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MORTALITY OF INFANTS AND CHILDREN

UNDER 5 YEARS OF AGE IN INDIA

A REPORT TO THE USAID

INDIA

BY DR. RUTH RICE PUFFER

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BRIEF REVIEW

The goal of the project which is directed to a rapid reduction of mortality in infancy and early childhood in India requires an understanding of the basic factors involved and documentation of death rates by several factors, especially by age and cause of death. These findings, from a rapid review of recent literature and from selected data, are given for a brief overall view for program planning and for recommendation for greater in-depth study of comparable data from several areas of India.

According to the recent report[1] of 25th March 1981 of the Ministry of Health and Family Welfare Health for All by 2000 A.D, the crude death rate for India as a whole was 14.1 and the crude birth rate was 33.2 per 1000 population. The population of India from the 1971 census* (2) was 547,949,800 of which 79,107,000 (14.4 percent) were under 5 years of age; of these 16,349,000 were infants (-1 year) and 62,758,000 were in early childhood (1 - 4 years). This report is concerned with mortality in this important segment of the population under 5 years of age.

The Sample Registration System[3] showed that in 1977 47.0 percent of all deaths were of children less than 5 years of age; the percentage in the rural area of 48.6 was higher than in the urban area 36.0 (Table I).

* The population according to the 1981 census was 658.140.676.

Table 1. Percentage of Total Deaths of Children 0-4 Years of Age in Rural and Urban Areas from Sample Registration System: India, 1977.

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

From the Survey of Infant and Childhood Mortality(4) conducted by the Office of the Registrar General, infant death rates and death rates per 1000 population for children under 5 years of age for rural and urban areas for 1978 were as follows:

	Infant (-1 year)	Neonatal (0-27 days)	Postneonatal (28 days-11mo.)	Under 5 years (0-4 yrs)
Total	125			50.1
Rural	136	76	60	54.2
Urban	70	42	28	30.5

An estimate on the basis of the distribution of population and deaths gave a rough death rate of 31 per 1000 population for the age group 1 - 4 years. Thus for the country as a whole these data indicate that mortality is greatest in infancy, especially in the neonatal period(a), and the rural death rates are much higher than the urban rates.

For the country as a whole the infant death rate for females of 131 per 1000 population was nine percent higher than the rate of 120 for males.(4) As reported by Padmanabha(3) the level of infant mortality for both sexes has not shown any appreciable decline in the recent past.

Estimates of infant mortality for 10 states in 1971 showed wide variations (Table 2). The State of Kerala had the lowest infant death rates of 58.1 and 45.0 in rural and urban areas while in Gujarat and Uttar Pradesh rates in both rural and urban areas were in excess of 100 per 1000 live births.

(a) Refers to infants less

Table 2: Estimates of Infant Mortality in Rural and Urban Areas in Different States(5) in 1971.

State/Union Territory	Infant deaths (per 1000 live births)	
	Rural	Urban
Andhra Pradesh	112.6	63.7
Gujarat	145.1	108.7
Haryana	64.0	52.0
Jammu & Kashmir	74.1	49.4
Kerala	58.1	45.0
Madhya Pradesh	141.3	75.6
Maharashtra	107.1	82.2
Orissa	132.9	79.1
Punjab	108.0	71.7
Rajasthan	112.8	74.2
Tamil Nadu	127.0	91.0
Uttar Pradesh	100.5	121.4
West Bengal	173.4	68.9

MORTALITY BY AGE AT DEATH

In order to understand the factors and causes responsible for high death rates in infancy, many fine studies of perinatal and infant mortality have been carried out in India. This document is primarily concerned with the deaths in infancy of those born alive, and not in the perinatal period which includes foetal deaths and deaths in the first week of life (0-6 days), as well as of mortality of children one through four years of age. Data from several studies which provided neonatal, postneonatal and infant death rates[a] based on live births have been included in Table 3.

Table 3: Infant Mortality and Mortality in Neonatal and Postneonatal Periods in 10 Areas of Eight Studies in India.

Location	Live Births	Infant (-1 year)		Neonatal (0-27 days)		Post-neonatal 28 days-11mths		Year
		No.	Rate	No.	Rate	No.	Rate	
Rural Community, Palghar (8)	8,109	677	83.5	353	43.5	324	40.0	1960-65
Ballabgarh (9)	1,529	141	92.2	78	51.0	63	41.2	1975
Urban Pondicherry(10)	807	65	80.5	28	34.7	37	45.8	1968-72
Urban birth cohort(11) South Delhi	5,592	254*	45.4		21.2		24.2	1969-72
Narangwal,Punjab(12)	2,984	310	103.9	178	59.7	132	44.2	1970-72
North Arcot District, Tamil Nadu(13) Rural	4,757	543	114.2	288	60.5	255	53.6	1970-72
Urban	3,485	381	109.3	152	43.6	229	65.7	1970-72
Ludhiana,Punjab(14) Three rural centers	1,961	194	98.9	101	51.5	93	47.4	1978-80
Urban center	925	51	55.1	24	25.9	27	29.1	1978-80
Rajasthan villages(15)	500*	62	124.0	31	62.0	31	62.0	1977

(a) Per 1000 live births
* Estimates were made from available deaths or rates.

(a) These divisions of infant deaths (under 1 year) into neonatal deaths (under 28 days) and postneonatal deaths (28 days through 11 months) are in accordance with the age classifications given on page 471 of Definitions and Recommendations of the International Classification of Diseases (6), Vol.1,1967

For six rural areas the infant death rates varied from 83.5 per 1,000 live births in the rural community, Palghar[8], to 124.0 in the Rajasthan villages. In the data from the rural health unit of Palghar, 86 of the deaths occured in the first day of life and the rate of 10.6 per 1,000 live births is indicative that probably nearly all of deaths immediately after birth were discovered. The death rate for the first week of life (0-6 days) was 28.7 and for the entire neonatal period 43.5 per 1,000 live births.[a] In the Ballabgarh prospective study[10] for the year 1975, 22 deaths occured in the first 24 hrs. which gave a death rate of 14.4; the rate for the first week was 27.5 and for the neonatal period 51.0 per 1,000 live births. The neonatal death rates in the other four rural areas varied from 51.5 to 62.0 per 1,000 live births which are indicative of excessive mortality in this period of early life. The pattern of mortality varied in the four urban areas included in the table probably due to differences in the socio-economic compositions of the populations. In general, there appears to be a pattern of mortality from these rural health studies of infant death rates of around 100 with rates and in the neonatal period of around 50 to 60 per 1,000 live births. These rates are lower than those for rural areas from the Survey of Infant and Childhood mortality[4] as given in the first part of the document. As in any developing country, rural health centers would probably not be established in the more isolated and poorer areas where death rates might be very high.

(a) During the period of this study (1960-1965) the neonatal death rate declined from a higher death rate of 50.4 for the first two years.

To bring into proper focus death rates by age in infancy and childhood, data collected in health centers in several villages of Ludhiana in the Punjab in the northwest section of India and in Tamil Nadu in the south have been utilized. In these programs all members of the families were kept under current observation and thus the records of births and of deaths of infants and children under 5 years of age are probably quite complete. A major problem in developing as well as developed countries is to secure the registration of all vital events and especially records of deaths occurring in the first day, week and even the first month of life. This has limited our knowledge of the causes of death in the age periods in which death rates are highest.

Patterns of mortality in developing as well as in developed countries vary markedly. Through utilization of standards recommended by the United Nations and the World Health Organization [6,7] comparisons of findings reveal distinct problems. Some of the results of a large research project in the Americas, [16] principally in developing countries of Latin America in which their standards were followed, are included in the tables with data of India to illustrate the wide variations and the value of comparable data to highlight problems as the basis for program planning.

The basic goal of the Inter-American Investigation of Mortality in childhood [16] of obtaining mortality statistics as accurate and comparable as possible proved a far greater task than was expected. Many deficiencies in hospital records and procedures and in registration systems were uncovered. Also the lack of standardization in use of terms such as foetal death, live birth and infant death was found to be serious

enough to invalidate many previous comparisons of neonatal and infant mortality. Of the 35,095 deaths under 5 years of age included 2,395 or 6.8 percent were discovered through intensive searches in hospitals and in the field.

Since the health programs in Ludhiana and the North Arcot District of Tamil Nadu efforts were directed to obtaining records of all births and deaths of infants and children under 5 years of age, the material from these two studies are utilized for understanding mortality by age and cause of death.

The Department of Community Health of Christian Medical College (C.M.C.) and Brown Memorial Hospital, Ludhiana, in the Punjab, has extended services to everybody through health centers in five villages of Narangwal, 7 villages of Lalton Kalan, 6 villages of Jamalpur and Fieldganj in the city. According to Thomas et al (18) "The aim of Community Health Department of C.M.C.Ludhiana, which was started in 1972, was to develop a methodology of comprehensive health care, within the existing health infra-structure of the government." They used three important tools," (1) The family folder in which socio economic and demographic data are filled in for each family and there are cards for family planning, pregnant women and children under 5 years; (2) a master register with various sections in which changes such as births and deaths are noted and (3) the diary for notation of the priorities for the day." Every home was visited at regular intervals and those in need of special services such as pregnant women, infants and children and those with malnutrition were visited more frequently.

Annual Reports of the Community Health Department describing the program in greater detail are released each year. In the 1980 Annual Report[14] a table provided the numbers of deaths in infancy and childhood by age groups and cause for the years 1979 and 1980. From the records maintained in the centers similar data were obtained for the year 1978 so that a larger number of deaths could be used for this report.[a] For the three years 1978 - 1980, 243 deaths of infants and children under 5 years were recorded for the rural villages and 74 deaths for the urban center. The number of live births in these three years were 1,961 for the rural villages and 925 for two sectors of the city.

(a) The ages at death and causes of death of infants and children under 5 years of age who died in 1978 and of those who died in the first week of life in 1979 and 1980 were obtained by Dr. Betty Cowan, Dr. H.N.S. Grewal and other members of the staff. The causes were coded in accordance with the 1965 Revision of the International Classification of Diseases (6) of the World Health Organization.

From the longitudinal studies in human reproduction carried out in 1970 - 1972 by Rao and Inbaraj[19] of the Christian Medical College (C.M.C.) of Vellore, India, data were available regarding deaths in infancy and childhood by age and cause of death for rural and urban areas. Married women in the reproductive age group were visited once in every five weeks to obtain menstrual data and those who had missed their periods were visited until termination of pregnancy or resumption of their menstruation and continued under follow-up. Each live born was visited within 48 hours after birth and subsequently. For every death, a complete death report was prepared. Attempts were made to determine the immediate causes of death and also to identify any missing deaths. During the three years 1970, 1971 and 1972, there were 4,757 live births in the rural area and 3,485 in the urban area. Of these liveborn infants 901 in the rural and 544 in the urban area died before reaching 5 years of age. Information regarding these deaths by age and cause has been used for this report.

