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Socio-Economic Determinants of Infant and Child Mortality in Sri Lanka: An Analysis of Post-War Experience

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PUTTĀ VATTHU MANUSSĀNAM

Children are the assets of mankind

(Buddha, Samyutta Nikaya 1.37)

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S.A. Meegama

Preface

The Sri Lanka Fertility Survey was conducted in 1975 by the Department of Census and Statistics, in association with the World Fertility Survey and the International Statistical Institute. The First Report, published in March 1978, contains a wealth of information concerning nuptiality, fertility, fertility preferences, and contraception. In accordance with WFS recommendations, however, relatively little attention was given to infant and child mortality because it was considered that a careful evaluation of the quality of data should precede the exploration of this important topic.

Dr. Meegama, who was National Director of the Sri Lanka Fertility Survey, has now redressed the balance in this detailed and ingenious study of the socio-economic determinants of infant and child mortality. He has exploited several data sources on this subject, but the main analysis is based on the fertility survey data. The report represents a major improvement in our understanding of childhood mortality in Sri Lanka and the results will be of great interest not only to demographers and medical practitioners, but to a wide range of policy-makers and administrators.

Dr. Meegama's study of mortality is the first on this subject to be published by the WFS and has demonstrated the great potential of the WFS data in this respect. I look forward to further studies on the data sets of other countries.

Sir Maurice Kendall
WFS Project Director

1 Introduction

The mortality decline in Sri Lanka in the immediate post-war years is well-known to demographers, both because of its rapidity and the controversy concerning its aetiology. However, this knowledge has not led to a detailed investigation of differentials in infant and child mortality, or of the causes of such differentials. To some extent, this neglect reflects a lack of information about mortality in terms of socio-economic variables, but it also reflects the lack of specialized surveys relating mortality to environmental factors and to other variables, such as the availability and use of health services.

In 1975, Sri Lanka conducted a fertility survey – as part of the World Fertility Survey – that makes it possible, for the first time, to analyse infant and child mortality trends and differentials in relation to a wide range of background variables. This survey also provides data for estimates of mortality trends among different groups of the population, estimates that cannot be made from vital registration data.

Published visual registration figures provide information on infant and child mortality, by place of residence, and on neonatal and post-neonatal mortality aggregated for the whole country but not by place of residence. Data from the fertility survey can be classified by place of residence as well as by other variables, such as father's occupation, mother's level of literacy, mother's age at time of birth of child, birth order, and facilities available to the household, particularly with reference to the type of toilet facilities.

1.1. INFANT MORTALITY

The Registrar General's statistics on infant mortality represent an approximate starting point for this study. Infant mortality (Table 1) in Sri Lanka fell by over 60 per cent between 1940 and 1960. Neonatal as well as post-neonatal mortality showed correspondingly large declines during this period, and has continued its decline during the last fifteen years at a slower rate, although there have been slight rises in some years. There are, however, indications of fluctations in infant mortality among more exposed groups in the population (Table 2).

In the years after 1950, mortality in the plantations (generally called estates) shows these fluctuations most clearly. On the other hand, there is a steady continuous decline in the aggregated figures for non-estate infant mortality. However, registration figures do not permit the study of mortality trends among the poorer groups in the non-estate population.

Fluctuations in childhood mortality generally indicate instability either in environmental conditions or in the availability of food. For example, deaths from gastro-enteritis and other diarrhoeal diseases could increase in some years depending upon the type of sanitary facilities available, the source of drinking water and their interaction with the weather. A household which has no lavatory and which obtains its drinking water from an unprotected well will face hazards which will change from year to year. Such fluctuations in mortality will also generally appear among populations where food supplies are dependent on rain-fed cultivation which is much more exposed to crop failure than irrigated lands. Fluctuations due to malnutrition or under-nutrition could also appear in the estates where the chance of procuring daily employment depends upon the vagaries of demand in the world markets. Sometimes the world price is less than the cost of production, whereupon there is an immediate impact on the employment market and work becomes very scarce.

