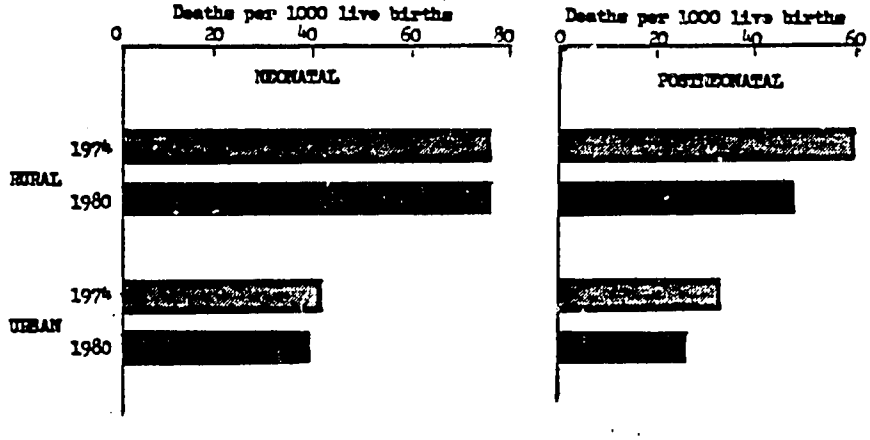
Source: Office of Registrar General.(22)

The death rate in the neonatal period, 0-27 days, is higher than in the postneonatal period, 28 days through 11 months. Reductions in mortality from health programs usually occur earlier in the postneonatal period and in children 1-4 years of age than in the neonatal period.

The estimated neonatal death rates in India are high, 70 per 1000 live births in 1974 and 69 in 1980 (Table 5). However, the postneonatal death rates are lower and a reduction occurred from the estimated rate of 56 per 1000 live births in 1974 to 45 in 1980. While neonatal death rates did not show a definite reduction, the estimated postneonatal death rates declined in both rural and urban areas (Figure 2).

Figure 2

Estimated Neonatal and Postneonatal Mortality for Rural and Urban Areas of India, 1974 and 1980



Many prospective studies of mortality in infancy have been carried out and several were described in the previous report.(42) In Table 6, infant, neonatal and postneonatal death rates are provided for those of the 1970's and 1980's. Two studies of the 1980's in the State of Haryana have been added, one by Kumar and

Table 6
Infant, Neonatal and Postneonatal Deaths per 1000 Live Births in Nine Areas of Seven Prospective Studies in India

Location	Live births	Infant (- 1 year)		Neonatal (0-27 days)		Postneonatal (28 days-11 mo)		Date
		No.	Rate	No.	Rate	No.	Rate	
Narangwal, Rural Punjab	2 984	313	104.9	179	60.0	134	44.9	1970-1973
North Arcot, Tamil Nadu								
Rural	4 757	543	114.1	288	60.5	255	53.6	1970-1972
Urban	3 485	381	109.3	152	43.6	229	65.7	1970-1972
Ballabgarh	1 529	141	92.2	78	51.0	63	41.2	1975
Rajasthan Villages	500*	62	124.0	31	62.0	31	62.0	1977
Ludhiana, Punjab								
Three Rural Centers	1 961	194	98.9	101	51.5	93	47.4	1978-1980
Urban Center	925	51	55.1	24	25.9	27	29.2	1978-1980
Haryana, Rural	2 480	192	77.4	96	38.7	96	38.7	1980
Beri and Kalanaur Blocks	1 779	176	98.9	98	55.1	78	43.8	1982-1983

*Estimates were made from available deaths or rates.

Source: Kielmann,[28] Rao,[44] Reddaiah,[46] Gupta,[14] Christian Medical College,[6] Kumar,[31] and Kishore.[30]

co-workers[31] in a rural community block of Haryana and the other by Kishore[30] in selected rural blocks of Beri and Kalanaur.

The study by Kumar et al[31] was carried out over a one-year period during 1980 in a population of 95,000 from among 106 villages. Health services were provided through the collaborative efforts of the Postgraduate Institute of Medical Education and Research, Chandigarh and Haryana State Health Department. Information on births, stillbirths and infant deaths was obtained by village chowkidars, community health volunteer, anganwadi worker and multipurpose health workers. The infant death rate was 77.4 per 1000 live births with half of the deaths in the neonatal period. The infant, neonatal and postneonatal death rates were lower than those in the Survey of Infant and Childhood Mortality in which the infant death rate in the rural area was 116, neonatal 56 and postneonatal 60 per 1000 live births probably due to the coverage of the health services.

The prospective study of Kishore[30] was conducted during one year from March 1, 1982 through February 28, 1983. The population in the Beri block was 40,253 and in the Kalanaur block 19,912. The information was collected by the para-medical staff, community health guides and anganwadi workers in 16 villages. Other channels were used as traditional birth attendants, village leaders and chowkidars. The investigator collected the reports and investigated every birth and child death up to 3 years of age. The infant death rate was 98.9 per 1000 live births with a neonatal rate of 55.1 and postneonatal rate of 43.8 per 1000 live births.

In the seven rural areas included in Table 6, the infant death rates varied from 77.4 to 124.0 per 1000 live births. In the two urban areas, the rates were 55.1 in the Urban Health Center of Ludhiana and 109.3 in the North Arcot District of Tamil Nadu. Most of the neonatal and postneonatal death rates for the rural

areas were lower in these experiences than in rural India which is expected because of their location and the health services rendered. However, these neonatal death rates are high signifying the serious problems in this period immediately after birth.

The distributions of deaths by age group are available for the rural areas of several of the prospective studies (Table-7). Not only are the neonatal death rates high but also they are very high in the early neonatal period, 0-6 days. In the five studies, the early neonatal death rates varied from 27.5 to 40.5 per 1000 live births. In three projects, the death rates in the first day of life were given also and varied from 10.0 to 14.4 per 1000 live births. This is the critical period for survival and for obtaining all of the deaths. In the United States, the death rate in the first 24 hours of life remained around 10 per 1000 live births from 1950 to 1964[52] before a gradual decline occurred. With the serious problem of low birth weights in India, the rates in the first day of life are expected to be high. Securing all of these deaths is difficult and depends on training of all workers in the definitions of a live birth and fetal death (stillbirth).

In the postneonatal period, death rates are usually higher for those dying from 28 days through 5 months than for those dying in the last six months of infancy. To illustrate the neonatal mortality and especially in the early neonatal period, the death rates in four age groups of infancy are shown in Figure 3 for the Beri and Kalanaur Blocks.[30]

Table 7

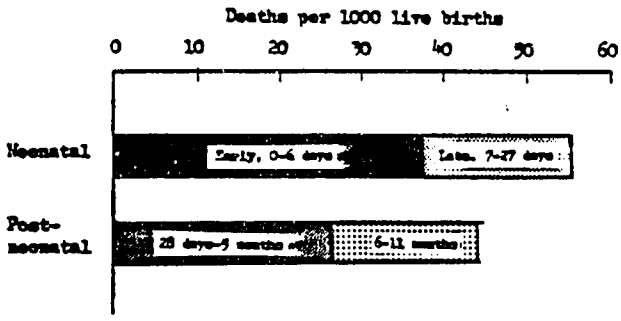
Infant Deaths per 1000 Live Births by Age at Death in Rural Areas of Five Prospective Studies in India

Age Group	Ludhiana Three Rural Centers 1978-1980	No. Arcot District Rural 1970-1972	Ballabgarh Center Rural 1975	Narangwal Study Rural 1970-1973	Beri and Kalanaur Blocks 1982-1983
Infant (-1 year)	98.9	114.2	92.2	104.9	98.9
Neonatal (0-27 days)	51.5	60.5	51.0	60.0	55.1
Early (0-6 days)	36.1	40.5	27.5	40.5	36.5
Under 1 day	13.2	10.0	14.4		
1-6 days	22.9	30.5	13.1		
Late (7-27 days)	15.3	20.0	23.5	19.4	18.5
Postneonatal	47.4	53.6			43.8
28 days-5 months	24.0	33.6	41.2	44.9	25.9
6-11 months	23.5	20.0			18.0

Source: Christian Medical College,[6] Rao,[44] Reddaiah,[46] Kielmann,[28] Kishore.[30]

Figure 3

Neonatal and Postneonatal Mortality by Age of Death in Beri and Kalanaur Blocks, India, 1982-1983



In addition to information regarding infant mortality and mortality for the first five years of life, there is great need for information regarding mortality of children 1-4 years of age. This is the age period when the immunization, oral rehydration, nutrition and other health programs usually have reduced mortality more rapidly than in infancy. For the Ludhiana and North Arcot District prospective studies, death rates are given for this four-year age group. In the Narangwal Experiment and in the study in the Beri and Kalanaur Blocks, death rates were provided for children one and two years of age (Table 8). Except for the rate in the rural area of the North Arcot District, the rates were much lower than in the Khanna study of Gordon et al[13] in 11 villages of the Punjab in 1957-1959. At that time the death rate for children 1-4 years of age was 27.4 per 1000 population.

Table 8

Deaths per 1000 Population of Children 1-4 -and 1-2 Years in Four Studies, India

Area	Age group	Death rate	Years
Narangwal Experiment	1,2 yrs.	12.3	1970-1973
North Arcot District			
Rural	1-4 yrs.	24.0	1970-1972
Urban	1-4 yrs.	15.0	1970-1972
Ludhiana, Three Rural Centers	1-4 yrs.	6.9*	1978-1980
Beri and Kalanaur Blocks	1,2 yrs.	12.7	1982-1983

* Estimated population base.

Source: Kielmann,[28] Rao,[44] Christian Medical College,[6] Kishore.[30]

Collection of information and publication of death rates for children 1-4 years of age are recommended for prospective studies in the future and in the Sample Registration Surveys of the Office of the Registrar General. Progress in health programs in this important age group could be evaluated and measures taken for the reduction of mortality.

To study the outcome of pregnancy, the deaths which occur before and during delivery as well as those which occur shortly after birth are combined and studied as perinatal mortality. The distinction between a fetal death (stillbirth) and death immediately after birth is often difficult and depends on evidence of one of the signs of life. The definition of a live birth adopted by the World Health Assembly and given in the International Classification of Diseases[62] follows:

> "Live birth is the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of the pregnancy, which, after such separation, breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached: each product of such a birth is considered live born."

Stillbirths or fetal deaths are those which lack this evidence of life. Thus the distinction between live births and stillbirths would be difficult whenever medical attention is not available. The combination of stillbirths and early neonatal deaths provides a method of assessing the outcome realizing that some of the deaths occurring soon after birth may be reported as stillbirths. Health programs are directed to preventing both stillbirths and early neonatal deaths, termed perinatal deaths.

From four of the prospective studies referred to in the 1981 Report, both perinatal and infant mortality were obtained. In Table 9, stillbirths, early neonatal deaths and perinatal deaths and rates are presented for the projects in Palghar, Pondicherry, Delhi and Narangwal. Kumar et al[31] in their study of infant mortality in rural Haryana recorded stillbirths as well as early neonatal deaths and thus the basic data for perinatal mortality. In the State of Maharashtra, Usha Shah[51] of the B. J. Medical College in Pune participated in an Inter-Country Collaborative Study of Perinatal Mortality sponsored by the World Health Organization in South-East Asia. A rural study area of 20 villages with a population of 43,000 was used. A clinic was situated in the headquarter's village of Sirur of the Rural Training Center. The outcome of all births and early neonatal deaths in the two-year period, August 1, 1977 through July 31, 1979 were recorded and analyzed. To ensure that each pregnancy was detected and its termination reported, birth weight recorded and information regarding deaths in the early neonatal period obtained, local village women were trained and supervized to carry out the work. Analyses of the results provided perinatal death rates and also excellent material for the study of birth weights and related factors as reported in the next section of this report.

Table 9

Stillbirth, Early Neonatal and Perinatal Mortality in Prospective Studies in India and Java, Indonesia

Area	Date	Total births	Stillbirths		Early neonatal deaths		Perinatal deaths		Live births
			No.	Rate*	No.	Rate**	No.	Rate*	
India									
Palghar, Rural	1960-1965	8 255	146	17.7	233	28.7	379	45.9	8 109
Pondicherry, Urban	1968-1972	827	20	24.2	19	23.5	39	47.2	807
Delhi Urban Cohort	Dec. 1969-Mar. 1972	5 732†	140	24.4	82	14.7	222	38.7	5 592†
Narangwal, Rural	1970-1973	3 121	137	43.9	121	40.5	258	82.7	2 984
Pune Rural Area	Aug. 1977-July 1979	3 173	90	28.4	82	26.6	172	54.2	3 083
Haryana, Rural	1980	2 525	45	17.8	73	29.4	118	46.7	2 480
South-East Asia									
Indonesia, Rural Java	Sept. 1976-Feb. 1980	2 342	34	14.5	72	31.2	106	45.3	2 308

* Rate per 1000 total births: ** Rate per 1000 live births † Singleton.