A prospective study of the outcome of live births for the year 1975 was conducted by the primary health center, Dayalpur, of Ballabgarh[9]. A population of roughly 35,000 population distributed in 22 villages is included in the program of the center. The villages are served through subcenters which have a male and female multipurpose worker. As part of his duties the male worker recorded births and deaths in his area by making domiciliary visits to each house once in two weeks and also conducted a census at the end of the year to obtain any missed events. Causes of death were ascertained by the field supervisor under the model registration scheme. Data from this study of 144 infant deaths by age with 1,529 live births as a base are included in Table 4.

Data on infant mortality for the years 1960 through 1965 for the rural health unit of Palghar were released in papers by Shah and co-workers.[8,17] The births and deaths occurred in rural villages served by the rural health unit at Palghar, a center for training of interns from the medical colleges of Bombay. The health unit with its nine sub-centers looked after 26 villages which were scattered in the "taluk". The center had a full time staff and provided both treatment and preventive services. Included in its program was the collection of vital statistics and thus their program provides valuable information for this document on mortality in childhood.

Shah and Udani[8] reported that the statistics were collected and recorded by public health nurses, midwives and sanitary inspectors. They state: "The registration of births and death events were almost accurate as in the villages and towns the medical and paramedical staff were personally in contact with each family and they were intimately aware about death or major illnesses in any family. All the families under the centre have been registered and family folders were maintained."

Only villages with reliable data were included. The base for calculation of infant death rates was 8,109 live births and 677 infant deaths were recorded in the period of six years. Thus their data on infant deaths by age and cause for 1960 - 1965 contribute to this brief view of mortality in India.

In addition to these five series of death rates of studies in India data for deaths under 5 years data are provided in Table 4 for comparison with the findings in two projects of the Inter-American Investigation of Mortality.

The project in Recife on the coast of north east Brazil was conducted in three heavily populated districts of the city which were considered to have socioeconomic and cultural conditions representative of those in the rest of the city and their populations had access to all the health services available in the city. As will be seen the Recife project was carried out in an area with the serious health problems of developing countries. Mortality in the California project in the U.S.A is provided to aid in establishing goals which may be attained.

(a) (b)

Table 4. Mortality in Infancy and in Children under 5 years of Age in Health Centers of Ludhiana District (14) of the Punjab,1978-1980, in Areas of North Arcot District of Tamil Nadu (19),1970-1972, in Health Center of Ballabgarh (9),1975,in Health Unit of Palghar,(8) 1960-1965, India and in Two Projects of the Inter-American Investigation of Mortality (16) 1968-1972.

Age Group	Ludhiana Three Rural Centers	North Arcot District Rural	North Arcot District Urban	Ballabgarh Primary Health Center Rural	Palghar Rural Health Unit	Inter-American Investigation of Mortality Recife Brazil	Inter-American Investigation of Mortality California USA Proj
Under 5 years	27.3	*45.6	*41.5			29.3	4.3
Infant (-1 yr.)	98.9	114.2	109.3	92.2	83.5	91.2	17.5
Neonatal (-27 days)	51.5	60.5	43.6	51.0	43.5	35.3	12.7
Under 7 days	36.1	40.5	29.3	27.5	28.7	25.3	11.1
Under 1 day	13.2	10.0	10.4	14.4	10.6	11.7	7.3
1-6 days	22.9	30.5	18.9	13.1	18.1	13.6	3.8
7 - 27 days	15.3	20.0	14.3	23.5	14.8	10.0	1.7
28 days - 5 months	24.0	33.6	42.8)	41.2	25.0	35.7	3.6
6 - 11 months	23.5	20.0	23.0)		14.9	20.2	1.2
1 - 4 years	* 6.9	24.0	15.0			9.0	0.7

a) Per 1000 live births
b) Per 1000 population in age group
c) The numbers of deaths on which rates are based are given in Table A of Appendix
d) For one year
* Estimated population base.

The death rates for children under 5 years of age in the rural areas of Ludhiana and of the North Arcot District of 27.3 and 45.6 are lower than the rural rate for India of 54.2 per 1000 population which might be due to their better socioeconomic conditions and health services. However, the death rate in the urban area of the North Arcot District of 41.5 is higher than the urban rate of 30.5 per 1000 for India and that in the urban center* of Ludhiana is lower.

The number of deaths of children under 5 years of age in Fieldganj was small,74, and the coverage of health services is reported to be good and thus in this small experience, the death rate may be lower. The death rate for children under 5 years of 29.3 per 1000 population in the Recife project was approximately the same as in rural India (30.5) and thus we have relatively comparable material for developing socities. The low death rate under 5 years of 4.3 per 1000 population in the California U.S.A.project indicates that great improvement in mortality may be attained.

In Table 4, mortality in infancy is presented in detail by age group in seven areas in order to learn where the problems are centered. Neonatal mortality (deaths of infants less than 28 days of age per 1000 live births) appears to be high in the rural areas of Ludhiana, North Arcot District and Ballabgarh for the rates, were 51.5, 60.5 and 51.0 respectively. The excess was principally in the first week of life. Complete data for deaths in the first 24 hours of life are difficult to obtain and are dependent on educationa programs in schools of medical, nursing, midwifery as well as the training programs for auxiliary workers. Thus the death rates of 10.0 - 14.4 per 1000 live births for the four areas of India is indicative of close observation of the outcome of all pregnancies. Shapiro et al (20) showed that the death ra

* Since the number of deaths in the urban area of Ludhiana (Fieldganj) was small, data are not included in Table 4.

in the first day of life in the United States declined from 15.0 per 1000 live births in 1935 to 10.2 in 1950 and remained around 10 per 1000 from 1950 to 1964. In the Inter-American Investigation this death rate of 10 per 1000 live births served as a measure for judging completeness of inclusion of deaths occuring in the first 24 hours of life, the critical period and probably the one providing the best indicator of registration or recording and utilization of the WHO definition of live birth. In areas where high proportions of babies are born with low birth weights, the death rate in the first day of life (a) may be considerably higher.

The death rates per 1000 live births for babies 28 days through 5 months of age of 24.0 in rural Ludhiana and 25.0 in Palghar appeared to be lower than the rates in the North Arcot District and in the Recife project.

For infants 6-11 months of age, the death rates were relatively similar in three areas varying from 20.0 to 23.5 per 1000 live births and the rate of 14.9 in Palghar was lower. As the basis for program planning death rates by causes are needed.

For children 1-4 years of age the estimated death rate. in Ludhiana appeared to be relatively favourable and those in the North Arcot District to be high.

(a) In Recife (21), for example, in a study of the outcome of pregnancy conducted after completion of the Investigation in a maternity with the best quality records Nunes found that the death rate in the first day of life was 19.1 per 1000 live births and for babies of mothers less than 20 years of age 24.7 per 1000 live births.

Cowan and Dhanoa [22] have described the program of the Community Health Department of Christian Medical College in Ludhiana for prevention of toddler malnutrition and deaths from 6 through 36 months of age by home-based nutrition health education in a chapter in the next edition of the book Nutrition in the Community (23). They reported the distinct problems of the underprivileged females in contrast to males and of both underprivileged males and females in relation to the privileged. The postneonatal mortality (28 days - 11 months) declined from 60.7 in 1977 to 35.3 per 1000 live births in 1980. Probably their program is also affecting the death rate of children 1 - 4 years. In 1978, 20 deaths were recorded in this age period while there were 29 in the two years 1979 and 1980 or 14.5 per year. Although these numbers of deaths are small, programs such as the one described are needed to lower the mortality (a).

(a) Since an opportunity was provided for a visit to Ludhiana and for discussions with Dr. B. Cowan and Dr. S. Thomas, the author has commented freely on the program by C.M.C in Ludhiana.

BIRTHWEIGHT AND INFANT MORTALITY

According to the Report of the Working Group[1] on Health For All By 2000 A.D. at present 30 percent of live births in India had birth weights below 2500 g. The target for 2000 A.D. is 10 percent.

In a recent document of the World Health Organization[24] data were quoted from 56 studies in India; of 22,471 births 30.0 percent had low birth weights of 2500 grams or less[a]. In 19 of these studies the percentages with low birth weights were between 20-29 and in 10 between 30-39. The percentages were 40 or more in 8 and less than 20 in 6. Excluding one small study the mean birth weights varied from around 2500 g to around 2900 g. In all but nine of the studies hospital deliveries were used and thus they may not be representative of all deliveries in India. Collection of data on birthweights in villages in rural India will depend in part on weighing of babies by midwives and auxiliary workers. The findings of two of these studies, referred to above, a longitudinal study of the survival and outcome of a birth cohort in New Delhi[25] and a prospective community survey of infant mortality in South India in the North Arcot District of Tamil Nadu State[26] have been utilized in this document to show the important relationship of birthweights to mortality in infancy.

(a) In the 1975 Revision of the International Classification of Diseases the definition of low birthweight was changed to "less than 2500 g (up to and including 2499 g.)". In prior Revisions low birthweight was 2500 g or less which is the definition used in the WHO document and the present report.

Table 5: Distribution of Birthweights in two Studies (25,26) in India and in Two Projects of the Inter-American Investigation of Mortality (21,28).

Birthweight in grams	Longitudinal study, (a) New Delhi India (25)		Community Survey (b) North Arcot District (26)		Recife, Brazil Study (21)		California U.S.A. project (28)	
	No.	Percent	No.	Percent	No.	Percent	No.	Perc
Total	6,026	99.9	4,220	100.1	23,235	100.0	47,613	100
1000 or less	)		)		145	0.6	213	0
1001 - 1500	) 165	2.8	) 46	1.1	261	1.1	294	0
1501 - 2000	)		232	5.5	659	2.8	706	1
2001 - 2500	1,218	20.2	1,067	25.3	2,334	10.0	2,417	5
2500 or less	1,383	23.0	1,345	31.9	3,399	14.6	3,630	7
2501 - 3000	2,762	45.8	1,738	41.2	7,668	33.0	9,099	19
3001 - 3500	1,552	25.8	906	21.5	8,125	35.0	18,790	39
3501 - 4000	292	4.8	203	4.8	3,447	14.8	12,369	26
4001 and over	37	0.6	28	0.7	596	2.6	3,725	7

a) From Table 8.1 Longitudinal Study of the survival and outcome of birth cohor Vol II(25). The data refer to single live births.

b) From table II of Rao and Inbaraj (26). Of 10,691 single live births observed for nearly half birthweights and gestational age or both were not ascertained.

In the longitudinal study in New Delhi, 23.0 percent of the babies weighed 2500 g. or less while in the community survey in the North Arcot District of Tamil Nadu State the percentage was higher, namely, 31.9. In two projects of the Investigation from which data are provided for comparison, the percentages were lower, 14.6 for Recife, Brazil and 7.6 for California, U.S.A. project. The distributions of births differ markedly in the four areas. The North Arcot District has the highest percentage with birthweights of 2000 g. or less, 6.6 in contrast to 2.5 in the California project.

Another feature of these distributions of birthweights is important. From several studies (21, 28-31), death rates in the first day of life and in the first 28 days of life were found to be lowest for babies in the weight group 3501-4000 g. However, in the two Indian studies the percentages of babies in this weight group were low, in fact, 4.8 for both studies in contrast to 14.8 in Recife and 26.0 in the California project. Also the percentages of the babies weighing 3001-3500 g. were much lower for the Indian studies than for the Recife and Californian projects (25.8 and 21.5 compared to 35.0 and 39.5 respectively). The distributions in the Indian studies were skewed to the left - that is to lower birth weights than in the two other series*.