Table 1 Infant Mortality in Sri Lanka: 1940–1974
(Deaths Per 1000 Live Births)

Year	Neonatal	Post-Neonatal	Total Infant
1940	86.3	62.7	149
1941	76.8	52.2	129
1942	71.0	59.0	120
1943	73.2	58.8	132
1944	73.4	61.6	135
1945	75.5	64.5	140
1946	75.7	65.3	141
1947	58.8	42.2	101
1948	52.6	39.4	92
1949	49.9	37.1	87
1950	46.9	35.1	82
1951	47.9	34.1	82
1952	46.3	31.7	78
1953	42.6	28.4	71
1954	43.1	28.9	72
1955	42.3	28.7	71
1956	40.6	26.4	67
1957	39.2	28.8	68
1958	37.3	26.7	64
1959	33.6	24.4	58
1960	34.2	22.8	57
1961	31.7	20.3	52
1962	32.5	20.5	53
1963	33.5	22.5	56
1964	34.3	22.7	57
1965	33.3	19.7	53
1966	34.6	19.4	54
1967	29.2	18.8	48
1968	31.0	19.0	50
1969	32.0	21.0	53
1970	29.7	18.3	48
1971	29.7	15.3	45
1972	30.3	15.7	46
1973	29.9	16.1	46
1974	29.1	21.9	51

Source: Administration Reports of the Registrar General of Ceylon on Vital Statistics, Department of Census and Statistics. Bulletin on Vital Statistics, 1976.

Because figures relating to infant mortality in the country as a whole are averages of those for different groups which might have different levels and trends, there is also a need to identify those groups in the population whose mortality has shown a consistent decline, those whose levels have been reasonably stable, and those whose mortality has increased.

Identification of such groups in the population assists

Table 2 Infant Mortality in Estate and Non-Estate Areas of Sri Lanka: Selected Years

(Deaths Per 1000 Live Births)

Year	Estate*	Non-Estate	Non-Estate as Per Cent of Estate
1930	194	172	89
1931	184	154	84
1940	149	149	100
1941	119	131	110
1950	108	79	73
1951	109	78	72
1955	115	66	57
1956	115	62	54
1960	100	52	52
1961	92	48	52
1965	94	49	52
1966	95	51	54
1971	93	41	44
1972	97	41	42
1973	103	42	41
1974	163	43	26
1975	102	41	40
1976	110	n.a	n.a

* Statistics for the estate population are not available prior to 1951; the figures from 1930 to 1950 refer to Indian immigrant labour on estates, and this labour accounts for approximately 85 per cent of the estate population.

Source: Administrative Reports of the Registrar General and unpublished data from the Department of Census and Statistics.

the health planner to provide special services to those groups who are handicapped, both with regard to nutrition and health care. Identification of groups whose mortality has changed (whether it be an increase or a decrease) also provides clues as to the causes which led to such changes. A health planner not only needs to identify those vulnerable groups in the population who have higher mortality levels, but, if his policies are to have a successful impact on lowering mortality levels, he also needs to seek the factors which lead to such differentials.

Cause of death statistics may sometimes be difficult to interpret even when the causes of death are certified by qualified medical practitioners. Where many deaths are registered without the opinion of an experienced medical practitioner the difficulties are greatly increased. To some extent in the case of infant and child mortality there are features of the statistics which help identification of the causal structure. For example, the age pattern of mortality in childhood is in general a useful pointer to the causes of mortality. The Fertility Survey provides information on:

a) Neonatal Mortality (i.e. deaths in the first month)
b) Post-Neonatal Mortality (i.e. deaths of infants aged 1-12 months).
c) Mortality of children aged 1 to 2 years and those aged 2 to 5 years.

The age pattern of mortality in the first year of childhood, according to published figures as seen in Table 3, is significantly different in Sri Lanka from patterns in some developing countries which have fairly reliable vital registration systems.