Source: P. M. Shah,[50] Srinivasa,[54] Ghosh,[10] Kielmann,[28] U. Shah,[51] Kumar,[31] Alisjahbana.[2]

Data on perinatal mortality for Table 9 were available for these six projects in India. Also the results of the South-East Asia Collaborative Study in Java, Indonesia, are included to indicate the wide variation in these rates. The perinatal death rate from the Narangwal Experiment of 82.7 per 1000 total births was the highest for all these areas. The rural area of Pune had the second highest rate of 54.2 per 1000 total births. There was considerable variation in the stillbirth and early neonatal death rates which may be due to differences in recording of these vital events and to the inclusions. In some areas, stillbirths may be restricted to those of at least 28 weeks of gestation or weighing at least 1000 grams while in others the period of gestation and birth weight may not have been considered. Perinatal mortality is often restricted to births of at least 1000 grams and gestations of 28 weeks and longer.

The experience in Java in Indonesia was similar to those in India but with a relatively low stillbirth rate. The perinatal death rate in another of the countries in the South-East Asia Study[66] was 51.2 per 1000 deliveries in the rural area of Burma.

The collection of complete and comparable data for perinatal mortality is extremely difficult and yet challenging. Prospective studies with current observations of pregnant women, distinction of live births and stillbirths and follow-up of all those born alive through the first week of life are needed to obtain greater understanding of the problems in this important period.

The Report of the Survey of Infant and Childhood Mortality[19] provided considerable information regarding factors influencing the level of infant mortality. Data from Statement 47 of the Report (Table 10) show that the infant death rate was much lower for infants of mothers who had at least primary education than for those of illiterate mothers in both rural and urban areas.

Table 10

Infant Mortality by Level of Education of Women, India, 1978

Educational level	Rural	Urban
Illiterate	145	88
Literate but below primary	101	57
Primary and above	71	47

Source: Office of Registrar General.[19]

The low level of infant mortality of 40 per 1000 live births in Kerala has been attributed in part to the high level of literacy in that State. Nair[38] stated that the effective rate of literacy in the State came to nearly 90 percent and that there existed only narrow differences between literacy rates of men and women and of rural and urban areas. Thus the extension of education to all will have a beneficial effect on infant mortality.

In Statement 49 of the Report,[19] infant mortality was shown to be lower when the age of marriage was at leasl 21 years (Table 11). In our study of infant mortality by age of the mother,[41] the infant death rates were found to be lowest for babies of mothers 25-29 years of age. Infant mortality of babies of young mothers under 20 years was excessive and the rates were high for those of mothers of 35 years and over. Thus postponement of marriage and births at favorable ages of mothers have definite influences on the size of the infant death rate.

Table 11

Infant Mortality by Age of Marriage, India, 1978

Age at marriage	Rural	Urban
Below 18 years	156	88
18-20 years	132	67
21 years and over	70	46

Source: Office of Registrar General.[19]

Many factors are interrelated which result in high infant death rates. One of the most important, especially in India, is the high incidence of low birth weights which is considered in the next section. Also the interrelated factors such as length of gestation and age of the mother in relation to birth weight are analyzed.

The data presented in this section show the tremendous loss of life, before and during birth as stillbirths and soon after birth as early neonatal deaths. Research on the outcome of pregnancy is desirable for understanding the role of the many factors and their interrelationships in causing excessive mortality in early life.

II. Low Birth Weight, Important Factor

Birth weight is the best predictor of a baby's chances for survival and healthy growth and development and is dependent on the health and nutritional state of the mother. The World Health Organization has collected data on birth weights from all available sources to give a world view of the problem of low birth weights.[65] For 1982, the estimates of live births of the world of low birth weight*(less than 2500 grams) was 16.0 percent (Table 2). Asia is the region of the world with the highest percentage, 19.7, three times the lowest of 6.5 for Europe.

*Low birth weight was defined as less than 2500 grams in the Ninth Revision of the International Classification of Diseases.[62] In the past, the definition was 2500 grams or less.

Table 12

Incidence of Low Birth Weight by Regions of the World, 1982

Region	Percentage
The World	16.0
Africa	14.0
Northern America	6.8
Latin America	10.1
Asia	19.7
Europe	6.5
Oceania	11.6
Union of Soviet Socialist Republics	8.0

Source: World Health Organization.(65)

In Asia, the incidence of live births of low birth weight was very high for the following countries:

	Percentage
Bangladesh	50.0
Thailand	38.0
India	30.0
Pakistan	27.0
Sri Lanka	27.0

In developing countries, hospitals have been the principal source of information regarding birth weights. In India, from the available data, principally from hospitals, the percentage of 30.0 is high. Very little is known about the distributions of birth weights in the rural and urban areas outside of hospitals. Efforts need to be introduced in health and community programs for weighing all babies at birth. Because of the seriousness of the problem, research is underway or being planned to determine the causes and prevention of low birth weights.(60)

Presentation of data regarding the incidence of low birth weights in India for areas outside of hospitals is difficult for several reasons. In prospective studies, birth weights usually are not obtained for all births. For example, in the Community Survey in North Arcot District of Tamil Nadu, Rao and Inbaraj(45) stated that for nearly half of the single live births they could not ascertain reliably the birth weight or gestation or both. Also for some of the studies, such as for the North Arcot District, Delhi Urban Cohort and the rural area near Pune, data for only the singleton live births were obtained. In some studies, births of less than 1000 grams are not included. In studies of perinatal mortality, the birth weights of total births are given. Until international rules are established and followed and all births are weighed routinely, the percentages of live births of low birth weight are only estimates. Weighing of babies is important for mothers and for those providing health care. Birth weights are the first records to be used as the basis for monitoring growth and development of infants as well as providing information regarding this serious problem. In health programs and special studies, the provision of birth weights of all live births would be a desirable goal. With these reservations regarding the quality and comparability of the data, the incidence of live births of low birth weights are given in Table 13 for five prospective studies. which are not hospital based.

Table 13

Incidence of Live Births of Low Birth Weight in Five Prospective Studies in India

Area	Live births	Low weight births* No.	%
Pondicherry, Urban	558	152	27.2
Delhi Urban Cohort**	6 026	1 383	23.0
North Arcot District, Rural and Urban**	4 220	1 345	31.9
Narangwal Villages, Rural Punjab	859	207	24.1
Pune Rural Area**	3 040	604	19.9

* The definition for low birth weight was 2500 grams or less except for the Pune study of less than 2500 grams.

** Singleton births.

Source: Srinivasa,[54] Ghosh,[10] Rao,[45] Kielmann,[28] and U. Shah.[51]

An early report often referred to of birth weights was carried out by P. M. Shah and P. M. Udani[50] in Palghar from 1960-1965. Of the 1,910 live births in the rural area, many were from a maternity ward and the experience may not be representative of rural areas. Of these live births, 722 or 37.8 percent weighed 2500 grams or less.

The results of the five prospective studies in Table 13 vary widely. In the recent perinatal study in the rural area near Pune,[51] the weights of singleton births were given. Only 4 of the live births were not weighed ; 19.9 percent of the singleton live births weighed less than 2500 grams.

As the infant death rate of 40 per 1000 live births is low in Kerala, the incidence of low birth weights is of special interest. Nair,[37] provided birth weights for four periods from 1959-1963 to 1976-1980. The proportion of less than 2000 grams declined from 11.0 to 3.8 percent and of less than 2500 grams from 20.5 to 16.3 percent. For the high income group, the percentage of live births of less than 2500 grams was only 3.2 in 1976-1980.

Many more and much larger and more complete series of birth weights are needed for widely distributed areas of both rural and urban areas of India for measurement of the problem. Hopefully, this is only a beginning of the collection of such data for live births.

For three prospective studies, Delhi Urban Cohort, North Arcot District and Pune Rural Area, the distributions of singleton live births by birth weight are available and are given in Table 14 and are shown in Figure 4. The birth weight group of 2501-3000 grams had the largest numbers of births with over 40 percent in that 500 gram group. The percentages in the next weight group of 3001-3500 grams were 21.5 to 25.8. They were very small in the higher weight groups. This pattern is distinctly different from that found in the United States as illustrated by the distribution of birth weights of the California

Table 14

Distribution of Singleton Live Births by Birth Weight in Three Prospective Studies in India

Weight in grams	Delhi Urban Cohort		Community Survey, North Arcot		Prospective Study, Pune Rural*	
	No.	%	No.	%	No.	%
Total	6 026	100	4 220	100	3 040	100
1500 or less	165	2.7	46	1.1	27	0.9
1501-2000			232	5.5	66	2.2
2001-2500	1 218	20.2	1 067	25.3	511	16.8
2500 or less	1 383	23.0	1 345	31.9	604	19.9
2501-3000	2 762	45.8	1 738	41.2	1 484	48.8
3001-3500	1 552	25.8	906	21.5	762	25.1
3501-4000	292	4.8	203	4.8	190	6.2
4001 and over	37	0.6	28	0.7		

*For the Pune Study, the weight groups were less than 1500, 1500-1999, 2000-2499, 2500-2999, 3000-3499, 3500 and over.

Source: Ghosh;[10] Rao,[45] and U. Shah.[51]

Project of the Inter-American Investigation of Mortality in Childhood.[61] The peak in India in all three projects occurs in a lower weight group than in the California Project.

The distributions of total births are available for two other studies of the South-East Asia Collaborative Study, Indonesia and Burma. As these were studies of perinatal mortality, the distriburions were given for total births and the distribution of live births could not be obtained as in the Pune study. The distributions in Table 15 are for rural areas in the studies. The proportions of the total births of low birth weight were 14.7 percent for Ujung Berung, a rural area near Bandung in West Java, Indonesia,[2] and 15.6 percent for the rural area in Burma.[66] The patterns of these distributions of birth weights differed from those in India with higher percentages in the weight group, 3000-3499 grams. The distribution of birth weights of live births in the California Project is given so that comparisons can be made with

Figure 4

Distribution of Singleton Live Births by Birth Weight in Three Studies in India and California Project

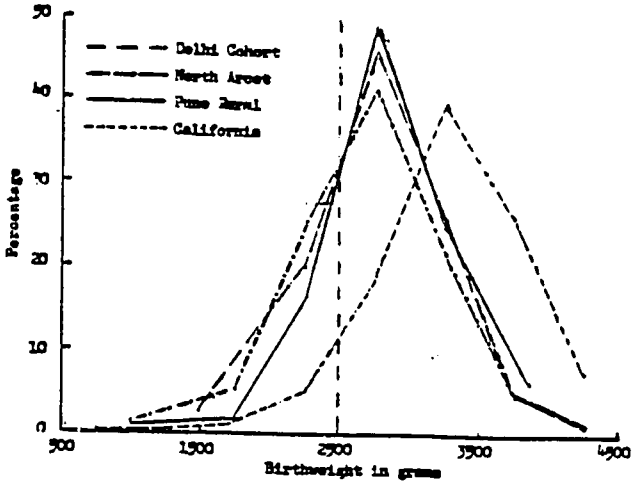


Figure 5

Distribution of Total Births by Birth Weight in Java, Indonesia and Burma and of Live Births in California Project

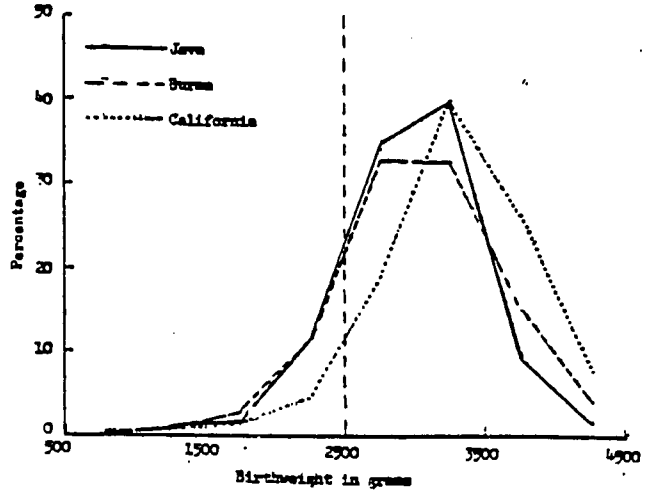


Table 15

Distribution of Total Births by Birth Weight in Studies in Indonesia and Burma

Weight in grams	Ujung Berung Java		Rural Area Burma	
	No.	%	No.	%
Total	2 337	100	1 695	100
Less than 1000			3	0.2
1000-1499	24	1.0	15	0.9
1500-1999	38	1.6	48	2.8
2000-2499	282	12.1	198	11.7
Less than 2500	344	14.7	264	15.6
2500-2999	813	34.8	554	32.7
3000-3499	926	39.6	552	32.6
3500-3999	217	9.3	255	15.0
4000 and over	39	1.6	70	4.1

Source: Alisjahbana,[2] World Health Organization.[66]

in five weight groups are shown for the North Arcot District in Figure 6. The estimated rate for the low weight births, 2500 grams or less, of 128.6 per 1000 live births is high and the rate for those weighing 2501-3000 grams was 77.2. However, the infant death rates were lower for those weighing over 3000 grams (51.9, 35.9 and 37.0 per 1000 live births for the three weight groups). The rate for those weighing 3501-4000 grams of 35.9 was less than half the rate for those weighing 2501-3000 grams. The optimal weight group appears to be 3501-4000 grams.