Birthweights need to be considered in relation to the age of the mother. As can be seen in Table 6 with data from the longitudinal study of a birth cohort in New Delhi, India, for mothers under 20 years of age higher proportions of the babies weighed 2000 g. or less and 2001-2500 g. than did those for mothers 20-24 years of age and older. In fact, over one third (34.4 percent) of the babies of mothers under 20 years of age weighed 2500 g. or less in contrast to 20.4 percent for baies of mothers 25-29 years of age. Also the percentages of babies weighing 3001 g. and over were higher for the older mothers.

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* In Appendix B the distributions of live births by birthweight in the North Arcot District and in the California project are shown in a figure.

Table 6: Distribution of Babies by Birthweight Group and Mother's Age From Longitudinal Study of a Birth Cohort in New Delhi, India.

Birthweight in grams	Total babies	AGE OF MOTHER									
		Under 20 years		20-24 yrs.		25-29 yrs.		30-34 yrs.		35 yrs. & over	
		No.	%	No.	%	No.	%	No.	%	No.	%
Total	6,022	454	100.0.	2,208	99.9	2,077	100.0	912	100.0	371	100.0
2000 or less	165	28	6.2	69	3.1	44	2.1	13	1.4	11	3.0
2001 - 2500	1,216	128	28.2	486	22.0	381	18.3	156	17.1	65	17.5
2500 or less	1,381	156	34.4	555	25.1	425	20.4	169	18.5	76	20.5
2501 - 3000	2,761	213	46.9	1,063	48.1	952	45.4	382	41.9	161	43.4
3001 - 3500	1,552	74	16.3	494	22.4	585	28.2	290	31.8	109	29.4
3501 & over	328	11	2.4	96	4.3	125	6.0	71	7.8	25	6.7

From Table 8.5 Longitudinal study of the survival and outcome of birth cohort, Vol.II (25). The data refer to single live births.

Birth order as well as maternal age is an important factor. Young mothers have a higher frequency of low weight births and this frequency increases with rising birth order (28, 32). In the two studies in India, infant mortality was also provided in relation to birth weights of single live births (Table 7). Death rates in the first day of life and in the first 28 days are also given in the table from several studies to illustrate the relationships of mortality in infancy to birthweight.

Table 7: Mortality in Infancy in Studies in New Delhi (25) and North Arcot District (26) of India and in First Day and/or First 28 Days of Life in Recife, Brazil Project (21), California (29) and Rebeirao Preto Brazil (28) Projects and in Birth Cohort (30) of the United States.

Birthweight in grams	Infant mortality per 1000 single births		Deaths in 1st day of life per 1000 live births		Deaths in 1st 28 days of life per 1000 live births		
	New Delhi India (a)	North Arcot Distt. India(b)	Recife Brazil Project	California U.S.A. Project	California U.S.A. Project	Ribeirao Preto Brazil Project	United States birth cohort 1960
Total	46.5	85.9	14.3	7.3	12.7	28.2	18.4
1000 or less	1000.0	568.2	753.1	725.0	940.0	890.6	912.8
1001 - 1500	615.4		300.8	264.5	434.8	676.3	521.5
1501 - 2000	242.7	218.8	76.7	45.2	106.9	391.0	180.6
2001 - 2250		102.6					
2251 - 2500	60.4	84.8	12.9	14.1	28.2	68.1	41.4
2501 - 3000	21.6	77.2	4.7	3.0	5.4	16.8	9.9
3001 - 3500		51.9	2.2	0.7	2.5	8.5	4.7
3501 - 4000	17.9	35.9	1.3	0.4	2.2	6.0	3.6
4001 over		37.0	8.1(c)	1.1	3.1	8.7	5.0

(a) From Table 15.1 Longitudinal study of the survival and outcome of birth cohort, Vol.II (25). Overall infant death rate from Ghosh et al (25).

(b) First year mortality rates from Rao and Inbaraj (26) were calculated by dividing the number of deaths during specified intervals by the total number of live born surviving at the beginning of the interval with adjustments for losses in follow-up.

(c) Small number of deaths in this group.

That death rates are high for low birthweight infants is well known. Progress is being made and will continue to be made in the reduction of mortality especially for those babies weighing 2001 - 2500 g.

Attention is directed to the death rates of babies in the higher weight groups. Even those weighing 2501-3000 g had higher death rates than those in weight group of 3001-3500 g and in nearly all of the experiences the rates for those weighing 2501-3000 g

were two or three times the rates in the birthweight group of 3501-4000 g., which has been termed the most favorable weight group. These findings point to the need of increasing birthweights in programs for reducing infant mortality. Thus the challenge at this time is to obtain data to understand the causes and factors responsible for the distinct distribution of birthweights in India and to introduce necessary measures to increase birthweights.

Kessner and co-workers (31) conducted a study of infant mortality in the 1968 cohort of 142,017 live births in New York city. Not only was the death rate in the first day of life of 10.2 per 1000 live births higher than in the California project but the frequency of low weight births was also higher (10.0 percent in New York City and 7.6 percent in the California project). These figures probably reflect real differences in the frequencies and in mortality as well. Kessner et al stated that infant mortality is related more closely to birthweight than to any other maternal or infant characteristic, and that more detailed studies are needed to refine risk categories and to direct the woman to appropriate services so as to decrease her chances of producing a low birthweight or nonviable infant.

In the Inter-American Investigation of Mortality efforts were made to obtain the lengths of gestation. In one project the mothers reported that they went from one pregnancy to another without menstruation. They were rarely able to give correct information and the analyses by birthweight were found to be much more satisfactory than by gestation.

Mortality due to immaturity as an underlying or associated cause in the Inter-American Investigation of Mortality in Childhood was especially

high for young mothers with increases occurring as the birth order rose (28). Not only are the risks for survival greater for babies of mothers when they are young (under 20 years) because of the excessive frequencies of low weight births but they increase even more with subsequent products when the birth intervals become shorter. Thus the importance of the combination of these three factors should be recognized in maternal and child health programs.

Studies of neonatal and infant mortality by age of the mother (16) have revealed the highest rates for the young mothers (under 20 years of age) and usually the lowest were for babies of mothers 25-29 years of age. Published data were found for two series in India, namely, neonatal mortality for the rural community of Palghar (8) and infant mortality for an urban area of Greater Bombay(33)a (Table 8). In both Indian experiences the death rates were very high for babies of the young mothers under 20 years of age. In rural Palghar, the neonatal death rate for babies of mothers under 20 years of age of 149.1 per 1000 live births was several times the rates for births of mothers 20-39 years of age.

Infant mortality in the urban setting of Greater Bombay was likewise very high for babies of mothers under 20 years of age, 127.9 per 1000 live births, and this rate was over twice the rates for those of mothers 25-29 and 30-34 years of age, 52.3 and 46.5 per 1000 live births respectively. The excessive mortality of young mothers is of course due to the very high frequencies of low weight babies of young mothers.

(a) The material by Ruzicka and Kanitker (33) on infant mortality in Greater Bombay from a publication by Vaidyanathan (34) was included in the book Demographic and Socio-economic Aspects of the Child in India(35)

Table 8 : Neonatal Mortality (a) in Rural Community of Palghar (8) 1960-1965, Sao Paulo, Brazil and California, U.S.A. projects (16) 1968-1970 and Infant mortality (a) in Urban Greater Bombay (33), Sao Paulo, Brazil and California, U.S.A. Projects (16), 1968-1970.

Age Group of Mother	Neonatal Mortality (-28 days)			Infant Mortality (-1 year)		
	Rural Palghar, India	Sao Paulo Brazil Project	California U.S.A. Project	Urban Greater Bombay India	Sao Paulo Brazil Project	California U.S.A.(b) Project
Total	43.5	33.7	12.7	73.6	65.1	17.5
Under 20 years	149.1	52.3	17.2	127.9	104.1	26.2
20-24 years	33.7	32.1	11.7	82.5	67.9	15.9
25-29 years	47.1	28.7	11.3	52.3	53.2	15.3
30-34 years	28.6	34.3	12.7	46.5	61.4	16.5
35-39 years	39.9	)37.2	)14.0	)74.3	)67.4	)17.5
40 years & over	117.2					

(a) Per 1000 live births
(b) For one year, 1969-1970

There are differences in the desirable weight gains for pregnant women recommended by British and United States obstetricians. The opinion of the Committee on Maternal Nutritional of the U.S. National Academy of Sciences (36) is for a gain of 24 pounds (10,900g) within a range of 20 to 25 pounds (9,100-11,300 g). The British figure (36) is 27 pounds (12,000 g). Desireable weight gains should be established for many areas of the world and pregnant women should understand the importance of satisfactory gains for the health of their babies.

According to a paper on maternal malnutrition in India (38) "On an average a normal health woman gains about 12 kg. (26.4 pound) of weight during pregnancies" and "It would appear that the best reproductive performance is associated with a weight gain of about 9 kg in the second half of pregnancy. However, serial studies have indicated that weight gain of poor Indian women averaged 6.5 kg during pregnancy".

Evidence has been accumulated by Lechtig et al (39) and Birch (40) pointing to the relationship of birthweight to the mother's general health and nutritional status. Supplementary feeding of 35,000 calories during pregnancy (about 19 extra calories per day) resulted in a reduced frequency of low-birth weight babies. Although success in feeding program for pregnant women has varied, progress is needed in developing procedures to assist women in greatest risk of producing low weight babies to receive recommended interventions.

In her report for the Integrated Maternal and Child Nutrition Project in India, Walsh (37) stated that unless birthweights can be substantially increased, it is unlikely that the infant mortality can be lowered. She suggested that research on the prevalence of maternal infections and maternal nutrition supplementation. Thus accurate and complete data on the causes of death in early life, especially in the neonatal period, are essential as part of research and programs directed to increasing birthweights and reducing infant mortality.

MORTALITY BY CAUSES

The Survey on Infant and Childhood Mortality(4) provided the top 10 causes of death for rural and urban areas for infants and for children one, two, three, four and five years of age.

In infancy, tetanus was the leading cause of death in the rural area with the exceedingly high death rate of 2267 per 100,000 population (Table 9). In the urban area, however, the death rate from tetanus was only one-fourth as high, namely, 501, and appeared as the second leading cause. Prematurity was listed as the second cause in the rural area and as the first in the urban area.

Table 9: Top 10 Causes of Infant Mortality (a) in Rural and Urban Areas of India (4) 1978

Rural Area		Urban Area	
Cause	Rate	Cause	Rate
Tetanus	2,267	Prematurity	849
Prematurity	1,179	Tetanus	501
Pneumonia	1,015	Dysentery	408
Dysentery	906	Infantile liver	338
Influenza	729	Influenza	309
Malaria	704	Diarrhea	286
Typhoid	573	Congenital malformations	281
Other disorders of respiratory system	392	Gastro-enteritis	260
Diarrhea	242	Typhoid	250
Gastroenteritis	195	Malaria	180
Total-10 causes	8,202	Total-10 causes	3,662
Remainder	5,398	Remainder	3,338
All causes	13,600	All causes	7,000

(a) Per 100,000 population

Diarrheal disease (009) of the 1965 Revision of the International Classification of Diseases [6] includes three causes which appear in the first 10, namely, dysentery, diarrhea and gastroenteritis: In Table 10, the death rates from diarrheal disease have been obtained by adding the rates from these three causes. For the rural area the death rates of 1,343 per 100,000 population is high and would rank second to tetanus as a principal cause. In the urban area the death rate from diarrheal disease of 954 would be the leading cause. Thus the two main causes of infant mortality are clearly evident, tetanus and diarrheal disease.