Except for Taiwan, the figures in Table 3 relate to countries which now have broadly similar levels of total infant mortality, but in Sri Lanka the proportion of all infant deaths which occur in the first week of life is much higher than elsewhere, indicating either the presence of particular problems in Sri Lanka or, on the other hand, reflecting differentials in coverage of registration systems during the first few days of life. In an interesting study of infant mortality in Taiwan, Sullivan[1] argues that the low neonatal rate is due to heavy under-reporting of deaths. This conclusion is based on a comparison of mortality in Taiwan with that in several European countries when their infant mortality was around a similar level. All of them reported much higher neonatal rates than did Taiwan. To assume that Taiwan or any other developing country should have an age pattern of infant mortality similar to those European countries at an earlier stage may not be entirely correct. The factors which influence neonatal mortality vary from country to country, and it is possible that the factors affecting neonatal mortality in Europe at that stage were different. Further evidence from the developing countries which have low rates is needed to arrive at a definitive conclusion. There is also no reason to believe that neonatal registration is better in Sri Lanka than in other countries, so, on balance, the data suggest that deaths in the first month of life are more prevalent in Sri Lanka.

[1] Sullivan, Jeremiah M., A Review of Taiwanese Infant and Child Mortality Statistics 1961–68. The Institute of Economics, Acadamica Sinica – Population Papers, February 1973, pp. 113-165.

Table 3 Age Pattern of Infant Mortality in Selected Countries

Country	Total Infant Mortality (Per 1000 Live Births)	Rate as Per Cent of Total				Total
		7 Days and Under	Over 7 Days to 28 Days	Over 28 Days to 6 Months	Over 6 Months to 1 Year	
Sri Lanka* 1971	44.9	48	18	23	11	100
Costa Rica 1972	44.8	33	14	34	19	100
Taiwan 1966	21.7	21	19	34	26	100
Portugal 1973	44.8	32	15	37	16	100
Mexico 1966	62.9	23	14	38	25	100
West Malaysia 1965	50.0	34	19	31	16	100

Source: Estimate from U.N. Demographic Year Books.
*Sri Lanka figures refer to the period over 1 week and under 1 calender month, and over 1 calender month and under 6 months.

1.2 CHILD MORTALITY

Child mortality in Sri Lanka has shown a continuous decline through this period. However, estate child mortality based on registration figures cannot be estimated because the published census reports do not provide information on the age structure of the estate population.

Table 4 Age Specific Mortality* of Children One to Four Years of Age: Census Years (Deaths Per 1000)

Census Year	Rate
1953	18
1963	9
1971	6

* No correction has been made for under-enumeration at the censuses.
Source: Department of Census and Statistics, Sri Lanka

1.3 THEORETICAL FRAMEWORK OF THE STUDY

A framework for the analysis of infant and child mortality must take into account several factors which influence and determine the level of mortality. These factors can be broadly classified as follows:

a) Demographic
b) Economic and Political
c) Environmental
d) Medical amd Health Care
e) Cultural
f) Geographic

1.3.1 DEMOGRAPHIC FACTORS

These can basically be divided into two classes. The first refers to those demographic factors which affect the health of the mother to the extent of exposing her offspring to a higher risk of infant mortality. They are the age of the mother, the birth interval, and the birth order of the child. The second class of variables refers to the sex and age of the child. There are significant differentials in mortality at different stages of childhood, and there is a need to analyse separately, peri-natal*, neonatal, post-neonatal, and child mortality.

1.3.2. ECONOMIC AND POLITICAL FACTORS

The above factors can broadly be divided into two groups, one operating at the macro level and the other at the household or family level. The macro level variables represent the economic level of the country. Has it the resources to have a well-spread and accessible network of ante- and post-natal clinics, maternity homes, trained midwives and health care centres, such as rehydration units? It means not only the availability of such services but also the capacity to invest in a well-spread network of roads and cheap public transport systems. Without such a network it is not possible to move the sick to hospitals, or to transport food to deficit areas especially during times of crop failures. This macro level variable also affects the general educational level of the country. This in turn affects the level of understanding of mothers, and would-be-mothers, and their ability to follow and understand not only the instructions given by health workers, but also their ability to realize when a child should be taken to hospital.[2]

Despite the importance of investment in such health care systems and public utilities, there also has to be the political will to divert ever scarce funds for such social welfare needs. Indeed it is not uncommon for some of the richer Third World countries to be much more deficient in providing such facilities than some of the poorer countries.