The reduction in perinatal mortality with increasing birth weights is shown in Figure 7 using data from the rural area near Pune. The perinatal death rates were lower for those weighing at least 3000 grams (11.7 and 15.7 per 1000 total births). The number of births in the weight group of 3000 grams and over was too small for division into two weight groups. Larger series of birth weights are desirable for study of these relationships.

the patterns in western countries.

In the rural areas of both the Indonesian and Burma studies, over half of births weighed at least 3000 grams, 50.5 percent in the Java study and 51.7 percent in the rural area in Burma. In the rural area near Pune, only 31.3 percent weighed at least 3000 grams. Both perinatal and infant mortality are lower for births of at least 3000 grams.

To illustrate the reduction in mortality with increasing birth weight, infant death rates of singleton live births

Figure 6

Infant Mortality of Live Births in Five Birth Weight Groups, North Arcot District, India

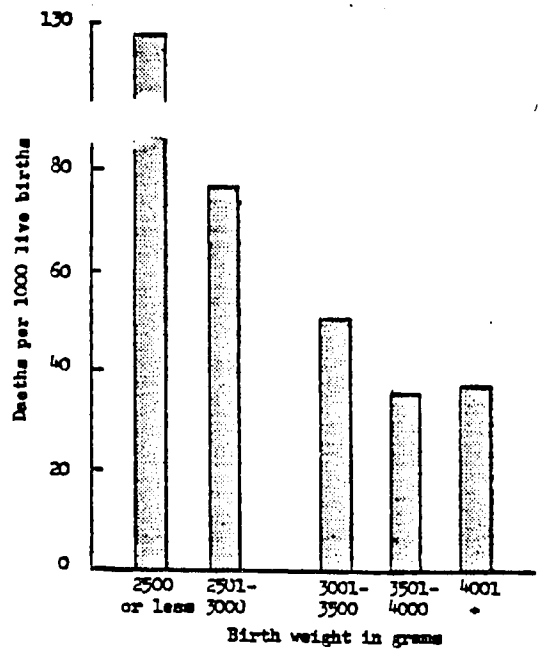
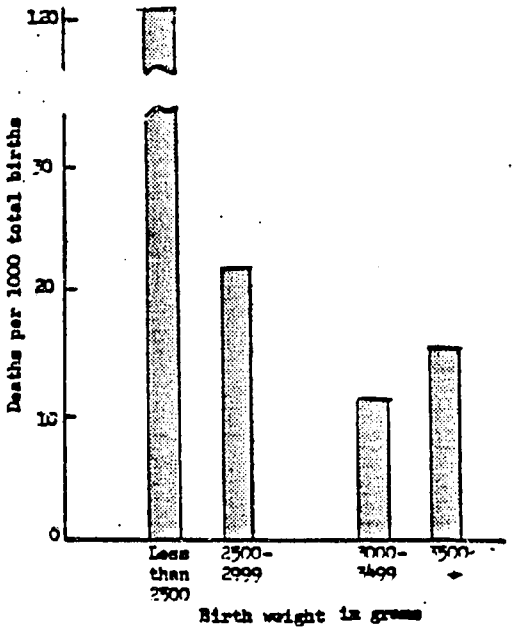


Figure 7
Perinatal Mortality of Total Births in Four Birth Weight Groups Pune Rural Area, India



In the large study of infant mortality of 142,017 live births by birth weight in New York City,[27] the infant death rate for those weighing 3501-4000 grams, 5.6 per 1000 live births, was less than half the rate for those weighing 2501-3000 grams, 12.1. Mortality usually is lower for those weighing at least 3000 grams. In the New York City experience, nearly two-thirds of the live births (65.8 percent) weighed over 3000 grams. Increasing birth weights to at least 3000 grams would appear to lower mortality, both infant and perinatal. Of course, many factors influence the birth weight of the fetus, maternal diseases and conditions, age of the pregnant woman, nutritional state, height and weight, birth interval, etc.

Shah[51] in her prospective study obtained birth weights and lengths of gestation of 3,040 singleton live births. Of these, 604 weighed less than 2500 grams and were of low birth weight: 100 were preterm of less than 37 weeks gestation and 504 were term births (Table 16). (The few post-term were included with the term.) The low weights of these term births are said to be due to intrauterine growth retardation. There appear to be two problems, the true preterm births, the prematures, with 3.3 percent of the live births. The group of term births of low birth weight accounted for 16.6 percent of the live births. By estimating from percentages provided by Bhargava[4] for the prospective study of the Delhi Urban Cohort, 4.4 percent were found to be preterm low birth weight births and 19.9 percent term births of low birth weight. This

Table 16

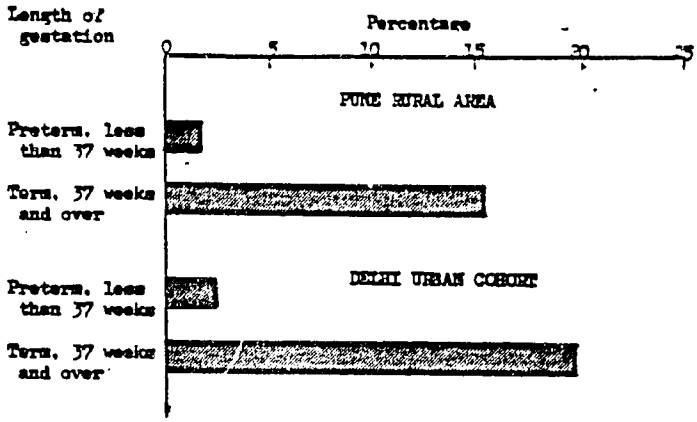
Distribution of Singleton Live Births by Birth Weight and Length of Gestation, Pune Rural Area and Delhi Urban Cohort, India

Birth weight and length of gestation	Pune Rural Area No.	Pune Rural Area %	Delhi Urban %
Live births	3 040	100	100
Less than 2500 grams	604	19.9	24.3
Preterm, less than 37 weeks	100	3.3	4.4
Term, intrauterine growth retardation (IUGR)	504	16.6	19.9
2500 grams and over	2 436	80.1	75.7
Preterm, less than 37 weeks	116	3.8	6.4
Term, 37 weeks and over	2 320	76.3	69.3

Source: Shah[51] and Bhargava.[4]

Figure 8

Percentage of Singleton Live Births of Low Birth Weight by Length of Gestation in Pune Rural Area and Delhi Urban Cohort, India



urban experience had slightly higher percentages for both the preterm and the term births of low birth weight. The relative frequencies of these two groups of low weight births in the Pune and Delhi studies are shown in Figure 8.

Bhargava[4] also provided data for calculating similar estimates from the large hospital study of 17,570 live births. The percentage of babies with low birth weights and gestation of less than 37 weeks, the preterm, was 6.3. The percentage of term babies of low birth weight was 22.0. Both of these percentages from the hospital study were higher than those of the Delhi Urban Cohort and the Pune Rural Area. These findings of two groups of low weight births, the preterm and the term, with the second group much larger raises many questions regarding causation. Are the causes or factors the same for the two kinds of low weight births?

Table 17

Distribution of Singleton Total Births, Stillbirths, Early Neonatal and Perinatal Deaths by Birthweight Prospective Study of Pune Rural Area, India

Birthweight in grams	Births*		Stillbirths*		Early Neonatal Deaths		Perinatal Deaths	
	No.	%	No.	%	No.	%	No.	%
Total	3 095	100	55	100	67	100	122	100
Less than 1500	31	1.0	4	7.3	17	25.4	21	17.2
1500-1999	80	2.6	14	25.5	18	26.9	32	26.2
2000-2499	525	17.0	14	25.5	10	14.9	24	19.7
Less than 2500	636	20.5	32	58.2	45	67.2	77	63.1
2500-2999	1 500	48.5	16	29.1	17	25.4	33	27.0
3000-3499	768	24.8	6	10.9	3	4.5	9	7.4
3500 and over	191	6.2	1	1.8	2	3.0	3	2.5

* Birth weights were unknown for 30 stillbirths and 4 live births.

Source: U. Shah,[51]

The prospective study of Shah[51] was directed to perinatal mortality (stillbirths and early neonatal deaths). Table 17 shows the distributions of the total singleton births, stillbirths, early neonatal deaths and perinatal deaths by birth weight. High proportions of the stillbirths and early neonatal deaths were of low weight births, 58.2 and 67.2 percent respectively. Seventy-seven or 63.1 percent of the perinatal deaths were of low weight births; an additional 33 or 27.0 percent were of births of 2500-2999 grams and only 12 or 9.8 percent of these perinatal deaths occurred in the favorable birth weight group of 3000 grams and over.

Both birth weight and length of gestation are used for calculation of perinatal mortality according to these two important factors (Table 18). The preterm low weight babies had a very high death rate of 439.7 per 1000 births. The rate for term babies (including post-term) of low birth weight (IUGR) of 50.0 per 1000 births was over two and one-half times the rate for those weighing at least 2500 grams. Thus to prevent perinatal deaths, the causes and prevention of preterm low weight babies and term babies with growth retardation must be determined. To analyze the multiple factors and their relationship to other high risk factors, large series of pregnant women and their babies will need to be followed through the first week of life.

Table 18

Distribution of Total Singleton Births, Perinatal Deaths with Rate by Birth Weight and Gestation in Pune Rural Area, India

Birthweight and length of gestation	Births		Perinatal Deaths		
	No.	%	No.	%	Rate*
Total births	3 095	100	122	100	39.4
Less than 2500 grams	636	20.5	77	63.1	121.1
Preterm, less than 37 weeks	116	3.7	51	41.8	439.7
37 weeks and over (IUGR)	520	16.8	26	21.3	50.0
2500 grams and over	2 459	79.5	45	36.9	18.3
Preterm, less than 37 weeks	118	3.8	3	2.5	25.4
37 weeks and over	2 341	75.6	42	34.4	17.9

* Rate per 1000 births

Source: Shah.(51)

The World Health Organization(63) carried out a large study of perinatal mortality* in eight countries to examine the various factors which influence the risk of stillbirth and early neonatal mortality separately and in combination. The percentages of singleton births according to birth weight and gestation for seven countries are given in Table 19 for comparison with the findings of Shah(51) in the prospective study in the rural area near Pune, India.

The percentages of the births with both risk factors, low birth weight and preterm, varied from 2 to 8 and the percentage for the Pune study was similar. However, there appeared to be a distinct difference in the percentages of babies with low birth weights and gestation of 37 weeks and over, the term babies, 17 percent in the Pune study in contrast to 2 to 7 percent in the seven countries. This difference in these percentages of the births of low weight births is shown in Fig-

Table 19

Percentage Distribution of Total Singleton Births by Birth Weight and Gestation in Pune Rural Area, India and in Countries of WHO Collaborative Study

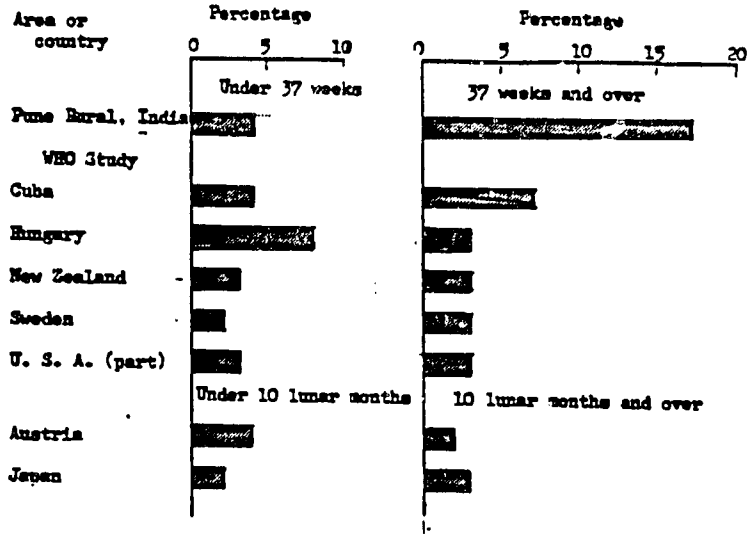
Area or country	Birthweight under 2500 grams		Birthweight 2500 grams and over	
	Gestation		Gestation	
	Under 37 weeks	37 weeks and over	Under 37 weeks	37 weeks and over
Pune rural area	4	17	4	76
WHO Study				
Cuba	4	7	7	82
Hungary	8	3	12	77
New Zealand	3	3	2	93
Sweden	2	3	2	93
U.S.A. (part)	3	3	4	90
	Under 10 lunar months		10 lunar months and over	
Austria	4	2	7	87
Japan	2	3	1	94

Sources: Shah(51) and World Health Organization(63)

* As defined for this study, "Perinatal mortality comprises late fetal deaths (stillbirths) and early neonatal deaths, that is it includes deaths between the 28th week of pregnancy and the end of the first week after birth."