Table 10: Mortality[a] from Diarrheal Disease in Infancy in Rural and Urban Areas of India, 1978.

Terms	Rural Area	Urban Area
Total	1,343	954
Dysentery	906	408
Diarrhea	242	286
Gastroenteritis	195	260

(a) per 100,000 population

The total death rate for the top 10 causes in the rural area was 8,202, which by subtraction from the rural infant death rate of 13,600 leaves a rate of 5,398 per 100,000 population which would be distributed over many other causes. The similar residual rate for the urban area is 3,338 per 100,000. Information regarding the composition of these residual groups would contribute to our understanding of other causes responsible for excessive mortality in early infancy.

Although prematurity is included as one of the top causes, the rules of International Classification of Diseases (6) specify that immaturity is not to be used as an underlying cause if any other cause of perinatal mortality is reported. However, immaturity is an important contributor to mortality; some of the low weight births are the consequence of certain maternal infections and conditions, certain complications of pregnancy and childbirth, conditions of the placenta etc. In many areas, high proportions of infant deaths, espeically in the neonatal period, are due to causes which are given in Section XV Certain Causes of Perinatal Morbidity and Mortality in the International Classification of Diseases (6). These residual rates would include probably deaths of some of the causes in Section XV.

The death rates from the top 10 causes for children one year of age are much lower than those in infancy (Table 11). In both rural and urban areas pneumonia was reported to be the leading cause of death.

In our Inter-American Investigation, from the diseases and conditions on hospital records or of information provided by the mother regarding the causes leading to death, frequently measles was the underlying cause which was followed by bronchopneumonia. However, such a death would be recorded officially as due to pneumonia. The correct assignment would be measles. According to the Classification, the underlying cause is "the disease or injury which initiated the train of morbid events leading directly to death".

For example, in the past, the size of the measles death rate in Recife was not known because the terminal cause (usually a lower respiratory infection) was commonly the assignment made. In the Investigation on the basis of death certificates there were 984 deaths from measles in 14 countries but the number on final assignment from all available information was 81 percent higher, 1,777. Since programs for immunization against measles are now being recommended for many countries, the size of the death rate from measles is very important. This is an example of the value of utilizing the rules for selection and modification set forth in the International Classification of Diseases[6]. Whereas 5,846 deaths were attributed to respiratory diseases on death certificates (in the Inter-American Investigation) only 4,546 or 78 percent were so assigned on the basis of clinical and other information available. In some of these, the respiratory disease was the terminal event.

Table 11: Top 10 Causes of Mortality of Children One Year of Age in Rural and Urban Areas of India (4) 1978 (a)

Rural Area		Urban Area	
Cause	Rate	Cause	Rate
Pneumonia	349	Pneumonia	246
Typhoid	317	Typhoid	141
Dysentery	283	Influenza	116
Influenza	236	Diarrhea	96
Diarrhea	176	Dysentery	86
Malaria	158	Infantile liver	85
Gastroenteritis	101	Bronchitis	74
Jaundice	99	Malaria	73
Other disorders of respiratory system	92	Tetanus	33
Tetanus	61	Jaundice	32
Total 10 causes	1872	Total 10 causes	982

(a) Per 100,000 population

The death rate of one year old children from dysentery, diarrhea and gastroenteritis combined in the rural area was 560 per 100,000 population and thus was less than one-half the rate of 1,343 per 100,000 population in infancy (under 1 year). In the past, studies by Gordan et al (41) on weanling diarrhea implicated the age of weaning as a time of high morbidity and mortality from diarrheal disease. Also Gordon et al pointed out the exceedingly high death rates for the disease in the second year of life. These data for India as well as the findings in the Investigation indicate that death rates from diarrhea are very high in the first year of life and are much higher than for children one year of age. In the 13 Latin American projects combined the total number of deaths from diarrheal disease declined from 1357 in the first month of life to 553 for those 6 months of age and 259 for those 11 months of age. Thus mortality was highest very early in life.

In the Khanna study[42] carried out in a rural population of the Punjab in 1957-1959, the causes of infant deaths were classified in accordance with the B List of the 1955 Revision of the International Classification of Diseases[43].

At that time the infant death rate in this rural population of the Punjab was very high, 156.2 per 1000 live births. Slightly more than half of the deaths were in the post-neonatal period (28 days - 11 months) [Table 12].

Table 12: Infant Mortality* by Cause in Neonatal and Postneonatal Periods in a Rural Population of the Punjab (42) 1957 - 1959.

Cause of death (a)	Infant (0-11 months) No.	Rate	Neonatal (0-27 days) No.	Rate	Postneonatal (28 days-11 months) No.	Rate
T o t a l	219	156.2	103	73.5	116	82.7
B 1,2 Tuberculosis	3	2.1	-	-	3	2.1
B 4 Typhoid fever	4	2.8	-	-	4	2.8
B6,36 Diarrheal disease	39	27.8	-	-	39	27.8
B 14 Measles	5	5.7	-	-	8	5.7
061 Tetanus (Out of B17)	30	21.4	29	20.7	1	0.7
B 31 Pneumonia	15	10.7	-	-	15	10.7
B 41 Congenital Malformations	5	3.6	3	2.1	2	1.4
Certain disease of early infancy	78	55.7	62	44.3	16	11.4
B42 Birth injuries, postneonatal asphysia, atelectasis	29	20.7	28	20.0	1	0.7
B43 Infections of the newborn	6	4.3	6	4.3	-	-
B 44 Peculiar to early infancy, immaturity	43	30.7	28	20.0	15	10.7
B 45 Unknown causes	14	9.9	5	3.6	9	6.4
B 46 Other residual	8	5.7	2	1.4	6	4.3
B 48 Accidents	6	4.3	1	0.7	5	3.6
Other known causes	9	6.4	1	0.7	8	5.7

*Per 1000 live births. Since the numbers of deaths are small, the rates are shown per 1000 instead of per 100,000 as is customary for causes.

(a) 1955 Revision of International Classification of Diseases (43)

The classification and grouping of causes by the International Classification reveals an entirely different pattern of mortality in the Khanna Study than that obtained by the listing of the top 10 causes in the Survey. Of the 103 neonatal deaths, 29 were due to tetanus giving the high death rate of 20.7 per 1000 live births. The infant death rate from tetanus of 21.4 per 1000 or in terms of 100,000

as used in the Survey of Infant and Childhood Mortality of 2,140 was only slightly lower than the rate of 2,267 per 100,000 population in rural India in 1978.

In the Khanna study 62 neonatal deaths were assigned to causes in the group of certain diseases of early infancy which gave a high rate for the group of 44.3 per 1000 live births[a]. These data have special importance because of the excessive neonatal mortality and because these causes are related to conditions and complications of pregnancy, difficult labor and other conditions resulting in death in the first few days of life. Immaturity is the consequence of some of these conditions although of others it is a contributory cause. Of the 12,104 neonatal deaths in the Latin American projects of the Investigation, immaturity was an associated cause of 6,868 and the underlying cause of 421. Thus 60.2 percent of those deaths were known to be of immature babies

In the Khanna study in the postneonatal period, diarrheal disease was the leading cause with a death rate of 27.8 per 1000 live births. In the 1955 Revision of the Classification, diarrheal disease of the newborn was included in B 43 Infections of the newborn and thus such deaths would not be shown in this table. In the post-neonatal period measles was responsible for 8 deaths or 5.7 per 1000 live births. This finding of 8 deaths from measles in infancy was important: in the past in the United States the incidence of measles was usually high in children of school age.

(a) In the Khanna study and in the following tables of this report because of small number of deaths, death rates by causes are given per 1000 live births instead of the usual unit of 100,000 for causes.

In the Inter-American Investigation of Mortality deaths from measles were found to occur early in life. The highest rates were either in infancy or among one-year old children. In several projects (such as El Salvador or Monterry, Mexico) infants aged 9-11 months had the highest death rates from measles. Measles mortality in rural areas was usually higher than in the corresponding cities. In San Juan Province of Argentina, the death rate of 1.3 per 1000 live births in the rural departments was over three times that in the city of San Juan. The differences in mortality between urban and rural areas were probably due to differences in susceptibility of tne population. The study of the associated causes of deaths due to measles as underlying cause revealed the important relationships and interactions. Of the 2,106 deaths from measles in the 13 Latin American projects, 1,061 or 50.4 percent had diarrheal disease as a complication and in 2.5 percent as a contributory or pre-existing condition to the onset of the underlying cause. Nutritional deficiency of the protein-calorie type was found as a contributory or pre-existing cause in 59.3 percent of all deaths due to measles and in 3.1 percent malnutrition was considered as a consequence of the measles which was the underlying cause. Pneumonia and bronchopneumonia were found as complications (usually as terminal causes) in 80.2 percent of the deaths due to measles. This very high proportion of measles deaths complicated by respiratory conditions is probably an indication of the severity of the disease, determined by the decreased resistance of the host. This discussion of mortality from measles is presented as an example of the complexity of mortality in infancy and childhood. If each one of the principal components - namely, measles, diarrheal disease, nutritional deficiency and respiratory conditions - were

to be analyzed in its own context and the concept of the interaction of causes were omitted, a distorted picture would be obtained. Also this example is given to illustrate the value of coordinated research in developing countries and of the need to analyze the multiple factors and causes. Moreover, it illustrates the value of the use of the rules of the International Classification of Diseases in studies and surveys for obtaining the underlying causes. From the available data in India, where respiratory diseases and diarrheal diseases are reported to be among top causes of deaths in infancy and childhood, the role of measles as the underlying cause of some of these deaths probably is not known. Thus if accurate data on measles mortality are required as the basis for an immunization program it is highly recommended that the underlying causes of deaths in rural villages as well as in urban centers be obtained and that the international rules of classification be followed.

From the data from the rural community of Palghar which was included in the paper by Shah and co-workers (8) the causes of death have been regrouped in accordance with the International Classification and death rates have been calculated to facilitate comparisons (Table 13). Data are presented for three age groups: Neonatal (0-27 days); 28 days - 5 months and 6-11 months of age in order to understand the distinct problems in infancy by age group.

(a) The interrelation of these causes is described in greater detail in Patterns of Mortality in Childhood (16). The co-author, Dr. Carlos V. Serrano made valuable contributions to such discussions.

Table 13: Infant Mortality* by Cause and Age Group, Rural Community of Palghar (6) 1960-1965.