In micro-economic terms the economic level of the household or family can greatly influence the health of the children. It can determine whether a pregnant woman has sufficient food during the ante-natal period, which in some cases could determine the number of infants born suffering from immaturity and debility. Similarly, economic well-being could be important in providing adequate food to children after the neonatal stage, especially important among groups where there is early weaning.

Even in those few Third World countries which have reasonable health care systems, economic well-being could determine whether a family could hire transport to take either a woman in labour or a sick child to hospital in time. Transport is important in Sri Lanka where most ambulances are old, poorly maintained or broken. Even the ambulances which are in working condition are available generally only in urban areas. Where public health care systems are weak, the family's economic situation would determine whether it could afford private health care services from private general practitioners, dispensaries, or even hospitals. Economic well-being is also one of the factors determining the level of sanitation as well as that of the availability of uncontaminated drinking water at the community and household levels.

1.3.3 ENVIRONMENTAL FACTORS

Many of the deaths in the first five years of life, especially in the Third World, are due to infections spread by environmental factors. One of the main causes of death during this period of life is diarrhoeal diseases, including gastro-enteritis. The incidence of this disease depends mainly on two factors: the availability and use of hygienically constructed lavatories and the availability of uncontaminated drinking water. Insanitary lavatories or the absence of lavatories leads to the breeding of flies and to the transmission of disease either through food taken by the child or by the flies settling on or near the mouth of an infant. Similarly, insanitary conditions can lead to the contamination of drinking water. This is especially so in those parts of rural Asia where drinking water is drawn from wells which are just without any protective walls.

1.3.4. MEDICAL AND HEALTH CARE FACTORS

These can have an effect from the very first day of life of a child. For example, an untrained midwife, or what is commonly known as a traditional midwife, could, by using unsterilized instruments to cut the umbilical cord, cause a number of infant deaths through resulting neonatal tetanus.

The lack of ante-natal and post-natal clinics could have an effect on mortality due to two different causes. An anaemic woman, or one who suffers from special problems, such as the RH factor, or a woman who needs a caesarian operation would benefit by attendance at ante-natal clinics since their condition could then be diagnosed and treated. The absence of post-natal clinics could mean a lack of adequate guidance in post-natal care and hygiene so that even well-intentioned mothers could make fatal errors. For example, the mother might feed a child condensed milk from a tin kept open for several days, with flies having uncontrolled access to settle and infect the milk.

In the Third World, where so many children die from respiratory and diarrhoeal infections, simple medical treatment could save many lives. In the case of most respiratory

* Peri-natal mortality cannot be calculated for Sri Lanka since the data on still births are unreliable at the national level.

[2] See Benjamin, Bernard. The Effects of Education on Mortality in Education and Population – Mutual Impacts Dohain (Belgium), for a discussion of the impact of education on infant mortality in England and Wales, pp. 171-173.

diseases, the availability of cheap antibiotics could drastically reduce death rates, while in the case of serious diarrhoeal diseases, access to a rehydration centre could also mean the saving of many lives. Indeed Dr. M.G. Candau, Director General of WHO in 1971, commented on the most serious of the diarrhoeal diseases,

> 'Today cholera is one of the most rewarding diseases to treat; no patient with uncomplicated cholera arriving at the treatment centre with his heart beating should die. A moribund case of cholera given proper intravenous rehydration should be quite comfortable in a few hours time, and recovery is complete with no sequelae. In most of the well-organized treatment centres, the case fatality varies from one per cent to three per cent. A higher fatality is mostly due to delay in bringing the patient to treatment centres. It is relatively high in children below five years, being between five per cent and eight per cent'.[3]

But as Dr. Candau comments, the figures reported to WHO show very high fatality rates, ranging from 20 to 30 per cent, since in many countries in the Third World modern treatment in the form of rehydration centres is not easily available, particularly in rural areas.