Figure 9

Percentage of Total Singleton Births of Low Birth Weight by Gestation in Pune Rural Area in India and Seven Countries of WHO Collaborative Study



ure 9 and is puzzling. These risk factors need to be combined in analyses of other factors.

The perinatal death rates are given for the seven countries and for the Pune Rural Area in Table 20 for the four groups of gestation and birth weight. The rates were high when both risk factors were present. The high perinatal death rates for term births of less than 37 weeks of gestation indicates possible differences in definitions. There were only 118 births in this group in the Pune study. In the countries of the WHO study the numbers of total births were large, in five countries they exceeded 100,000 and in the other two they were 50.000 and 62,000. However, there are limitations in the comparability of data from countries. Differences and inclusions in regard to length of gestation and fetal deaths may account for some of the variation.

Data were available regarding birth weights by age of the mother in two prospective studies. In the Pune study, the total births were given by age of the mother (Table 21). Of the mothers under 20 years, 30.8 percent of the total births were of low birth weight. Only 14.1 percent of the births of mothers 25-29 years were of low birth weight. In the Delhi studu, 34.4 percent of the live births of mothers under 20 years of age weighed 2500 grams or less. In this study, the percentages were lower for babies of mothers 25 years and over (18.5-20.5). The numbers in both experiences were too small for subdivision of the group 35 years and over. The percentages of births of low birth weight are shown by age of

Table 20

Perinatal Deaths per 1000 Births by Birth Weight and Gestation in Pune Rural Area in India and Countries of WHO Collaborative Study

Area or country	Birthweight under 2500 grams		Birthweight 2500 grams and over	
	Gestation		Gestation	
	Under 37 weeks	37 weeks and over	Under 37 weeks	37 weeks and over
Pune Rural Area	440	50	25	18
WHO Study				
Cuba	439	33	81	13
Hungary	258	12	80	7
New Zealand	325	54	73	6
Sweden	277	23	95	5
U. S. A.)part)	236	12	53	4
	Under 10 lunar months		10 lunar months and over	
Austria	283	18	141	7
Japan	334	88	78	8

Source: Shah[51] and World Health Organization.[63]

Table 21

Percentage of Singleton Births of Low Birth Weight by Age of Mother in Pune Rural Area and Delhi Urban Cohort, India

Age of mother	Pune Rural Area			Delhi Urban Cohort		
	Total births	Less than 2500 grams No.	%	Live births	2500 grams or less No.	%
Total	3 095	636	20.5	6 022	1 381	22.9
Under 20 years	471	145	30.8	434	156	34.4
20-24 years	1 391	299	21.5	2 208	553	25.1
25-29 years	793	112	14.1	2 077	425	20.4
30-34 years	304	55	18.1	912	169	18.5
35 years and over	136	25	18.4	371	76	20.5

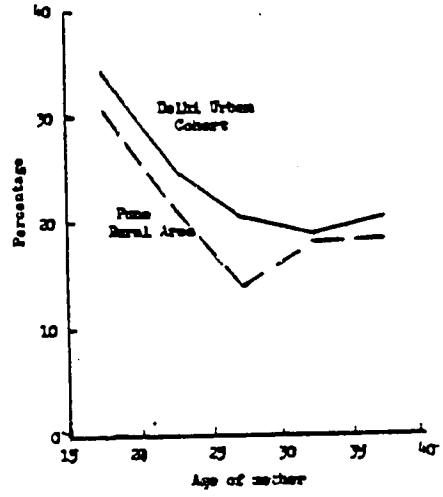
Source: Shah[51] and Ghosh.[10]

the mother in Figure 10. In both experiences, high proportions of of the births of young mothers were of low birth weight resulting in high perinatal and infant mortality.

Usually the percentage of live births of low birth weight is lowest for mothers 25-29 years of age and an increase is noted with increasing age for the older mothers.[58] As reported in the Survey of Infant and Childhood Mortality,[19] infant mortality was much higher for those married below 18 years of age than for those married at 21 years and above. This excessive mortality is due in part to the high incidence of babies of low birth weight of young mothers. Young mothers continue to have high infant mortality of their babies even in the full term births.[59]

Figure 10

Percentage of Singleton Births of Low Birth Weight by Age of Mother in Pune Rural Area and Delhi Urban Cohort, India



In the large study of the relation of birth weight to mortality conducted in the United States,[58] the incidence of low birth weights was obtained by age of the mother and birth order. Of live births of mothers 15-19 years of age, the proportions of the births of low birth weight became very high for the fourth and fifth births. A marked increase was noted in the proportions of births of low birth weight with increasing birth order of mothers 20-24 years of age. The percentages were lower for mothers in the age group 25-29 years of age. Thus age of mothers and birth order are important factors to be analyzed in combination to birth weight in studies of perinatal and infant mortality.

Several other factors influence the outcome of pregnancy and require consideration in planning for the prevention of births of low birth weight. As reported by Agarwal and co-workers,[1] "Women with prepregnancy weight of under 40 kg deliver 66 % of their babies weighing less than 2500 g." and "If the pregnancy weight gain is less than 5 kg 61.5 % of the babies born weigh less than 2500 g." Increases of the weights of mothers before pregnancy and satisfactory weight gains during pregnancy serve to lower the incidence of births of low birth weight. Mothers need to become aware of the importance of a satisfactory diet during pregnancy. In a report of a successful village nutrition program in Thailand,[39] it was stated that mothers had not understood the importance to health of a proper diet during pregnancy, lactation and infancy. Thus efforts could well be directed to weight increases in pregnancy and an indicator established for India.

Several studies have been reported on variables such as height, weight and weight gain during pregnancy. Bhatt and co-workers[5] indicated the important relation between maternal weight gain and the incidence of births of low birth weight. Maternal factors in relation to birth weight are discussed by Saigal and Srivastava[47] and Bahl and co-workers.[3]

Kusum P. Shah[49] in a recent paper reviewed the multiple causes responsible for low birth weights, the positive effect of improved maternal nutrition on birth weight and the value of supplemental feeding. Horwitz[15] refers to the new opportunities for nutrition programs in a paper entitled "Changing Concepts of Health and Health Services: New Opportunities for Nutrition Programs" with ten recommendations for nutrition programs including food supplementation.

In August, 1984, announcement was made in the United States[60] of a major national study to be undertaken by the National Institute of Child Health and Human Development on the causes and prevention of premature births. This study will examine the role of bacteria in stimulating early labor and may lead to important discoveries which will accelerate progress in lowering infant mortality dramatically, especially in countries with high incidences of low weight births.

This section has considered in detail only three of the high risk factors. low birth weight, short gestation period and maternal age. The interrelationships of these with the other factors need evaluation which will require relatively large studies beginning in pregnancy and extending through infancy and perhaps also through childhood.

Since low birth weights are responsible for high proportions of deaths in the perinatal period and infancy, an important initial step would be the introduction of weighing all babies at birth. A recommendation of a United Nations and World Health Organization Working Group[64] states:

> "In view of the critical importance of low birth weight and prematurity in neonatal mortality, it was recommended that countries attempt to record information on birth weight, tabulate birth weight distributions, and, where possible, calculate mortality rates by birth weight. Such activities might well begin in hospitals. However, because of the importance of low birth weights in rural areas, midwives and village workers should also be encouraged to weigh babies soon after birth, and scales should be made available for this purpose."

Evidently weighing of babies by traditional birth attendants is being incorporated into local health programs in India. V. Kumar[32] states: "Dais can now recognize lo birth weight babies. They have learnt to weigh newborn babies and to read the weight range by looking at the colours on the weighing machine."

Increases of birth weights will be necessary to reduce infant mortality. Prospective studies of the outcome of pregnancy in relatively large areas in widely separated areas of India are advisable in order that data regarding the multiple factors involved and their interrelationships be obtained to serve as the basis of programs to prevent the excessive losses as stillbirths and infant deaths.

III. Causes of Death

For this section of the report, causes of death in infancy and childhood have been obtained from several sources, namely, publications of the Office of Registrar General, the Tetanus Survey of the Ministry of Health and Family Planning, a publication of the State of Maharashtra and special studies. Data from these sources serve to highlight some of the health problems and to indicate the great need for age-specific death rates by causes for infants and children of India for program planning and evaluation of progress toward the goals.

The Survey of Infant and Childhood Mortality of the Office of the Registrar General,[19] carried out for the Year of the Child, provided death rates from the ten leading causes of death for rural and urban areas for infants and children by single year of age for 1978. In the household visit, the respondent reported the cause of death without probing by the enumerator. A list of 20 causes was used. As in the International Classification of Diseases[62] three of the diseases, dysentery, gastroenteritis and diarrhea, are included as

Table 22

Three Leading Causes of Infant Mortality in Rural and Urban Areas of India, 1978

Rural Area	Rate*	Urban Area	Rate*
Tetanus	1980	Diarrheal disease	939
Diarrheal disease**	1289	Prematurity	698
Prematurity	1248	Tetanus	530

* Rate per 100 000 population
** The rate for gastroenteritis from the Provisional Report, 1981, was used for this estimate.
Source: Office of Registrar General.(19)

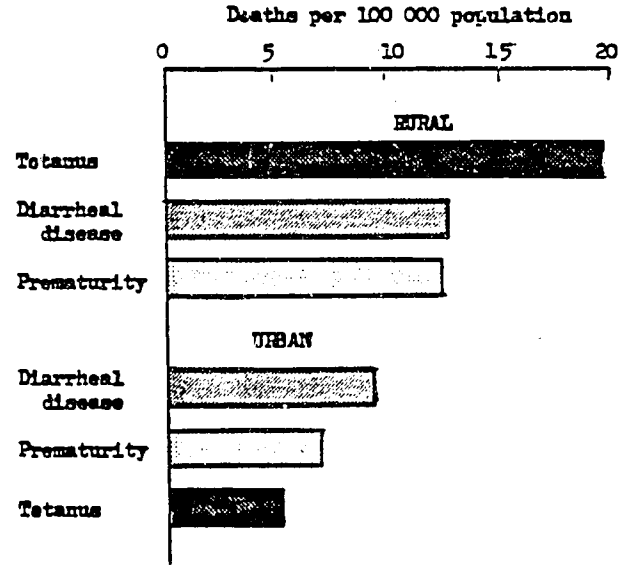
diarrheal disease, category 009, they have been combined in this report.

In the rural area, the three leading causes were tetanus, diarrheal disease and prematurity (Table 22 and Figure 11). In the urban area, the same three were leading causes but in a different order. These three diseases are serious health problems which require major attention in health programs.

If the four types of respiratory diseases which are included in the list of 20 causes, namely, influenza, bronchitis, pneumonia and other disorders of the respiratory system are combined, the death rate from diseases of the respiratory system would be very high. For infants in the rural area, the death rate would be 2 707 per 100 000 population and would be the leading cause of death. Often, influenza and pneumonia are combined in listing the leading causes of death. The respiratory diseases are serious health problems. It is likely that the respondent would report a terminal condition as pneumonia and not the underlying cause. Some of the infectious diseases as tuberculosis, whooping cough or measles may have been underlying causes of the respiratory conditions reported by the respondent.

Figure 11

Leading Causes of Infant Mortality in Rural and Urban Areas of India, 1978



Measles appeared as one of the ten leading causes of death of 1, 2 and 3 year old children in the urban area and of 2 and 3 year old children in the rural area. Data regarding the death rates from measles of infants and children in each year of age and for the age group 1-4 years would be valuable for planning the immunization program. In future surveys, the provision of deaths and death rates for the causes for the age group 1-4 years would enable analyses of the infectious, respiratory and other diseases in this important age group. This is the age

period in which rapid progress can be attained by immunization, oral rehydration and nutrition programs.

The Survey of Infant and Childhood Mortality also provided age-specific death rates for the ten leading causes of deaths for the states. The major health problems as indicated by respondents could be analyzed as the basis for the programs in each state.