Underlying Cause(a)	Infant -1year No.	Rate	Neonatal 0-27 days No.	Rate	28 days-5 months No.	Rate	6-11 months No.	Rate
Total	677	83.5	353	43.5	203	25.0	121	14.9
Diarrheal disease	89	11.0	19	2.3	40	4.9	30	3.7
Tetanus	30	3.7	28	3.5	2	0.2	-	-
Measles	9	1.1	-	-	2	0.2	7	0.9
Septicemia	31	3.8	20	2.5	10	1.2	1	0.1
Other infectious diseases	15	1.8	1	0.1	6	0.7	8	1.0
Nutritional deficiency	102	12.6	5	0.6	55	6.8	42	5.2
Bronchopneumonia	98	12.1	14	1.7	60	7.4	24	3.0
Congenital anomalies	9	1.1	9	1.1	-	-	-	-
Certain perinatal causes	232	28.6	232	28.6	-	-	-	-
Birth injuries	19	2.3	19	2.3	-	-	-	-
Anoxic, hypoxic conditions, etc.	10	1.2	10	1.2	-	-	-	-
Immaturity	203	25.0	203	25.0	-	-	-	-
Other causes	5	0.6	-	-	1	0.1	4	0.5
External causes	3	0.4	2	0.2	1	0.1	-	-
Ill-defined and unknown causes	54	6.7	23	2.8	26	3.2	5	0.6

* Deaths per 1000 live births. (a) 1965 Revision of International Classification of Diseases.

As is well known the death rate is highest in the neonatal period in which over half of the deaths are usually due to certain perinatal causes. In the Palghar experience the neonatal death rate from certain perinatal causes was 28.6 per 1000 live births and accounted for two-thirds of the neonatal death rate of 43.5 per 1000 live births. No deaths were assigned to these causes after the neonatal period and probably those with immaturity in the neonatal period who survived developed nutritional deficiency which became the underlying cause or as an associated cause of an infectious disease. In this experience tetanus caused 28 deaths which gave a neonatal death rate of 3.5 per 1000 live births and diarrheal

disease was responsible for 19 deaths and a rate was 2.3 per 1000 live births.

An attempt has been made to classify causes of death of children under 5 years of age in accordance with the 1965 Revision of the International Classification of Diseases for three years 1978, 1979 and 1980 for the Ludhiana rural villages and for the three years 1970-1972 for communities in the North Arcot District of Tamil Nadu. In addition to the experience in Palghar, these were the only other known series with detailed information by age and causes which could be classified by the International Classification. There may be others.

For the North Arcot District[19], the numbers of deaths were listed in tables by causes which were then coded by the International Classification. These tables included many deaths reported only by symptoms and thus the group of ill-defined and unknown causes is large. In Ludhiana, deaths by causes were given in the Annual Report for 1980[14] for the two years 1979 and 1980. However, records were reviewed for all deaths in the first week of life and for all deaths in 1978 to obtain age at death and cause.

In the Ludhiana experience, there were 243 deaths of children under 5 years with 193 of these of infants (-1 year). Neonatal deaths (-28 days) accounted for 101 of these deaths and for the other 11 months in the first years, there were 93 deaths (47 from 28 days - 5 months and 46 deaths from 6-11 months of age or only 9.4 and 7.7 deaths on the average per month of age). Thus the excessive mortality in this experience is in the neonatal period. Likewise, in the rural communities of the North Arcot District 288 of the 528 infant deaths were in the neonatal period. This is the age period most affected by under registration and deaths in the first week of life are commonly considered to be the least susceptible to reduction of mortality.

The abnormal conditions included the section of "certain causes of perinatal mortality", categories 760-778 of the International Classification of Diseases, have been grouped as follows:

Maternal conditions (760-763)
Other complications of pregnancy (769)
Difficult labor and injury at birth (764-768,772)
Conditions of placenta and cord (770-771)
Hemolytic diseases of newborn (774,775)
Anoxic and hypoxic conditions not elsewhere classified (776)
Immaturity * (777)
Other conditions of newborn (778)

* If no other perinatal cause was stated.

In Table 14 the numbers of neonatal deaths with rates per 1000 live births are given for three rural centers of Ludhiana and for rural and urban communities of North Arcot District in India. To show the type of information on causes of death obtained in research projects and to point out the patterns of neonatal mortality in two distinct and widely differing areas, data for two projects of the Investigation [16] in Recife, Brazil, and in the California of U.S.A. are provided also.

Table 14: Underlying Causes of Neonatal Mortality[a] in Three Rural Centers of CMC Ludhiana District (14) of the Punjab 1978-1980 and in Rural and Urban Areas of CMC North Arcot District of Tamil Nadu (19) 1970-1972, India and Two Projects of Inter-American Investigation of Mortality (16) 1968-1970.

Underlying Causes[b]	Ludhiana Three Rural Centers		North Arcot District[c]				Recife Project		California Project	
			Rural		Urban					
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
All Causes	101	51.5	288	60.5	152	43.6	1,073	35.3	570	12.7
Diarrheal disease	9	4.6	4	0.8	3	0.9	146	4.8	2	0.0
Tetanus	4	2.0	4	0.8	1	0.3	22	0.7	-	-
Other infectious disease	1	0.5	3	0.6	5	1.4	30	1.0	14	0.3
Diseases of respiratory system	5	2.6	3	0.6	-	-	62	2.0	13	0.3
Congenital anomalies	11	5.6	7	1.5	2	0.6	55	1.8	105	2.3
Certain perinatal causes	50	25.5	174	36.6	94	27.0	721	23.7	424	9.5
Maternal conditions	3	1.5	4	0.8	-	-	28	0.9	51	1.1
Complications of pregnancy	8	4.1	d		d		128	4.2	127	2.8
Difficult labor, birth injuries	-	-	d		d		135	4.4	42	0.9
Conditions of placenta, cord	2	1.0	d		d		58	1.9	103	2.3
Hemolytic disease	-	-					10	0.3	5	0.1
Anoxic, hypoxic conditions	9	4.6	111	23.3	55	15.8	260	8.6	73	1.6
Immaturity	24	12.2	32	6.7	22	6.3	59	1.9	19	0.4
Other	4	2.0	27	5.7	17	4.9	43	1.4	4	0.1
Other and unknown causes	21	10.7	93	19.6	47	13.5	37	1.2	12	0.3

(a) Per 1,000 live births

(b) 1965 Revision of International Classification of Diseases (6)

(c) Rural total includes 8 deaths and urban 9 deaths, which were not included in the tables by causes of the report (19), as due to other and unknown causes.

(d) Probably included in other perinatal causes.

There were 101 deaths in the neonatal period of babies followed in the Ludhiana three rural centers and the rate was 51.5 per 1000 live births. Nine deaths were due to diarrheal disease, and although the number of deaths is small, the rate of 4.6 was practically the same as that of 4.8 per 1000 live births in Recife, but was higher than the rate of 2.3 in Palghar. In comparison with the death rate from tetanus in rural India of 22.7 per 1000 population, the death rate was low in the Ludhiana experience; only four deaths were reported. An active immunization program of pregnant women is carried out by the health centers.

In the Ludhiana experience 11 deaths were recognized as due to congenital anomalies giving a death rate of 5.6 per 1000 live births. Although the number of deaths is small, this is a relatively high rate. In the Recife and California projects the rates were 1.8 and 2.3 per 1000 live births. Further study of death rates from congenital anomalies is suggested.

In the experience of Ludhiana, half of the deaths (50) were classed in the broad group of certain perinatal causes which gave a rate of 25.5 which was similar to that in Recife and in Palghar but was over twice the rate in the California project. This is valuable information, again suggesting the importance of a larger series for greater in-depth study of these causes and if possible, the relation of immaturity to them.

In the communities of the rural area of the North Arcot District of Tamil Nadu, there were 288 neonatal deaths and the death rate of 60.5 per 1000 live births was high. Unfortunately, over one-fourth of these deaths were attributed to ill-defined and unknown causes. The number of deaths due to diarrheal disease (4) was small, due perhaps to the terminology used.

Only 4 deaths were said to be due to tetanus. However, the term "Chevvappu" which was defined by Rao and Inbaraj (19) to signify hemolytic disease of the newborn, anoxia and hypoxia might also include some deaths due to tetanus[a]. In this experience, 174 deaths were classed as certain perinatal causes and the death rate of 36.6 per 1000 live births was high. Greater detail of the specific causes would aid in understandig their contribution to excessive neonatal mortality.

To illustrate the seriousness of immaturity data from two projects of the Inter-American Investigation are used, of Recife in Brazil and the California project of the United States. Immaturity can be considered the most important factor in vulnerability to disease and death in the neonatal period.

(a) This subject was discussed with Dr. Mark Steinhoff, a member of the Department of Child Health of C.M.C. Hospital in Vellore.

Table 15: Immaturity as Underlying or Associated Cause of Neonatal Mortality (a) In Two Projects of Inter-American Investigation of Mortality (16).

Immaturity	Recife Project			California Project		
	No.	Rate	Percent	No.	Rate	Percent
Total neonatal deaths	1,073	35.3	-	570	12.7	-
Total with immaturity	699	23.0	65.1	443	9.9	77.7
Underlying cause	59	1.9	5.5	19	0.4	3.3
Associated cause	640	21.1	59.6	424	9.5	74.4
Contributory	465	15.3	43.3	164	3.7	28.8
Consequence	175	5.8	16.3	260	5.8	45.6

(a) Per 1000 live births.

Neonatal mortality with immaturity as an underlying or an associated cause is given in the Table 15 in the two projects. Whenever immaturity was diagnosed as an associated pathological state in a neonatal death, efforts were made to establish the cause-effect relationship with other perinatal condition, that is, whether immaturity was a consequence of other causes or contributory to the fatal outcome. Over three-fourths (77.7 percent) of the neonatal deaths in the California project had immaturity as an underlying or associated cause. The percentage (65.1) was lower in Recife, However, in Recife the neonatal death rate for those with maturity of 23.0 per 1000 live births was over twice the comparable rate of 9.9 in the California project. The wide difference in these rates was found for those neonatal deaths in which immaturity was a contributory cause with the much higher rate in Recife. In a previous section of this document it was reported that the percentage of babies of low birthweight was around twice as high in Recife as in the California project. These problems and interrelationships of causes in early life deserve greater study.

In India, study of the interrelation of these causes of neonatal mortality are especially important. Cowan (44) stated that in Ludhiana, of 140 neonatal

deaths in the four year period 1977-1980, 58 or 41 percent were known to be of babies.
premature. The neonatal death rate in the schedule caste (44) was around three times that in the non-schedule caste. Actions directed to reduction in immaturity and thus mortality in this age period probably would also have a great impact on the health of infants surviving the first four weeks of life.

Analysis of mortality after the neonatal period in the two age groups 28 days-5 months and 6-11 months of age is particularly difficult because of limited data (Table 16 and 17)

Table 16: Mortality[a] of Infants from 28 days - 5 months Followed in Three Rural Centers of Ludhiana District in the Punjab (14) 1978-1980 and in Rural and Urban Areas of North Arcot District of Tamil Nadu (19) 1970-72, India, and Recife Project, Brazil (16).