1.3,5 CULTURAL FACTORS

Cultural factors can also have an effect on mortality[4]. Even among groups in the population where women do not go out to work, the custom of early weaning could lead to serious problems, especially among the poorer groups in the population. In such cases the child could be fed infected food or food which has little or no nutritional value. In such instances, children suffering from malnutrition or under-nutrition are an easy prey to other diseases.

1.3.6 GEOGRAPHIC FACTORS

Even given all other factors are constant, geography can have an effect on mortality. Extreme climatic conditions where it is very cold or where there is very heavy rain can lead to higher mortality mainly due to an increase in the incidence and severity of respiratory diseases. In the estates of Sri Lanka where infant and child mortality has remained at significantly higher levels than in the rest of the country, there are substantial differences in mortality between districts which are cold and those where the climate is less extreme. As Table 5 indicates, infant mortality in estates in the colder Nuwara Eliya district is substantially higher than in Badulla district where the climate is mild.

Table 5 Infant Mortality in the Estate Sector, by District

(Deaths Per 1000 Live Births)

Year	Nuwara Eliya	Badulla
1966	102	70
1973	103	88
1975	99	82

Source: Report of the Registrar General of Ceylon on Vital Statistics, and unpublished material with the Department of Census and Statistics.

It is, of course, possible that this differential is due to other causes, but it is large enough to merit further detailed investigation, though the present study does not attempt this.

The heterogeneity in economic conditions by geographical zones in Sri Lanka also provides clues regarding the causes determining mortality levels. This is clearly illustrated in a comparison of mortality differentials between the Urban, Rural, and Estate sectors. The estates, or plantations, have much higher infant and child mortality than the rest of the country, according to both the Registrar General's figures and the survey estimates. A geographical classification which yields such significant mortality differentials can be the first step in the search for the factors which are the cause of high mortality. Thus, the probability of an infant or a child dying in an estate is higher, but this is due to specific factors discussed earlier: demographic, environmental, medical, cultural, or economic. The question is to attempt to determine which of the above causes are significantly related to mortality in that particular area.

1.4 CONCEPTUAL AND METHODOLOGICAL PROBLEMS IN THE SEARCH FOR CAUSES

Leaving aside questions of defective data and memory lapses involved in analysing retrospective survey data, there are also several conceptual problems which have to be taken into account in interpreting relationships derived from such data. In the search for causes using the Fertility Survey data, it must be noted that data on place of residence and on all background variables relating to socio-economic and environmental factors refer to conditions prevailing in 1975, while the mortality data essentially consist of deaths pooled over a twenty-five year period.

In causal analysis, one method of handling the data consists of searching for significant correlations between mortality rates and all possible explanatory variables available from the survey data. Another method consists of constructing a model according to the existing state of knowledge concerning the causes of mortality. In the case of infant and child mortality, the causes are broadly known, but the quantitative effect of each causal factor differs from country to country, from area to area, and between social classes within a country. Essentially the method of analysis used in this study has been to test the validity of the models constructed on the basis of this knowledge, for different age groups, by examining whether there are significant correlations between mortality rates and the explanatory variables described in the model.

One major problem which arose was the identification of suitable indicator variables to represent the causal factors denoted in the model. The WFS questionnaire was primarily designed to study fertility. Some of the key variables which could affect the level of mortality were not covered in the survey and have to be represented by substitute indicators. In other instances, causal factors have not been taken into account at all in the analysis, since even substitute indicators are lacking.

A search for causes always faces the problem of multicollinearity or correlation between explanatory variables which complicates the disentangling of the individual effects of each of the explanatory variables. In this study this problem surfaces at many points. For example, the lack of toilet facilities can have an effect on mortality levels by increasing the risk of contacting diarrhoeal diseases, but households which lack toilet facilities are also nearly all from the lower social classes who live at a sub-

[3] Candau, Dr. M.G., The Seventh Cholera Pandemic, *WHO Chronicle*, 25 (1971), p. 158.