In Andhra Pradesh, the same three causes as for India were leading causes for infants in the rural area but with slightly higher death rates, tetanus 2050, diarrheal disease 1400 and prematurity 1329 per 100 000 population. The two diseases, tetanus and measles, for which immunization programs are recommended, caused 25.9 percent of the infant deaths in the rural area. Diarrheal disease caused an additional 12.4 percent of these deaths. These three diseases were reported to be responsible for 38.3 percent of the infant deaths. In Table 23 the percentages of infant deaths due to tetanus, measles and diarrheal disease are given by single years of age under 5 years. For the children 2, 3 and 4 years around half of the deaths were caused by the three diseases.

Table 23

Percentages of Deaths due to Tetanus, Measles and Diarrheal Disease and Death Rates by Age under 5 Years in Rural Andhra Pradesh. 1978

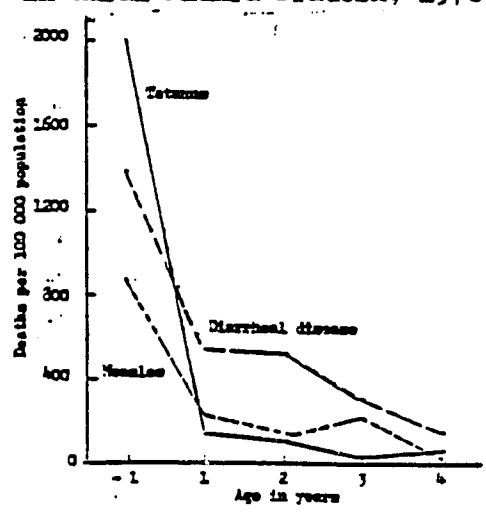
Age	Percentages				Deaths per 100 000 population			
	Tetanus	Measles	Diarrheal disease	Three diseases	Tetanus	Measles	Diarrheal disease	Three diseases
Under 1 year	18.1	7.8	12.4	38.3	2050	875	1400	4325
1 year	6.7	10.9	25.6	43.2	147	245	560	942
2 years	7.3	10.0	34.0	51.3	115	157	538	810
3 years	3.0	19.0	27.2	49.2	36	226	325	587
4 years	14.3	5.0	31.9	51.2	75	26	167	268

Source: Office of Registrar General(19)

The death rates from these diseases are shown in Figure 12. The infant death rate from these three diseases combined was exceedingly high, 4325 per 100 000 population or 43.2 per 1000 population. The prevention of these three diseases could effect a major reduction in infant and child mortality in rural Andhra Pradesh.

Figure 12

Mortality from Tetanus, Measles and Diarrheal Disease under 5 Years in Rural Andhra Pradesh, 1978



At recent seminars on infant and child mortality,[17] interest was expressed in securing more information on health problems for use at the state level. Data from the Survey of Infant and Childhood Mortality[19] could be analyzed for each state. For example, tetanus caused the exceedingly high death rate of 6851 per 100 000 population for infants in the rural area and 2386 in the urban area of Uttar Pradesh. Also measles was one of the leading causes of death of 1, 2 and 3 year old children in both rural and urban areas of Uttar Pradesh. Similar study of the causes in each state would indicate the major problems. Immunization for tetanus and measles would result in major reductions in mortality.

As reported by Sokhey,[53] sample surveys were organized in 1981 by the Directorate General of Health Services to collect reliable baseline data for planning the tetanus immunization program. By retrospective house to house visits, samples of around 2 000 live births were collected for the rural and urban areas of states. Deaths within one month of birth were investigated by a medical officer to confirm the cause of death. The diagnosis was based on clinical symptoms and if there was any doubt regarding the assignment of tetanus as the cause of death, a second opinion was obtained.

The neonatal death rates from tetanus neonatorum varied widely in the states (Table 24). The rates in the rural areas varied from a low of 1.9 per 1000 live births in Kerala to a high of 66.7 in Uttar Pradesh (Figure 13). The rates were were much lower in the urban areas with Uttar Pradesh having the highest rate of 15.3 per 1000 live births.

This use of medical interviewers in the tetanus survey was an excellent method of obtaining reliable information for the immunization program. This method of using medical interviewers for investigating the cause of death could be applied also in the health surveys of the Office of the

Table 24

Neonatal Mortality* from Tetanus Neonatorum of Survey in Rural and Urban Areas of States of India, 1981

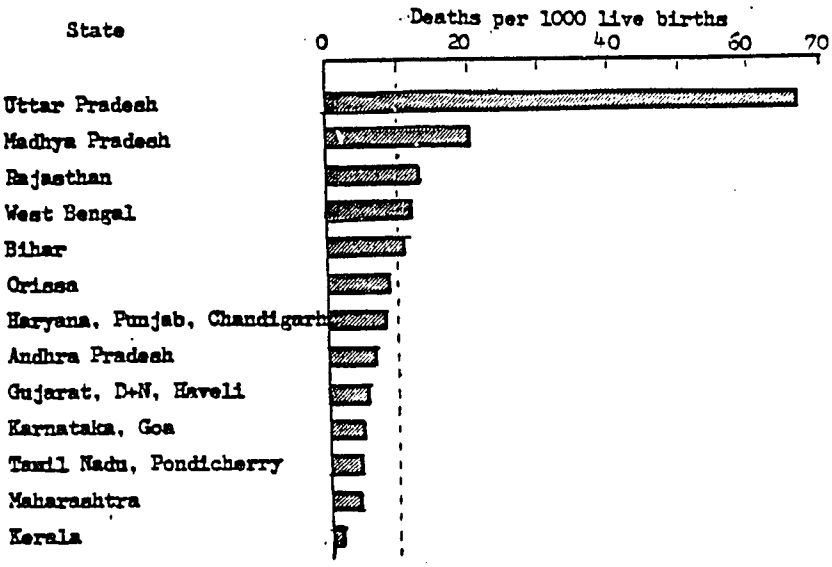
State or City	Rural Area			Urban Area		
	Live births	Tetanus No.	Tetanus Rate	Live births	Tetanus No.	Tetanus Rate
Total	27 854	370	13.3	30 024	95	3.2
Andhra Pradesh	2 207	15	6.8	2 210	6	2.7
Bihar	2 395	27	11.3	2 091	11	5.3
Delhi	-			2 066	2	1.0
Gujarat, D+N Haveli	2 056	12	5.8	2 095	4	1.9
Haryana, Punjab and Chandigarh	2 139	18	8.4	2 250	7	3.1
Karnataka and Goa	2 369	12	5.1	2 192	3	1.4
Kerala	2 105	4	1.9	2 090	4	1.9
Madhya Pradesh	2 160	44	20.4	2 094	3	1.4
Maharashtra	2 073	10	4.8	2 029	10	4.9
Orissa	2 090	18	8.6	1 998	4	2.0
Rajasthan	1 628	22	13.5	2 369	8	3.4
Tamil Nadu, Pondicherry	2 252	11	4.9	2 339	-	
Uttar Pradesh	2 279	152	66.7	2 091	32	15.3
West Bengal	2 101	25	11.9	2 110	1	0.5

* Rates per 1000 live births.

Source: Sokhey[53]

Figure 13

Neonatal Mortality from Tetanus in Samples of Rural Areas of States of India, 1981



Registrar General. Reliable information is urgently needed as the basis for other immunization programs and for other causes of excessive mortality in infancy and childhood. A United Nations and World Health Organization Working Group[64] recommended the use of suitably-trained medical interviewers in intensive mortality investigations and surveys who would visit the family and obtain information regarding the fatal illness (or injury) and the medical attention received.

The causes of the medically certified deaths in institutions and teaching hospitals in urban areas of several states are published in the volume, Mortality Statistics of Causes of Death, 1979 of the Office of the Registrar General.[18] Using data from that report, Table 25 gives the numbers of deaths due to tetanus and the percentages of all deaths in three age groups, infants, children 1-4 years and those 5 years and over for five states and three other areas. The percentage

Table 25

Medically Certified Deaths due to Tetanus for Three Age Groups in Hospitals in Urban Areas of Five States and Three Territories of India, 1979

State or territory	Under 1 year			1-4 years			5 years and over		
	Total deaths	Tetanus No.	%	Total deaths	Tetanus No.	%	Total deaths	Tetanus No.	%
Andhra Pradesh	3 553	342	9.7	1 440	33	2.3	12 486	351	2.8
Assam	107	8	7.5	144	1	0.7	1 643	37	2.3
Maharashtra	20 200	133	0.7	8 178	168	2.1	74 879	1417	1.9
Rajasthan	1 647	32	1.9	251	17	6.8	2 866	129	4.5
Uttar Pradesh	236	45	19.1	205	5	2.4	1 594	63	4.0
Chandigarh	462	31	6.7	124	1	0.8	1 819	31	1.7
Delhi	4 992	260	5.2	1 543	16	1.0	13 801	153	1.1
Goa, Daman + Diu	819	32	3.9	351	4	1.1	6 263	25	0.4

Source: Office of Registrar General.[18]

of infant deaths due to tetanus in these hospitals of urban areas of Uttar Pradesh was very high (19.1) which is additional evidence of the seriousness of tetanus in that area. In Andhra Pradesh, the percentage (9.7) was high also. Many deaths

from tetanus occurred in children 1-4 years of age and likewise in the older children and adults and thus immunization for prevention of tetanus is advisable for persons of all ages.

These findings from the tetanus survey and from hospitals justify that control measures for prevention of tetanus should receive high priority. At a seminar of the National Institute of Public Cooperation and Child Development in January 1984,[23] it was recommended that 100 percent of pregnant women should be given tetanus toxoid and as a long term measure all the girls should be immunized with tetanus toxoid.

In the Eighth Revision of the International Classification of Diseases[62] tetanus neonatorum was classified in the category 037 for tetanus. However, in the Ninth Revision, it was included in the section for Certain Perinatal Conditions as 771.3. In the mortality statistics of hospitals in the states of Haryana, Karnataka and Orissa, the Ninth Revision had been used and thus the numbers of deaths due to tetanus in infancy were not available. In the State of Maharashtra, tetanus neonatorum was included in 037 as in the Eighth Revision. This was evident from the report, Annual Vital Statistics of the Maharashtra.[33] In view of the great importance of tetanus in many countries of the world, tetanus should be tabulated separately so that the numbers of deaths are available for planning and evaluation of tetanus programs.

The causes of death provided in the volume, Mortality Statistics of Causes of Death, 1979,[18] have been utilized to gain some understanding of the health problems encountered in infants and children. This is a selected experience of those who died in certain hospitals in urban areas of several states and territories. These findings give some indication of the problems and serve to point out the great need of death rates by causes for all deaths in this age group. The data on causes of medically certified infant deaths in hospitals of urban areas of four states, Haryana, Karnataka, Maharashtra and Orissa. in which the Ninth Revision of the International Classification of Diseases[62] was used. are presented in Table 26.

In three states, around 20 percent of these infant deaths were due to infectious and parasitic diseases. In the State of Haryana. the percentage (8.9) was only half as high but 11.3 percent of the deaths were due to ill-defined causes. In these experiences, intestinal infections were responsible for over two-thirds of the deaths due to infectious and parasitic diseases. The numbers

Table 26

Medically Certified Causes of Death of Infants in Hospitals of Urban Areas of Four States of India, 1979

Cause of Death, Ninth Revision of International Classification of Diseases	Haryana		Karnataka		Maharashtra		Orissa	
	No.	%	No.	%	No.	%	No.	%
Total deaths	1614	100	3625	100	20200	100	2240	100
Infectious and parasitic diseases 001-138	143	8.9	762	21.0	3926	19.4	443	19.8
Intestinal infections 001-009	113	7.0	563	15.5	2706	13.4	344	15.4
Tuberculosis 010-018	4	0.2	37	1.0	178	0.9	20	0.9
Diphtheria 032	5	0.3	8	0.2	13	0.1	10	0.4
Whooping cough 033	-		1	0.0	6	0.0	3	0.1
Septicemia 038	1	0.1	105	2.9	663	3.3	29	1.3
Acute poliomyelitis 045	2	0.1	9	0.3	26	0.1	6	0.3
Measles 055	7	0.4	13	0.4	111	0.5	5	0.2
Other infectious and parasitic diseases	11	0.7	25	0.7	218	1.1	26	1.2
Nutritional deficiencies 260-269	13	0.8	64	1.8	[illegible]	1.6	146	6.5
Diseases of the nervous system and sense organs 320-389	36	2.2	236	6.5	706	3.5	116	5.2
Diseases of respiratory system 460-519	196	12.1	491	13.5	2869	14.2	176	7.9
Diseases of digestive system 520-579	20	1.2	91	2.5	283	1.4	36	1.6
Congenital anomalies 740-759	14	0.9	164	4.5	1039	5.1	81	3.6
Certain perinatal conditions* 760-779	896	55.5	1677	46.3	10426	51.7	1116	49.8
Immaturity 764, 765	251	15.6	776	21.4	5728	28.4	496	22.1
Symptoms and ill-defined 780-799	182	11.3	31	0.9	303	1.5	50	2.2
External causes 800-999	11	0.7	25	0.7	93	0.5	14	0.6
All other causes	103	6.4	84	2.3	212	1.0	62	2.8

* Tetanus neonatorum in the Ninth Revision of the International Classification of Diseases is included under "Certain Conditions Originating in the Perinatal Period," 771.3, and thus the numbers of infant deaths from tetanus were not available.