Underlying Cause[b]	Ludhiana Three Rural Centers		Tamil Nadu, North Arcot Districts(c)				Recife, Brazil Project	
			Rural		Urban			
	No.	Rate	No.	Rate	No.	Rate	No.	Rate
All Causes	47	24.3	160	33.4	149	42.8	1,085	35.7
Diarrheal disease	17	8.7	33	6.9	55	15.8	729	24.0
Measles	-		6	1.3	2	0.6	20	0.7
Other infectious diseases	-		10	2.1	12	3.4	53	1.7
Nutritional deficiency	-		-		1	0.3	12	0.4
Diseases of respiratory system	8	4.1	3	0.6	6	1.7	178	5.9
Congenital anomalies	2	1.0	-		1	0.3	40	1.3
Certain perinatal causes	12	6.1	40	8.4	14	4.0	4	0.1
Other and unknown	4	2.1	66	13.9	57	16.4	44	1.4
External Causes	4	2.1	2	0.4	1	0.3	5	0.2

(a) Per 1000 live births

(b) According to 1965 Revision of International Classification of Diseases(6)

(c) Total include deaths, which were not included in the tables by causes of report (19), as due to other and unknown causes.

For age period 28 days - 5 months there were 47 deaths of infants followed in
of Ludhiana
three rural health centrers and the cause of death for 17 was diarrheal disease and for 8, diseases of the respiratory system. Twelve deaths were assigned to

certain perinatal causes and all but one of these deaths were said to be due to prematurity or low birthweight. The unsatisfactory condition of babies at birth continues to increase mortality after the neonatal period. Cowan[44] reported also that in the four year period, many of those dying from 28 days - 5 months were the low weight babies who survived the neonatal period.

In the experience of Palghar, likewise, the high death rate of 6.8 per 1000 live births from nutritional deficiency was probably due to the deterioration of the condition of babies of low birth weights.

In both rural and urban areas of the North Arcot District diarrheal disease was one of the leading causes of death. In the rural area, 40 deaths were assigned to certain perinatal causes of which 27 were "Chevvappu" and three were immaturity. Thus these perinatal causes which are usually causes in the neonatal period continued to be reported for even some of the infants as much as 3-5 months of age. In the North Arcot District the causes were ill-defined or unknown for around one-third of the deaths. In the Recife project around two-thirds (67%) of the deaths were due to diarrheal disease with an additional 16% to diseases of the respiratory system. However, measles was a cause of several deaths even in this period of early life, 6 in rural and 2 in urban North Arcot District and 20 in the Recife project.

In the Recife project of 606 of the 1,085 deaths in infants 28 days-5 months, nutritional deficiency was an associated cause and in 12 the underlying cause. Some of these deaths may have been of low weight babies at birth who did not have resistance to diseases. Of those dying of diarrheal disease, measles and other infectious disease, 62.7 percent had nutritional deficiency as the associated cause. Additional information from similar research in India would be valuable for study of the multiple causes of death.

The pattern in the six month age period 6-11 months was somewhat different (Table 17). In Ludhiana rural centers 29 of the 46 deaths were due to infectious diseases and slightly less than half of the deaths in the rural and urban areas of North Arcot District were due to infectious diseases. Of the deaths with causes known, diarrheal disease was the leading cause. Measles caused several deaths in these babies in all three areas of India included in this table as well as in the rural communities of Palghar. Deaths from measles are found to occur very early in life in developing countries.

For these four experiences in India the numbers of deaths from diarrheal disease are given in Table 18 with the average number per month for the two six months periods and for the 48 month age group, 1-4 years. In the rural community of Palghar there were on the average 9.8 deaths per month in the first six months of life and 5.0 in the later six months. In the other three experiences the averages were relatively similar for the two periods in infancy. However, they do indicate that even young babies are at risk of dying from diarrheal disease.

Table 17: Mortality[a] of Infants 6-11 months of Age Followed in Three Rural Centers of Ludhiana District in Punjab (14) 1978-1980 and in Rural and Urban Areas of North Arcot District in Tamil Nadu (19) 1970-1972, India and in Recife, Brazil Project (16) 1968-1970.

Underlying Cause[b]	Ludhiana Three Rural Centers		Tamil Nadu, North Arcot District (c)				Recife, Brazil Project	
			Rural		Urban			
	No.	Rate	No.	Rate	No.	Rate	No.	Rate
All Causes	46	23.5	95	20.0	80	23.0	615	20.2
Diarrheal disease	23	11.7	32	6.7	25	7.2	266	8.8
Measles	3	1.5	6	1.3	8	2.3	109	3.6
Other infectious diseases	-	-	11	2.3	5	1.4	36	1.2
Nutritional deficiency	3	1.5	-		-		35	1.2
Diseases of nervous system and sense organs	3	1.5	-		-		15	0.5
Disease of respiratory system	10	5.1	1	0.2	-		89	2.9
Congenital anomalies	-		-		1	0.3	16	0.5
Other and unknown	2	1.0	43	9.0	38	10.9	44	1.4
External Causes	2	1.0	2	0.4	3	0.9	5	0.2

(a) Per 1000 live births; (b) According to 1965 Revision of International Classificat

In India, breast feeding is probably provided by a high proportion of mothers. However, Cowan (44) said that good breast feeding was only possible with infants of normal birth weight and that the premature "has to contend with the battle of bottles, dilute dirty milk, diarrhea etc." In the Recife project where only 26.8 percent of the infants dying in the first year of life (exclusing the neo-natal period) were breast fed for one month or longer the death rate from diarrheal disease was very high in the first six months of life (28.8 per 1000 live births). While there were on the average 146 deaths per month of age during this period, the average was much lower for the next six months, (44). For the 48-month period, 1-4, years, on the average only 2.6 deaths from diarrheal disease occurred per month. These points are made to show the importance of oral rehydration programs, and education of the mothers regarding these procedures, for their babies in early life.

Table 18: Deaths from Diarrheal Disease with Averages Per Month in Infancy and Early Childhood in Rural Community of Palghar 1960-1965 (6), in Three Rural Centers of CMC Ludhiana District (14) 1978-1980, and in Rural and Urban Areas of North Arcot District of Tamil Nadu (19) 1970-1972, India and in Recife Project in Brazil (16) 1968-1970.

Age at death	Palghar Rural Community		Ludhiana Three Rural Centers		Tamil Nadu, North Arcot District				Recife, Braz Project	
					Rural		Urban			
	No.	Average per Month	No.	Average per Month	No.	Average per Month	No.	Average per Month	No.	Average per Month
Infant	89	7.4	49	4.1	69	5.8	113	9.4	1,141	95.1
0-5 months	59	9.8	26	4.3	37	6.2	58	9.8	875	145.8
6-11 months	30	5.0	23	3.8	32	5.3	55	9.2	266	44.5
1-4 years			11	0.2	90	1.9	34	0.6	127	2.6

Mortality in the 1-4 year age group is provided for the same three areas in Ludhiana and the North Arcot District and for Recife and El Salvador projects

of the Inter-American Investigation of Mortality. In this age period the death rate for the three rural centers in Ludhiana of 6.9 per 1000 estimated population was lower than in the other four experiences. As in other tables the number of deaths, 49, was small. However, the program of the community health workers of the Department of Community Health, of Christine Medical College in Ludhiana, as described by Cowan and Dharos (22), provides nutrition health education, immunizations and and family planning and is having an impact on mortality of these children called "toddlers" locally.

Table 19: Mortality [a] of Children 1-4 years of Age Followed in Three Rural Centers of Ludhiana District of Punjab(14) 1978-1980 and in Rural and Urban Areas of North Arcot District of Tamil Nadu(19) 1970-1972, India and in Two Projects of Inter-American Investigation of Mortality(16) 1968-1970.

Underlying Cause [b]	Ludhiana Three Rural Centers		North Arcot District (c)				Recife Project		El Salvador Project	
			Rural		Urban					
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
All causes	49	6.9	358	24.0	163	15.0	862	9.0	1,078	11.1
Diarrheal disease	11	1.6	90	6.0	34	3.1	127	1.3	501	5.2
Measles	8	1.1	37	2.5	36	3.3	267	2.8	116	1.2
Other infectious disease	1	0.1	29	1.9	20	1.8	124	1.3	114	1.2
Nutritional deficiency	5	0.7	-		-		100	1.0	137	1.4
Disease of nervous system and sense organs	1	0.1	1	0.1	1	0.1	39	0.4	22	0.2
Disease of respiratory system	8	1.1	2	0.1	-		129	1.3	54	0.6
Congenital anomalies	1	0.1	-		-		10	0.1	18	0.2
Other and unknown	12	1.7	191	12.8	67	6.1	36	0.4	82	0.8
External causes	2	0.3	8	0.5	5	0.5	30	0.3	34	0.3

(a) Deaths per 1000 population.

(b) According to 1965 Revision of International Classification of Diseases (6).

(c) Total includes several deaths, which were not included in the tables by causes of the report (19), as due to unknown causes.

The death rate of children 1-4 years of age in the rural area of the North Arcot District of 24.0 per 1000 population was the highest of the five areas; the diarrheal disease death rate was high as it was also in the El Salvador project which has a rural area. Soon after the beginning of the field work in the Investigation, many deaths from measles were evident in Recife. The early findings of high death rates from measles in the Recife and Bolivia projects led the Ministers of Health of the Americans (45) to recommend the establishment of vaccination programs against the disease throuhout the Americas. Vaccine was obtained for a massive program in Recife in the second year of the Investigation and thus without that program the death rate from measles in the 1-4 year old children would have been somewhat higher than the rate of 2.8 per 1000 population as given in the table. The death rates from measles of 3.1 per 1000 estimated population in the urban area and 2.5 in the rural area of the North Arcot District would appear to indicate that measles in those areas was also a serious health problem justifying an immunization program. Some of the deaths in the large ill-defined and unknown group might have been due to measles. In the Recife and El Salvador projects,deaths from tuberculosis, diptheria and whooping cough accounted for many deaths in the residual group of other infectious diseases. In the North Arcot District in the rural area, 17 of the 29 deaths due to other infectious diseases were caused by chickenpox. In the urban area, amaebic dysentery and whooping cough each caused five deaths.

In both rural and urban areas the high death rates for children 1-4 years of age were due to infectious diseases, of which some could be prevented by immunization and those due to diarrheal disease would require treatment by oral rehydration. Analyses of the contributory causes as well as the stated causes

of death would be needed to determine in how many the deficient nutritional state was responsible for susceptability to these infectious diseases. A method of study of the multiple causes is being proposed in order to know the role of immaturity as an important contributory factor in early infancy and nutritional deficiency in the older infants and young children.

In the rural areas of Ludhiana (44) many of the deaths were of the young children - especially of females - of the scheduled castes. For example, 73 percent of the females of the scheduled castes (44) who died in the six month period 6-11 months of age had severe malnutrition.

In Nutrition In India Swaminathan (46) states that even today malnutrition continues to be one of the major public health problems in the country. He reported that the peak prevalence of kwashiorkor was between the ages of 1-2 years but that for marasmus it was earlier. This is in accordance with the findings of the Inter-American Investigation of Mortality with the highest death rates from kwashiorkor in the second year of life and from marasmus as underlying or associated cause, of children 2-4 months of age.