Source: Office of Registrar General.(18)

of deaths from five of the six diseases for which immunization programs are recommended, are given. (Tetanus could not be shown for the reason given above.) Although the numbers are small, they indicate that deaths from these diseases are occurring in infancy and that some infants with these diseases are brought to hospitals where their deaths could not be prevented. Immunization and oral rehydration programs could probably be effective in preventing some of these deaths due to infectious diseases.

In two states, Karnataka and Maharashtra, 2.9 and 3.3 percent of the deaths were due to septicemia which is a relatively important cause of death in early infancy. Recent research(36) is suggesting that in utero infections may lead to preterm deliveries and deaths due to sepsis, gastroenteritis, etc. in the newborn. The interrelationship of causes requires study, especially in the teaching hospitals.

Respiratory diseases were responsible for 7.9 to 14.2 percent of these infant deaths. The underlying causes of some of these deaths could have been infectious diseases as measles, whooping cough, etc. There were puzzling differences in the percentages of deaths due to nutritional deficiency, diseases of the nervous system and sense organs and congenital anomalies.

The group, "Certain conditions originating in the perinatal period", is especially important in planning for the reduction of infant mortality. In these hospital experiences of four states, around half of the deaths were classified in this group with the shortened title, "Certain perinatal conditions". In the Ninth Revision, tetanus neonatorum is included as 771.3 in infections specific to the perinatal period and may account for a significant portion of the deaths in the group of certain perinatal conditions 760-779.

In the Ninth Revision, two categories were designated for deaths in which immaturity was recorded:

764 Slow fetal growth and fetal malnutrition
765 Disorders relating to short gestation and unspecified low birth weight

The numbers and percentages of infant deaths assigned to these two categories, combined as immaturity*, are given in Table 26. The State of Maharashtra had a high proportion of infant deaths due to immaturity, 28.4 percent. The percentages were lower and varied from 15.6 to 22.1 in the three other hospital experiences.

If the underlying causes such as maternal infections or conditions or complications of pregnancy and childbirth were directly responsible for the deaths and were specified on the death certificates, they would have taken precedence over the conditions included in 765 and immaturity would be an associated cause. The Rules for Classification state that category 765 is "Not to be used if any other cause of perinatal mortality is reported". Deaths assigned to other perinatal conditions may have been of low weight babies also. Probably higher percentages of these infants who died were of immature babies.

In the Inter-American Investigation of Mortality in Childhood.(41) the important underlying causes in this group of certain perinatal conditions were maternal conditions, complications of pregnancy, difficult labor and birth injury, conditions of the placenta and cord, and anoxic and hypoxic conditions. Immaturity was classed as an associated cause, the consequence of many maternal conditions, complications of pregnancy and conditions of the placenta. For programs to prevent deaths due to certain perinatal conditions, information is needed regarding underlying causes as well as the important associated cause of immaturity.

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* As prematurity indicates a gestation period of less than normal time, immaturity, which is defined as not fully grown or developed, is preferred as it includes those preterm or with intrauterine growth retardation.

Table 27

Medically Certified Causes of Death of Children 1-4 Years of Age in Hospitals of Urban Areas of Five States and One Territory of India, 1979

Cause of death, Ninth Revision*	Andhra Pradesh		Haryana		Karnataka		Maharashtra		Orissa		Goa, Daman + Diu	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total deaths	1440	100	512	100	1985	100	8178	100	1036	100	351	100
Infectious and parasitic diseases 001-138	591	41.0	161	31.4	959	48.3	3652	44.7	457	44.1	71	20.2
Intestinal infections 001-009	212	14.7	93	18.2	492	24.8	1899	23.2	274	26.4	22	6.3
Tuberculosis 010-018	188	13.1	6	1.2	185	9.3	664	8.1	50	4.8	15	4.3
Diphtheria 032	6	0.4	6	1.2	59	3.0	63	0.8	29	2.8	1	0.3
Whooping cough 033	12	0.8	-		17	0.9	23	0.3	-		2	0.6
Tetanus 037	33	2.3	18	3.5	59	3.0	168	2.1	25	2.4	4	1.1
Acute poliomyelitis 045	26	1.8	5	1.0	16	0.8	69	0.8	17	1.6	2	0.6
Measles 055	74	5.1	16	3.1	54	2.7	459	5.6	10	1.0	3	0.9
Other infectious and parasitic diseases	40	2.8	17	3.3	77	3.9	307	3.8	52	5.0	22	6.3
Nutritional deficiencies 260-269	102	7.1	12	2.3	198	10.0	453	5.5	117	11.3	33	9.4
Diseases of the nervous system and sense organs 320-389	255	17.7	53	10.4	332	16.7	858	10.5	137	13.2	34	9.7
Diseases of respiratory system 460-519	135	9.4	92	18.0	216	10.9	1789	21.9	106	10.2	80	22.8
Diseases of digestive system 520-579	75	5.2	13	2.5	70	3.5	367	4.5	50	4.8	28	8.0
Symptoms and ill-defined 780-799	105	7.3	82	16.0	33	1.7	291	3.6	40	3.9	61	17.4
External causes 800-999	72	5.0	42	8.2	60	3.0	353	4.3	28	2.7	11	3.1
All other causes	105	7.3	57	11.1	117	5.9	415	5.1	101	9.7	33	9.4

* Ninth Revision of International Classification of Diseases was used for all except State of Andhra Pradesh and Union Territort of Goa, Daman and Diu for which the Eighth Revision was used.

Source: Office of Registrar General.[18]

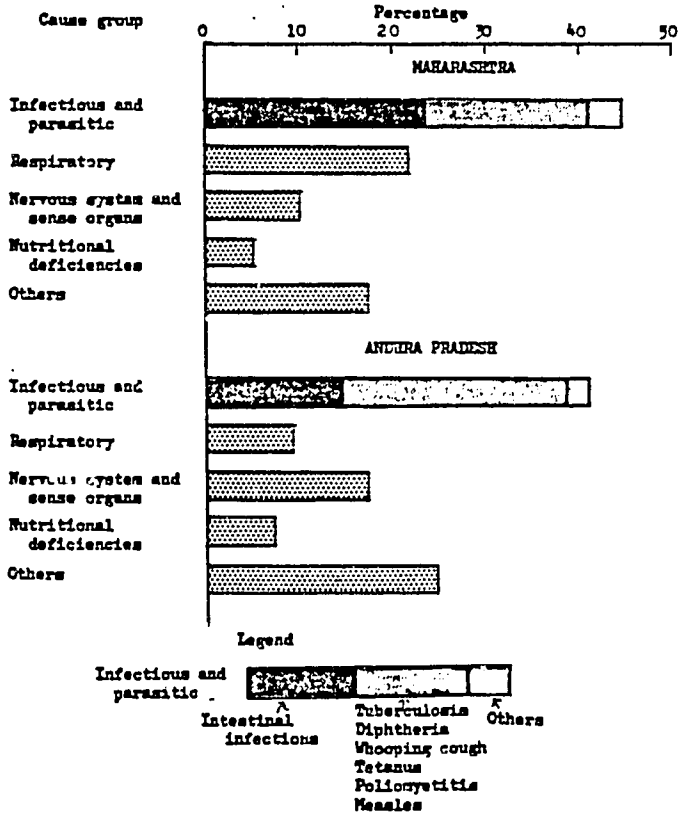
The pattern of causes of death of young children 1-4 years of age differs from that in infancy. Table 27 provides the causes of death for six areas from the same source, Mortality Statistics of Causes of Death, 1979[18] of India. The data from the State of Andhra Pradesh and the Union Territory of Goa, Daman and Diu are added to those of the four states used in Table 26 to increase the experience and the variation in problems. According to a notation on page 273 in the publication from which this material was obtained,[18] deaths classified by causes for Goa, Daman and Diu relate to the entire Union Territory. The pattern of mortality in this territory appears to differ from those of hospital deaths in urban areas of the five states. For example, the proportions of deaths due to infectious and parasitic diseases and especially of intestinal infections are lower. In four states, over 40 percent of the deaths were due to infectious and parasitic diseases. Excluding Goa, Daman and Diu, intestinal infections caused 14.7 to 26.4 percent of these deaths of children 1-4 years of age in Andhra Pradesh, Karnataka and Maharashtra, 13.1, 9.3 and 8.1 percent respectively were assigned to tuberculosis. The other five diseases for which immunization programs are recommended caused varying numbers of deaths.

Mortality from measles deserves special attention. In Maharashtra in this hospital experience, there were 459 measles deaths of children 1-4 years of age (5.6 percent) and, as given in Table 26, an additional 111 measles deaths of in-

fants. Also in Andhra Pradesh, measles caused 74 or 5.1 percent of these deaths. As noted in the Survey of Infant and Childhood Mortality,[19] measles was one of the ten leading causes of deaths of children 2 and 3 years in the rural area and of 1, 2 and 3 year old children in the urban area for all of India. In the 1981 Report,[42] measles was shown to be an important health problem in the three rural centers in Ludhiana and in both rural and urban areas of the North Arcot District. However, measles is probably causing many more deaths than reported. In our Investigation of Mortality,[41] measles was found to be the underlying cause of 288 deaths attributed to diarrheal disease (16.2 percent) and to 287 due to pneumonia or influenza (16.2 percent). Of deaths from measles in the 13 Latin American Projects, diarrheal disease was a complication (consequence) of 50.4 percent. Measles was found to be a much more serious disease in developing countries than previously recognized. Immunization programs were initiated during our Investigation. Recently, M. and V.I. Mathan[34] stated that 34 percent of deaths from diarrheal disease in a prospective study in Bangladesh were measles associated and that diarrhea or dysentery was the most common complication of fatal measles cases. As pointed out by John,[26] measles immunization should be included in the national immunization program. This has been recommended in a seminar in 1984[23] and also by Steinoff et al[55] Foster[7] of the Center for Disease Control in Atlanta stated recently that of all the potential child health interventions, measles vaccine at 9 months of age was the single most important intervention affecting child survival.

Figure 14

Broad Groups of Causes of Medically Certified Deaths of Children 1-4 Years in Hospitals of Urban Areas of Maharashtra and Andhra Pradesh, India, 1979



In the hospital experience in Andhra Pradesh, 344 deaths from poliomyelitis of persons of all ages were reported or 2.0 percent of total deaths. Infant deaths from poliomyelitis numbered 136 or 3.8 percent. Probably many infants and children die from these diseases at home. These data are presented to emphasize the importance of the immunization programs. If oral rehydration and immunization programs can be provided, mortality in infancy and early childhood can be reduced markedly.

To illustrate the serious problems in children 1-4 years of age, the distributions of deaths in five broad groups of causes for the two states, Maharashtra and Andhra Pradesh, are shown in Figure 14. High proportions of the deaths in the group of infectious and parasitic diseases are due to two groups, intestinal infections and the six diseases for which immunization programs are recommended. Although the intestinal infections include typhoid fever, shigellosis, etc., nearly all the deaths are included in the category for diarrheal disease, 009. In Andhra Pradesh, the proportion of the deaths due to the six diseases was 23.5 percent and in Maharashtra 17.7 percent. Respiratory diseases were responsible for a high proportion of the deaths in Maharashtra. Some of the deaths may have been due to a terminal pneumonia. Diseases of the nervous system and sense organs caused many deaths, 17.7 percent in Andhra Pradesh and 10.5 percent in Maharashtra. As many of these deaths are reported to be due to meningitis, studies are needed to determine the cause of the meningitis as the basis for preventive programs.

The State of Maharashtra has the largest numbers of medically certified deaths in hospitals in the Report of the Office of the Registrar General.[18] Of the 39.655 infant deaths for all of India, 20,200 occurred in Maharashtra. This large experience of hospital deaths in Maharashtra has been utilized to indicate the distinct patterns of causes of early and late neonatal deaths and of postneonatal deaths in two age groups (Table 28 and Figures 15 and 16). The Annual Vital Statistics of

Table 28

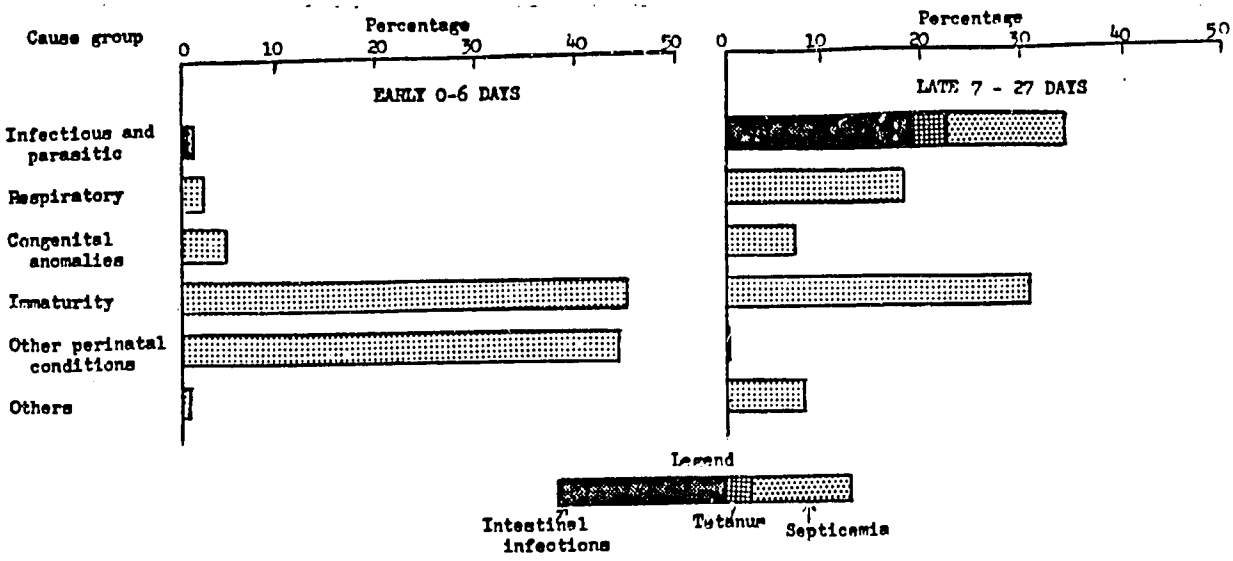
Medically Certified Causes of Deaths in Infancy by Age in Hospitals of Urban Areas of Maharashtra State, India, 1979

Causes, Ninth Revision	Infant		Neonatal				Postneonatal			
			Early		Late					
	- 1 year		0-6 days		7-27 days		28 days-5 mo.		6-11 mos.	
	No.	%	No.	%	No.	%	No.	%	No.	%
Total deaths	20 200	100	10 552	100	2 456	100	4 192	100	3 000	100
Infectious and parasitic diseases 001-138	3 926	19.4	173	1.6	844	34.4	1 513	36.1	1 396	46.5
Intestinal infections 001-009	2 706	13.4	75	0.7	462	18.8	1 136	27.1	1 033	34.4
Tuberculosis 010-018	178	0.9	-		-		38	0.9	140	4.7
Diphtheria 032	13	0.1	-		-		2	0.0	11	0.4
Whooping cough 033	6	0.0	-		-		1	0.0	5	0.2
Tetanus 037	133	0.7	19	0.2	88	3.6	19	0.5	7	0.2
Septicemia 038	668	3.3	79	0.7	294	12.0	246	5.9	49	1.6
Acute poliomyelitis 045	26	0.1	-		-		5	0.1	21	0.7
Measles 055	111	0.5	-		-		19	0.5	92	3.1
Other infectious and parasitic diseases	85	0.4	-		-		47	1.1	38	1.3
Nutritional deficiencies 260-269	333	1.6	-		-		259	6.2	74	2.5
Diseases of the nervous system and sense organs 320-389	706	3.5	37	0.4	90	3.7	291	6.9	288	9.6
Diseases of respiratory system 460-519	2 869	14.2	253	2.4	458	18.6	1 346	32.1	812	27.1
Diseases of digestive system 520-579	283	1.4	23	0.2	40	1.6	147	3.5	73	2.4
Congenital anomalies 740-759	1 039	5.1	522	4.9	180	7.3	253	6.0	84	2.8
Immaturity 764, 765	5 728	28.4	4 784	45.3	765	31.1	147	3.5	32	1.1
Other perinatal conditions 760-763,766-779	4 708	23.3	4 700	44.5	8	0.3	-		-	
Symptoms and ill-defined 780-799	303	1.5	53	0.5	47	1.9	118	2.8	85	2.8
External causes 800-999	93	0.5	5	0.0	2	0.1	9	0.2	77	2.6
All other causes	212	1.0	2	0.0	22	0.9	109	2.6	79	2.6

Source: Maharashtra. Director of Health Services.[33]

Figure 15

Broad Groups of Causes of Medically Certified Early and Late Neonatal Deaths in Hospitals of Urban Areas of Maharashtra, India, 1979



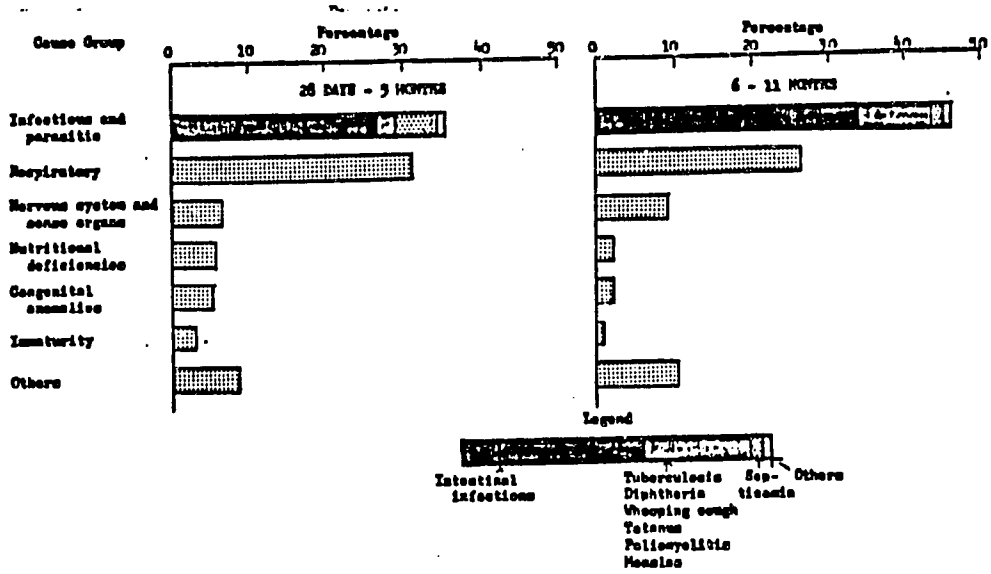
the Maharashtra, 1980[33] includes the causes of the infant deaths according to the age of death for 1979.

Over half of the infant deaths in this hospital experience of Maharashtra, 10,552 deaths or 52.2 percent were early neonatal deaths (0-6 days). Certain perinatal conditions were the underlying causes of 89.9 percent with immaturity responsible for 45.3 percent of early neonatal deaths. This is a very high percentage and is evidence of the seriousness of immaturity in the area. Congenital anomalies caused 4.9 percent and infectious and parasitic diseases only 1.6 percent. The pattern was distinctly different for the late neonatal deaths (7-27 days). However, immaturity was the cause of 31.1 percent and infectious and parasitic diseases for 34.4 percent. Eighty-eight or 3.6 percent of the deaths were due to tetanus, 12.0 percent to septicemia and 18.8 percent to intestinal infections.

The postneonatal period is divided in order to show the differences in the causes for those who died from 28 days through 5 months and for those who died in the last six months of infancy (6 through 11 months). In these periods of infancy. the infectious and respiratory diseases are responsible for high proportions of the deaths (Figure 16). In addition to the intestinal infections. the six diseases for which immunization programs are recommended caused 84 deaths in infants of 28 days through 5 months and 276 in the last six months of infancy. Tuberculosis and measles were responsible for 4.7 and 3.1 percent respectively of the deaths in this late neonatal period. Thus oral rehydration and immunization programs are needed for infants.

Figure 16

Broad Groups of Causes of Medically Certified Postneonatal Deaths in Two Age Groups in Hospitals of Urban Areas of Maharashtra, India, 1979



These examples of distributions of causes of deaths in hospitals of urban areas illustrate the types of health problems. However, there may be wide differences in the problems in the various areas of India. Collection and inclusion of data on deaths occurring at home in urban and rural areas is advisable. The use of medical interviewers trained in searching for underlying causes and using the International Classification of Diseases[62] is being recommended for use in special studies.[64] Age-specific death rates from the causes are preferible to percentage distributions in analyzing mortality statistics.

During 1979-1980, a cross-sectional retrospective survey of infant mortality was undertaken in the State of Gujarat by Gandotra and co-workers.[8] In addition to the extensive analysis of infant mortality and its causes, a prospective study was undertaken to obtain the causes of infant deaths in rural Gujarat during the year 1981. Paramedical personnel of the public health centers of nine selected districts obtained information regarding the fatal illnesses. The causes of the 1,175 infant deaths were confirmed by the medical officers of the health centers and were classified according to the groups of the Ninth Revision of the International Classification of Diseases.[62] Also the causes of 2,443 infant deaths in four hospitals in urban areas of Ahmedabad, Jamnagar, Baroda and Surat were obtained and given in a table of their publication.[8] Some of the patients in these hospitals came from rural areas and a majority of cases admitted to these hospitals were invariably emergency cases. Data from these two sources are presented in Table 29.

Table 29

Percentage Distribution of Causes of Neonatal and Postneonatal Deaths in Prospective Study of Infant Deaths in Rural Gujarat and in Urban Hospitals in Gujarat, India, 1981

Group of causes*	Rural Gujarat			Urban Hospitals		
	Infant	Neo-natal	Post-neonatal	Infant	Neo-natal	Post neonatal
Total	100	100	100	100	100	100
Infectious and parasitic diseases	16.7	6.9	29.9	22.3	7.9	42.1
Endocrine, nutritional, metabolic and immunity disorders	11.2	8.0	15.4	1.4	0.1	3.1
Diseases of blood and blood forming organs	1.6	0.4	3.2	10.7	5.2	18.4
Diseases of respiratory system	14.5	8.6	22.4	11.1	3.0	22.2
Diseases of digestive system	1.6	1.2	2.2	3.6	1.1	7.1
Congenital anomalies	3.4	4.3	2.2	4.4	5.3	3.2
Certain perinatal conditions	38.5	62.0	6.8	44.7	76.0	1.6
Symptoms and ill-defined	12.5	8.6	17.9	1.8	1.4	2.3

* Ninth Revision of International Classification of Diseases.

Source: Gandotra.(8)

In this prospective study in rural Gujarat, 676 or 57.5 percent of the infant deaths occurred in the neonatal period (0-27 days). In the four hospitals, likewise, neonatal deaths exceeded postneonatal with 58.0 percent in the neonatal period. Certain perinatal conditions caused 62.0 percent of the neonatal deaths. In accordance with the Ninth Revision, this group includes deaths from neonatal tetanus. In commenting on the causes of deaths in this group, Gandotra stated that neonatal tetanus continues to remain a significant killer of the infant in Gujarat. Also he stated that prematurity seemed to be taking a heavy toll. From his data, 30.3 percent of the neonatal deaths were calculated to be due to prematurity. These percentages were lower than for the hospitals in the urban area of Maharashtra, where 78.9 percent of the neonatal deaths were due to certain perinatal conditions and 42.7 percent to immaturity.

The infectious and parasitic diseases were responsible for 29.9 percent of postneonatal deaths in rural Gujarat. In commenting on the high percentage of deaths due to this group in Saurashtra, Gandotra stated that gastroenteritis coupled with a high incidence of measles and other diarrheal diseases were probably more rampant in Saurashtra division compared to other divisions. His comment on deaths from measles in infancy in this prospective study in a rural area indicates the importance and great need for such studies as the basis for the measles immunization program. The relatively high percentage of deaths due to the group of endocrine, nutritional and other disorders suggests that many deaths may have been due to nutritional deficiency in that area. This is one of the first known prospective study of infant mortality in a rural area in which underlying causes of death were obtained and coded by the Ninth Revision of the International Classification.

U. Shah(51) classified causes of early neonatal deaths according to the Ninth Revision of the Classification and reviewed in detail the causes leading to death. Even though the numbers of deaths are small, the deaths by causes with rates are given in Table 30 to show the causes of excessive mortality in this age period.

Table 30

Causes of Early Neonatal Mortality in Pune Rural Area, India

Cause	Deaths	Rate*
Total	67	22.0
Infectious and parasitic diseases 001-139	2	0.7
Congenital anomalies 740-759	4	1.3
Certain perinatal conditions 760-779	59	19.4
Immaturity 764.765	32	10.5
Birth trauma 767	6	2.0
Hypoxia, birth asphyxia, etc. 768-770	10	3.3
Other, rest of 760-779	11	3.6
Symptoms and ill-defined 780-799	2	0.7

* Rate per 1000 live births.