Taylor and co-workers (48-50) carried out the Narangwal experiment on interactions of nutrition and infections in the Punjab and reported in a chapter in Nutrition In The Community (51) as follows:

> "At the start of our research, 25 percent of children showed second and third degree malnutrition. Between 1968 and 1971 an intensive nutritional and infection control programme caused a 50 percent reduction in child mortality and significant improvement in weight and height of study children as compared with control groups, but there was still 17 percent second and third degree malnutrition in the village children after two years of work."

In the Inter-American Investigation of Mortality the synergistic action of infectious diseases became evident (Table 20). Nutritional deficiency was an associated cause in 60.9 percent of the deaths from infectious diseases, as compared with only 32.7 percent of deaths from all other causes. These findings are in accord with previous research indicating the importance of the nutritional state of the host in the development of disease. Scrimshaw, Taylor, and Gordon (52) provided a comprehensive review of the interaction of nutrition and infection.

Table 20: Nutritional Deficiency as Associated Cause of Death Under 5 Years of Age (Excluding Neonatal Deaths) by Underlying Cause Group in Latin American Projects Combined (16).

Underlying cause group	Total deaths	Nutritional deficiency as associated cause	
		No.	Percent
All causes	21,951	10,349	47.1
Infective and parasitic diseases	12,598	7,667	60.9
Diarrheal disease	8,770	5,331	60.8
Measles	2,103	1,311	62.3
Other	1,725	1,025	59.4
Nutritional deficiency	1,163		
Diseases of respiratory system	4,469	1,435	32.1
Other causes	3,721	1,247	33.5

The seriousness of nutritional deficiency as a public health problem is well known in India. However, its specific effect on mortality under 5 years of age needs measurement. This is especially important for evaluation of intervention and food supplement programs as they are introduced. Thus this review of mortality under 5 years has shown the need for the initiation of programs for measurement of the effects of immaturity and nutritional deficiency on mortality. Recommendations are being made for incorporation of these procedures in the programs of health units of teaching centers of medical schools.

What is now known about nutritional deficiency as well as about low birth weight and immaturity would seem to indicate that the deficient nutritional state of populations is perhaps the most important cause of excessive mortality in developing areas. A kind of vicious cycle is established whereby mothers who have been handicapped since early life by nutritional deficiency and other environmental factors give birth to low-weight infants. Many of these infants die from infectious diseases because of their increased vulnerability. Measures to break this vicious cycle through adequate nutrition of future mothers and their offspring are mandatory in order to safeguard the health and intelligence of children.

SUMMARY

According to the Sample Registration System, in 1977, 47.0 percent of all deaths were of children less than 5 years of age; the percentage in the rural area of 48.6 was higher than in the urban area, 36.0 The 1971 Census showed that 14.4 percent of the population was less than 5 years of age.

The infant death rate in 1978 from the Survey of Infant and Childhood Mortality was reported to be 125 per 1000 population and the rate had not shown any appreicable decline in the recent past. The rural rate of 136 was nearly double the urban rate of 70 per 1000 population. The rates in the neonatal period, 76 in rural and 42 in the urban area, were very high. The estimated rate for the age group, 1-4 years, was 31 per 1000 population.

In the Survey on Infant and Childhood Mortality, tetanus was the leading cause of death in infancy in the rural area with the exceedingly high death rate of 22.7 per 1000 population. In the urban area, however, the death rate from tetanus was only one-fourth as high, namely, 5.0 per 1000 population and appeared as the second leading cause.

The death rate from diarrheal disease was obcained by combining three top causes, namely, dysentery, diarrhea and gastroenteritis. By this combination the death rate from diarrheal disease of 13.4 per 1000 ranked second to tetanus as a principal cause in the rural area and became the leading cause in the urban area, with prematurity second and tetanus third.

For children one year of age, by the combination of the three causes, diarrheal disease became the leading cause of death of children one year of age. The death rate of 5.6 was less than half the death rate of 13.4 per 1000 population in infancy, thus indicating the excessive mortality from diarrheal disease in infancy.

Infant death rates were obtained for 10 areas from eight studies; the rates in the six rural areas varied from 83.5 to 124.0 per 1000 live births and with one exception the rates were excessive in the neonatal period (51.0 to 60.5 per 1000 live births). Death rates were found to be very high in the first few days of life (under 7 days).

For three studies by staff of medical schools in India, deaths by age and cause were coded according to the 1965 Revision of International Classification of Diseases. Over half of the deaths in the neonatal period were due to certain perinatal conditions. The rates in these four experiences (of Palghar, Ludhiana and rural and urban areas of North Arcot District) varied from 25.5 to 36.6 per 1000 live births. Perinatal conditions as causes are very important for understanding the factors responsible for excessive neonatal mortality. Low weight births are the consequence of maternal infections and conditions and of other complications of pregnancy while for others, immaturity is a contributory cause. In the Ludhiana experience, eight deaths (rate of 4.1 per 1000 live births) were due to complications of pregnancy and two to condition of the placenta and cord. In the Palghar experience, 28 deaths were due to tetanus (rate 3.5 per 1000 live births); the immunization program of pregnant women was probably responsible for the lower rate in Ludhiana while in the North

Arcot District tetanus deaths may be reported as "chevvappu" which was stated to be hemolytic disease and anoxia and hypoxia.

Diarrheal disease caused nine neonatal deaths in the Ludhiana experience and the rate was similar to that in the Recife project. Although the number of deaths due to congenital anomalies was small, the relatively high rate in the Ludhiana experience indicates that further data should be obtained to clarify the problem.

In the age period of 28 days through 5 months, diarrheal disease, nutritional deficiency and bronchopneumonia were responsible for many of the deaths in Palghar causing relatively high rates. In other three experiences certain perinatal causes continued to be recorded as the cause of death and many of these were due to immaturity. Thus the causes responsible for mortality in the neonatal period continued to be responsible for mortality in this age period. The death rates from diarrheal disease were relatively high and a few deaths from measles were reported in these very young infants. For infants 6-11 months of age, diarrheal disease was the leading cause with high rates in Ludhiana and North Arcot District. Measles caused several deaths of these infants.

In the age priod 1-4 years, the death rate from all causes of 6.9 per 1000 population in Ludhiana rural health centers was low compared to the rural and urban rates of 24.0 and 15.0 per 1000 population in the North Arcot District. The lower mortality in Ludhiana is probably due to the health services provided in that area. The death rates from measles in the North Arcot District in this age period (as well as a few deaths in infants) and by other considerations of Indian material indicate that

an immunization program is advisable.

Since pneumonia is often the terminal condition, the importance of measles as the underlying cause probably is not known in India. In the North Arcot District the causes of many of the deaths were fevers and other ill-defined causes.

The seriousness of nutritional deficiency as a health problem is well known in India. However, its specific effect on mortality under 5 years of age needs measurement which would require study of the multiple causes of these deaths.

According to the Report of the Working Group on Health for All by 2000 AD, at present, 30 percent of live births in India had birthweights below 2500 gm. In two studies, one a longitudinal study of the outcome of a birth cohort in New Delhi, and the other a community survey in the North Arcot District of Tamil Nadu State, the distribution of babies by birth weights revealed high frequncies of low-weight babies. In the New Delhi study, 23.0 percent of the babies weighed 2500 gms or less while in the survey in the North Arcot District the percentage was higher, namely, 31.9. In two projects of the Investigation used for comparisons, the percentages were lower, 14.6 in Recife, Brazil and 7.6 in the California project in U.S.A. The distribution varied markedly and those in India were skewed to the left - to low birth weights - and very few births in India were found in the most favorable weight groups, 3501-4000 gms. in which mortality is lowest. Higher proportions of the babies of young mothers (under 20 years) had low birth weights than did those of the older mothers.

Two Indian studies, one of neonatal mortality by age of mother in the rural community of Palghar and the other of infant mortality for an urban area of Greater Bombay showed that the death rates were very high for babies of young mothers under 20 years which of course is due to the high frequencies of low weight babies of young mothers.

The studies in India indicate the need for assignment of underlying causes according to the International Classification of Diseases in order to gain a better understanding of the causes of neonatal mortality and comparability of results. A WHO Center for Classification is proposed to be established in India to serve Southeast Asia. Also a method of study of underlying causes with immaturity and nutritional deficiency as associated causes has been recommended to begin with data in Ludhiana for five years, 1977-1981 and to be extended to other teaching centers. Such studies will not only serve for measurement of the effect of immaturity and nutritional deficiency on mortality but also for evaluation of intervention and food supplementation programs. They would be the foundation of a satisfactory vital statististics system.

Also standard procedures are recommended to collect and analyze comparable data on birthweights for similar assessment and evaluation in health programs. Increases in birthweights are essential for any major reduction in mortality in infancy and early childhood.

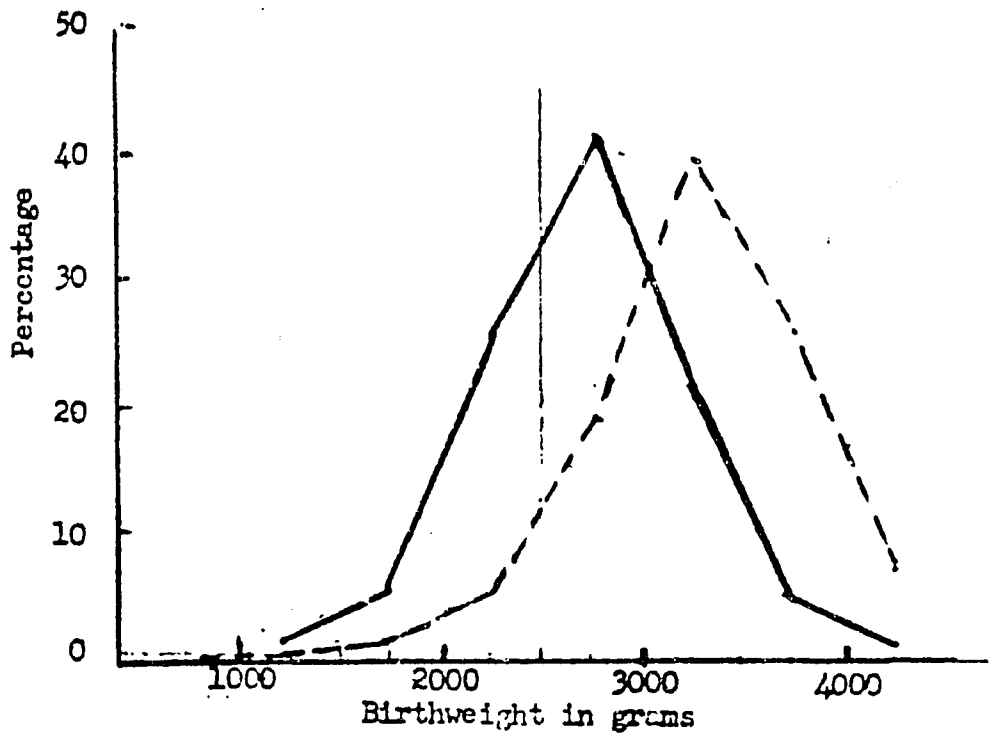
Appendix Table A. Deaths in Infancy and in Children under 5 years of age in Health Centers of C.M.C.Ludhiana District (14) of the Punjab, 1978-1980, in Areas of C.M.C North Arcot District of Tamil Nadu (19),1970-1972,in Health Center of Ballabgarh (9),1975, in Health Unit of Palghar (8), 1960-1965,India and in Two Projects of the Inter-American Investigation of Mortality (16)1968-1972.