Source: U. Shah.(51)

Deaths due to infectious and parasitic diseases included one from diarrheal disease and one from tetanus. Of the 67 deaths, 59 (88 percent were assigned to certain perinatal conditions and the death rate of 19.4 per 1000 live births is high. The number of deaths due to immaturity (764 and 765) in which no other cause could be determined was 32 giving a rate of 10.5 per 1000 live births. Shah concluded that low birth weight was the most important factor being present in 45 of the 67 early neonatal deaths, the underlying cause of 32 and the associated cause of 13. Of these 45 deaths of low weight babies, 35 were preterm (less than 37 weeks) and 10 were term births with growth retardation.

In the prospective study in Beri and Kalanaur blocks,(30) the causes of infant deaths were determined. As the number of live births was given, 1,779, death rates have been calculated to enable comparisons with rates in other studies. The neodeath rate from tetanus of 9.0 per 1000 live births was similar to the rate for the rural area of 8.4 for Haryana, Punjab and Chandigarh in the tetanus survey (Table 24). The early neonatal death rate of 18.5 due to immaturity was very high, again evidence of the seriousness of the problem in India. The postneonatal death rates were 11.2 per 1000 live births for the infectious diseases and 11.2 for nutritional deficiency. Although these experiences are not large, they are valuable by providing death rates by causes for neonatal and postneonatal periods in rural areas.

In addition to infectious and parasitic diseases, respiratory diseases are responsible for high death rates in infancy and early childhood. Some of these may be considered terminal causes of those ill with infectious diseases as measles, whooping cough, diphtheria or tuberculosis. Steinhoff(56) has estimated the annual respiratory mortality from these underlying causes as well as from acute respiratory infections. Excluding measles and

Table 31

Causes of Infant Mortality by Age Group in Beri and Kalanaur Blocks, India

Cause**	Infant		Neonatal				Post-neonatal	
			Early		Late			
	No.	Rate	No.	Rate	No.	Rate	No.	Rate
Total	176	98.9	65	36.5	33	18.5	78	43.3
Infectious and parasitic diseases 001-139	40	22.5	10	5.6	10	5.6	20	11.2
Diarrheal disease 009	22	12.4	2	1.1	2	1.1	18	10.1
Tetanus 037	18	10.1	8	4.5	8	4.5	2	1.1
Nutritional deficiencies 260-269	20	11.2	-		-		20	11.2
Respiratory diseases 460-519	27	15.2	13	7.3	6	3.4	8	4.5
Congenital anomalies 940-759	6	3.4	2	1.1	3	1.7	1	0.6
Immaturity 764.765	40	22.5	33	18.5	7	3.9	-	
Other causes	4	2.2	2	1.1	-		2	1.1
Unspecified	39	21.9	5	2.3	7	3.9	27	15.1

* Rate per 1000 live births.

**Causes classified by Ninth Revision, International Classification of Diseases.

Source: Kishore.(30)

tuberculosis, acute respiratory infections are estimated to cause approximately one million deaths of children per year in India. He referred to the recommendations of the Task Force on Acute Respiratory Diseases of the Indian Council of Medical Research[24] for a study of the relative importance of various etiological agents (bacteria, viruses, mycoplasma, fungi, chlamydia, etc.)

This recommendation for research into etiological agents is especially pertinent at this time. According to recent reports, important advances are being made in the field of immunology. In a paper in the World Health Forum in 1983, Schild and Assaad[48] stated as follows:

> "Mankind is now on the threshold of a new era in the technology of vaccine development and production, which stems from important advances in biotechnology, in particular recombinant DNA and cell fusion techniques. It offers hope of producing vaccines for many of the diseases that are yet uncontrolled and of developing vaccines that are more effective, safer, and more cost-effective than those in current use."

The important task ahead in India is to develop vital statistics with death rates by specific causes as the basis of programs of the future. As recommended by the UN/WHO Working Group,[64] special investigations of mortality in infancy and childhood are advisable to include the determination of the underlying causes of death and the associated causes as immaturity and nutritional deficiency. Many papers indicate the role of immaturity in causing the excessive neonatal mortality. The underlying causes of immaturity are a field for intensive research. A proposal for studies[43] was made which would lead to satisfactory methods for collecting complete and reliable vital statistics for a Registration Area in India.

The International Classification of Diseases should receive widespread distribution to medical schools, other educational institutions and health agencies so that the principles for stating and classifying underlying causes become well known. Application of the Rules for Classification would enable comparisons of rates within the country and with other countries. As recommended,[17] a WHO Collaborating Center for Classification of Diseases is desirable for developing a broad educational program including teaching of international procedures in medical schools and training courses for classification of causes of death.

A desirable goal would be to obtain death rates by causes coded by the International Classification for infants and for children 1-4 years in the three following programs: 1. Health surveys of the Office of the Registrar General. 2. Special investigations of mortality in infancy and childhood and 3. Complete and reliable vital statistics in an expanding Registration Area for India.

Summary

In developing an update of the report on infant and child mortality in India prepared in 1981, the outstanding problem to be attacked appears to be mortality in the early neonatal period and improvement of the chances of infants for survival and healthy growth and development. Progress has been made in several fields and recommendations in 1984[23] supported immunization programs for all six diseases, tuberculosis, whooping cough, diphtheria, tetanus, measles and poliomyelitis. Oral rehydration packets are being provided. Nutrition supplements are given in the program of the Integrated Child Development Services and health services are being extended.

1. Nearly half of all deaths (47 percent) were of infants and children under 5 years of age in 1977. The variation in the death rates of children 0-4 years of age was great: the death rate of 64.9 per 1000 population in Uttar Pradesh was over five times the rate of 12.6 in Kerala. The rural death rate of 54.1 per 1000 population was 76 percent higher than the urban rate of 30.7. Excessive mortality in infancy was in part responsible for the high death rate for children 0-4 years of age. Provision of death rates for children 1-4 years is advisable for evaluation of programs.

2. The infant death rate of 114 per 1000 live births for 1980 was lower than the rates in the past. The neonatal death rate is excessive, especially in the early neonatal period, 0-6 days. The postneonatal death rate has declined from 56 per 1000 live births in 1974 to 45 in 1980 with a reduction in both rural and urban areas. Data from a few studies of perinatal mortality (stillbirths and early neonatal deaths) indicated the importance of collection of complete and comparable data in a difficult and yet challenging field. The most critical period for survival of the infant and likewise for obtaining the facts regarding the birth and infant death is the first 24 hours of life. Throughout the world special attention needs to be given to the condition of the infant at birth and to current registration or reporting of all births and deaths in early life in accordance with international definitions.

3. The birth weight of an infant is the most important determinant of its chances for survival. Although 30 percent of the live births in India are reported to be of low birth weight, less than 2500 grams, very little is known about the distributions of live births by birth weight throughout the country. In five prospective studies, the percentages of the live births of low birth weight varied from 19.9 in the rural area near Pune in the State of Maharashtra to 31.9 in the North Arcot District of Tamil Nadu. For three of these studies, the distributions of

birth weights were available. The weight group, 2501-3000 grams, had the largest numbers of live births with over 40 percent in that 500 gram weight group in each study. The pattern of these distributions of birth weights was distinctly different from those in western countries. The peak in India is shifted to the left, that is to lower birth weights. The low weight babies have excessive death rates and even those with birth weights of 2501-3000 grams experience death rates at least twice as high as those weighing 3001-4000 grams. Around 70 percent of the infants weighed less than 3001 grams and appeared to be at greater risk of death than do those with birth weights of 3001-4000 grams. The pattern of birth weights in two countries in South-East Asia, Indonesia and Burma, differed from those in India and over 50 percent weighed at least 3000 grams at birth. For a reduction of infant mortality in India, birth weights need to be increased so that the chances for survival will be increased.

4. Shah[51] in her prospective study in the rural area near Pune found that of 3,040 live births, 604 (19.9 percent) weighed less than 2500 grams*; 100 (3.3 percent) were preterm, less than 37 weeks gestation, and 504 (16.6 percent) were term births of low birth weight, intrauterine growth retardation (IUGR). In the Delhi Urban Cohort, the corresponding percentages were 4.4 preterm and 19.9 term of low birth weight. The Inter-Country Collaborative Study of Shah was directed principally to perinatal mortality (stillbirths ane early neonatal deaths). The perinatal death rate for the preterm births of 439.7 per 1000 total births was much higher than the rate of 50.0 per 1000 births for the term births of low birth weight, intrauterine growth retardation. The latter rate was over two and one-half times the rate for those with weights of at least 2500 grams. The findings of Shah were compared to those of the WHO Collaborative Perinatal Study in seven countries. The percentages of the infants with both risk factors, preterm and of low birth weight, varied from 2 to 8 and the percentage of 4 for the Pune Study was similar. However, a distinct difference was noted in the term births of low birth weight, 17 percent in the Pune Study in contrast to 2 to 7 percent in the seven countries. Thus the problem of term births of low birth weight appears to be much greater in India. To analyze the multiple factors involved and their relationship to the two risk factors, relatively large series of births will be needed. The impact of increasing weight gains in pregnancy on the resulting birth weight of term births deserves investigation. The prevention of IUGR should receive major attention. The prevention of preterm deliveries may be more difficult but such research is being supported in the United States.[60]

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* Low birth weight was defined as less than 2500 grams in the Ninth Revision of the International Classification of Diseases.[52] In the past, the definition was 2500 grams or less.

5. The Survey of Infant and Childhood Mortality of the Office of the Registrar General[19] provided the ten leading causes of death for India and for the states. The three leading causes in the rural area were tetanus, diarrheal disease and prematurity and the same three in a different order in the urban area. The causes were analyzed in Andhra Pradesh and three diseases, measles, tetanus and diarrheal diseases, caused around half of the deaths in the rural area in 2, 3 and 4 year old children. As information regarding causes of death is needed in each state, much greater use of survey data could be made by the provision of data on all deaths by causes with rates. Also, the data could be combined for the 1-4 year age group for evaluation of progress in the immunization, oral rehydration, nutrition and other health programs. By utilization of medical interviewers, as in the National Tetanus Survey, underlying causes of death could be obtained and coded according to the International Classification of Diseases. Analyses of death rates by causes for infants and children 1-4 years for each state and for India would enable greater understanding of health problems over the country.

6. The causes of medically certified deaths in hospitals in urban areas of several states have been published in the volume, Mortality Statistics of Causes of Death. 1979[18] of the Office of the Registrar General. The distributions of these deaths were analyzed for infants and children 1-4 years of age. Also the Annual Vital Statistics of the Maharashtra[33] provided infant death by causes for four age groups which revealed the distinct problems for early and late neonatal deaths and in two postneonatal age groups. High proportions of neonatal deaths were due to immaturity which provided additional evidence of the seriousness of the problem of low birth weights in India. The causes of death in the group assigned to Certain Perinatal Conditions require further investigation for determination of the underlying causes as maternal infections and conditions, complications of pregnancy and childbirth, etc. and the role of immaturity as an associated cause. Introduction of the Rules for Classification of the International Classification would be beneficial. A WHO Collaborating Center for Classification of Diseases is recommended for a broad educational program including teaching in medical schools and training courses on classification of causes of death.

7. Tetanus caused deaths at all ages but especially in the neonatal period. Immunization of all pregnant women and girls was recommended at a seminar in 1984.[22] Measles was found to be a serious problem from the Survey of Infant and Childhood Mortality, hospital statistics and special studies and immunization is justified to prevent deaths in infancy and childhood. The other four diseases for which immunization programs are recommended caused deaths in children 1-4 years of age and

some deaths in infancy. Therefore these death rates as well as other data justify immunization programs. Intestinal infections were responsible for relatively high proportions of deaths in the postneonatal period and in children 1-4 years of age in the hospital experience. The many deaths due to diseases of the nervous system indicate the advisability of studies to determine the causes of meningitis as the basis of preventive programs. Many deaths were assigned to nutritional deficiencies. These infants and young children who die from nutritional deficiencies may be the survivors of those with intrauterine growth retardation, a field for further investigation. Research into the etiological agents responsible for the high death rates from respiratory diseases is advisable in view of the possibilities of new vaccines.(48)

8. Even recognizing the selective nature of the hospital deaths in urban areas, they clearly indicate serious problems requiring actions by health services. Also causes of death are needed for those dying at home in urban and rural areas. Death rates by causes by age group would enable greater understanding of the size of the problems. Special studies are proposed(43, 64) to provide complete and comparable natality statistics (including birth weights) and mortality statistics with rates for causes of death. The methods developed for collection of vital statistics in special studies should lead to a Registration Area and gradually to complete coverage for India.

9. A desirable goal would be to obtain death rates by causes coded by the International Classification of Diseases for infants and children 1-4 years of age in the three programs: 1. Health surveys of the Office of the Registrar General. 2. Special investigations of mortality in infancy and childhood and 3. Complete and reliable vital statistics in an Expanding Registration Area for India.

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