Age Group	Ludhiana Three Rural Centers	North Arcot District		Ballabgarh Primary Health Center Rural	Palghar Rural Health Unit	Inter American Investigation of Mortality	
		Rural	Urban			Recife Brazil	California USA Proj
Under 5 years	243	901	544			3,635	898
Infant (-1 yr.)	194	543	381	141	677	2,773	784
Neonatal (-27 days)	101	288	152	78	353	1,073	570
Under 7 days	71	193	102	42	233	769	496
Under 1 day	26	48	35	22	86	357	327
1-6 days	45	145	67	20	147	412	169
7 - 27 days	30	95	50	36	120	304	74
28 days - 5 months	47	160	149)	63	203	1,085	161
6 - 11 months	46	95	80)		121	615	53
1 - 4 years	49	358	163			862	114

(a) For one year

Appendix B

Percentage Distribution of Births by Birthweight in North Arcot District of Tamil Nadu State, India and in California Project, U. S. A.



REFERENCES

1) Ministry of Health and Family Planning, Government of India, Health for All by 2000 A.D. Report of the Working Group, 25th March, 1981.

2) United Nations, Demographic Yearbook New York 1979.

3) Padmanabha, P. Use of sample registration system for studying levels, trends and differentials in mortality - the Indian experience. Paper for UN/WHO Working Group on Data Bases for Measurement of Levels, Trends and Differentials in Mortality, Bangkok, 1981.

4) Office of the Registrar General, Ministry of Home Affairs, New Delhi, India. Survey of Infant and Child Mortality 1979 - A Preliminary Report.

5) United Nations, Department of Economic and Social Affairs "Poverty Development, and Policy Development - A case study of selected issues with reference to Kerala." New York, 1975 p. 134.

6) World Health Organization, International Classification of Diseases Eighth Revision, Geneva, 1967.

7) World Health Organization, Nomenclature Regulations, Official Records No. 13, Geneva, 1948 (included on pages 475 - 477 of International Classification of Diseases (6) of the World Health Organization.

8) Shah M. and P.M. Udani , Analysis of the vital statistics from the rural community, Palghar - II Perinatal, neonatal and infant mortalities Indian Pediatrics Vol. 6 No. II Oct. 1969.

9) Reddaiah, V.P. and L.M. Nath, Infant mortality in rural areas of comprehensive rural health services project, Ballabgarh, Indian Pediatrics, 15 No. 7, Pages 547 - 551 July 1978.

10) Srinivasa D.K, M. Danabalan, M. Gnanasujayam, G.N. Prabhakara and D. Anand, Influence of maternal care parity and birth weight on neonatal mortality - A prospective study in an urban community - Indian J. Med. Res. 64,3, March 1976.

11) Ghosh S.T.K., T.S. Ramanujacharyula, V. Hooja and S. Madhavan, Mortality pattern in an urban birth cohort. Indian J. Med. Res. 69 April 1979, Pp. 616 - 623.

12) Kielmann, A.A., C.E. Taylor, C. De Sweemer, I.S. Uberoi, H.S. Tabulia, N. Masih and S. Vohra, The Narangwal experiment on interactions of nutrition and infections, II Morbidity and mortality effects. Indian J. Med. Res. 68 (Suppl.) Dec. 1978 pp 21 - 41 from table II.

13) Rao P.S.S. and S.G. Inbaraj, A prospective study of infant mortality and congenital malformations in relation to intra-uterine growth rates in South India. Indian J. Med. Research 67, Feb. 1978, pp 245 - 254

14) Christian Medical College and Brown Memorial Hosp. Ludhiana, Punjab Community Health Department, Ninth Annual Report, 1980, for 1979 and 1980; 1978 data was compiled by Staff of Dept. of Community Health of Christian Medical College.

15) Gupta, S.D., T.P. Jaia, S. Joshi and D.K. Mangal, Infant mortality in Rajasthan villages. Indian Pediatrics, 18, Feb. 1981, pp 101 - 105.

16) Puffer R.R. and C.V. Serrano. Patterns of Mortality in Childhood, Pan American Health Organization, Scientific Publication, 262, Washington, DC, 1973.

17) Shah P.M., P.M. Udani and K.P. Shah, Analysis of the vital statistics from the rural community, Palghar - I: Foetal wastage and maternal mortality. Indian Pediatrics Vol. 6. No. 9 Sept. 1969.

18). Thomas, S.P., B. Cowan and H.S. Grewal, Reaching the unreached through the state health system in Punjab. (Unpublished document).

19) Rao, P.S.S. and S.G. Inbaraj, Perinatal, infant and early childhood mortality in North Arcot District of Tamil Nadu, India, Longitudinal Studies in Human Reproduction, Monograph No.6, Christian Medical College, Vellore, 1973.

20) Shapiro, S., E.R. Schlesinger and R.E.L. Nesbett Jr. Infant, Perinatal, Maternal and Childhood Mortality in the United States. Harvard University Press, Cambridge, Mass 1968.

21) Nunes R.M., Estudo e. acoes sobre reproducao humana enutricao em Recife Boletin de la Oficena Sanitaria Panamericana - Oct. 1976 p- 304 - 312.

22) Cowan, B. and J. Dhanoa, The Prevention of Toddler Malnutrition by Home-based Nutrition Health Education. Chapter to be published in next edition of Nutrition in the Community (23).

23) Mc. Laren, D.S. Nutrition in the Community, John Wiley & Sons, London, 1976.

24) World Health Organization, The incidence of low birth weight, a critical review of available information. World Health Statistics Quarterly Vol. 33, No.3 1980.

25) Ghosh S., S.K. Bhargava and I.M. Moriyama, Longitudinal Study of the Survival and Outcome of a Birth Cohort Vol. II. Dept. of Pediatrics, Safdarjang Hospital, New Delhi.

26) Rao, P.S. and S.G. Inbaraj, Perinatal, infant and early childhood mortality, Longitudinal studies in Human Reproduction, Monograph No. 6 Vellore, India 1973.

27) World Health Organization, International Classification of Diseases, Ninth Revision, Geneva, 1977.

28) Puffer, R.R. and C.V. Serrano, Birthweight, Maternal Age, and Birth Order, Three Important Determinants in Infant Mortality, Pan American Health Organization, Scientific Publication No.294, Washington DC, 1975.

29) Wallace H.M., H. Goldstein, V. Eisner and A.C. Oglesby, Patterns of mortality in infancy and early childhood in California project. Bulletin of Pan American Health Organization, Vol. 9, No. 1, 1975, p 32-38.

30) Chase H.C., A Comparison of Neonatal Mortality from Two Cohort Studies, National Center for Health Statistics, Series 20 No. 13, United States Dept. of Health, Education and Welfare, Washington D.C. 1972.

31) Kessner, D.M, J. Singer, C.E. Kalk and E.R. Schlesinger, Infant Death: An Analysis by Maternal Risk and Health Care, Washington, National Academy of Sciences 1973.

32) Loeb, J. Weight at Birth and Survival of Newborn. by Age of Mother and Total Birth Order, National Center for Health Statistics, Series 21, No.5 U.S. Department of Health, Education and Welfare, Washington DC, 1965.

33) Ruzicka L.T. and T. Kanitkar, Infant mortality in an urban setting: The case of Greater Bombay. Data published by Vaidyanathan (34).

34) Vaidyanathan K.E., Studies of Mortality in India Grandigram Institute of Rural Health and Health Planning, 1972.

35) Srinivasan K., P.C. Saxena and T. Kanitkar, Demographic and Socio-economic Aspects of the Child in India, Himalayas Publishing House, Bombay, India 1979.

36) United States National Academy of Sciences, Maternal Nutrition and the Course of Pregnancy, Washington 1970.

37) Walsh J., Integrated maternal and child nutrition project. Research Pricrities for increasing birth weights of Indians. Report to USAID/India April, 1981.

38) Indian Council on Medical Research, Maternal Malnutrition: Its effects on foetal nutrition, ICMR Bulletin, Vol. 7, No. 12 Dec. 1977.

39) Lechtig A., J.P. Habicht, H. Delgado., R.E. Klein, C. Yarbrough and R. Martorell, Effect of food supplementation during pregnancy on birthweight Pediatrics 56 (4): 608 - 520, 1975.

40) Birch H.G. Malnutrition, learning and intelligence. Am. J. Public Health 62: 773 - 784, 1972.

41) Gordon J.E., I.D. Chitkara, and J.B. Wyon. Weanling Diarrhea Am.J. Med. Sci., 245; 345 - 377, 1963.

42) J.E. Gordon, S. Singh and J.B. Wyon, Causes of death at different ages by sex and by season in a rural population of the Punjab, 1957 - 1959, a field study. Ind. J. Med. Research 53, 9, Sept. 1965, pp 906 - 917.

43) World Health Organization, International Classification of Diseases, Seventh Revision Geneva, 1957

44) Cowan B. Proposal for Reducing Child Mortality (Personal Communication)

45) Pan American Health Organization, Special Meeting of Ministers of Health of the American. Official Document 89, Washington, D.C. 1969.

46) Swaminathan, M.C., Nutrition in India, chapter 28 of Nutrition in the Community (48) edited by D.S. Mclaren

47) Mc Laren D.S., Nutrition in the Community John Wiley & Sons London 1976.

48) C.E. Taylor, A.A. Kielmann, C. DeSweemer, I.S. Uberoi, H.S. Takulia, C.G. Neumann, W. Blot, H. Shankar, S. Vohra, G. Subbulakshmi, R.S.S. Sarma, R.L. Parker, C. McCord, N. Masih , D. Laliberte, S. Kielmann, D.N. Kakar and A. Forman., The Narangwal experiment on interactions of nutrition and infections: 1. Project design and effects upon growth. Indian J. Med. Res. 68 (Suppl), December 1978 p 1 - 20.

49) A.A. Kielmann, C.E. Taylor, C. DeSweemer, I.S. Uberoi, H.S. Takulia, N. Masih and S. Vohra, The Narangwal experiment on interactions of nutrition and infections : II. Morbidity and mortality effects. Indian J. Med. Res. 68 (Suppl), Dec. 1978, p 21 - 41.

50) R.L. Parker, C.E. Taylor, A.A. Kielmann, A.K. Srinivasa Murthy and I.S. Uberoi. The narangwal experiment on interactions of nutrition and infections :III. Measurement of services and costs and their relation to outcome. Indian J. Med. Res. 68 (Suppl), Dec. 1978 p 42 -

51) Taylor C.E. and E.M. Taylor, Multifactorial Causation of Malnutrition, Chapter 7 in Nutrition in the Community (47).

52) Scrimshaw, N.S.C.E. Taylor and J.E. Gordon, Interactions of Nutrition and Infection World Health Organization, Monograph Series No. 57, Geneva, 1968.