[4] Benjamin B., Social and Economic Factors in Mortality Mouton. The Hague, 1965.

sistence level and where children and pregnant women suffer from malnutrition, which also leads to higher mortality. The method of analysis used here attempts to separate the individual effect of each of these causes.

1.5 DATA AND THE METHOD OF ANALYSIS

The analysis is based on approximately 25.000 live births born in the period 1948 to 1974 to the ever-married women aged less than 50 years who were interviewed in the Fertility Survey sample. Although this cohort of women had a few hundred births and a few infant and child deaths before 1948, it was decided to take 1948 as a cut-off point , as malaria was a major cause of death in the years before 1948, but of much less importance since that date.

The analysis of neonatal and post-neonatal mortality was based on the number of deaths of children born in the period 1948 to 1974. Of the 1948 cohort of births, deaths in the neonatal and post-neonatal stage would have occurred in both 1948 and 1949, and from these data the neonatal and post-neonatal mortality rate for 1948 could be calculated. This procedure applies for succeeding years until the cohort born in 1973.

Exposure to risk of the 1974 births is incomplete because the survey was conducted in July-August 1975, and consequently those deaths of the 1974 birth cohort which occurred in the months of 1975 after July-August would not be included. The error due to this omission is extremely small since mortality data even on the births of December 1974 through the first six months of 1975 would have been recorded in the survey. In the case of neonatal mortality there would have been no omission since neonatal deaths among births which occurred in December 1974 could only have taken place either in December 1974 or January 1975 and should have been recorded in the survey. Coverage of post-natal deaths among the birth cohort of 1974 is not complete, but approximately 60-70 per cent of post-neonatal deaths, even of those born in December 1974, would have been recorded in the survey, for, on the average, 60-70 per cent of post-neonatal deaths in Sri Lanka occur in the second to sixth month of life. For these reasons, the 1974 cohort was included in the study of death rates up to age one.

Basically the method of analysis used was the life table technique of studying the history of a cohort. In this instance it was a pooled cohort of births occurring over a period. In analysing child mortality at ages 1 to 5, the cohort studied was the births occurring in the period 1948 to 1970, the cut-off point being 1970 to allow full exposure to risk.

In the case of neonatal and post-neonatal mortality the analysis dealt with approximately 25,000 births, 968 neonatal deaths and 556 post-neonatal deaths. In the case of child mortality the analysis was based on approximately 19,000 children who had survived the neonatal and post-neonatal stages and of whom 602 died between ages one to five.

With regard to the reliability of the data it is interesting to compare infant mortality rates calculated from registration figures with those calculated from retrospective data collected in the survey[5]

[5] See Appendix I for a note on completeness of vital registration and quality of cause of death statistics in Sri Lanka.

Table 6 Infant Mortality in Sri Lanka: 1948-1974

(Deaths Per 1000 Live Births)

Period	Registration Figures	Fertility Survey
1948-1952	84	70
1953-1958	69	66
1959-1964	55	60
1965-1970	52	59
1971-1974	47	56

Source: Administration Reports of the Registrar General and the Fertility Survey.

Although they do not refer to exactly the same population (the survey figures do not include births and deaths occurring during this period to women who had died by the time of the survey), they show a broad similarity both in levels and trends.

1.6 MORTALITY TRENDS AND DIFFERENTIALS

In a search for causes, it is useful to have estimates of the differences in mortality levels between groups in the population, which can then be the basis for further analysis.

The Fertility Survey provides data on both infant and child mortality by place of residence (Table 7).

Table 7 Infant and Child Mortality in Sri Lanka, by Place of Residence: 1948-1974

Place of Residence	Infant Mortality		Child Mortality*
	Neonatal	Post-Neonatal	
Urban	31 *(4,274)*	27 *(4,143)*	26 *(3,252)*
Rural	36 *(18,619)*	19 *(17,964)*	32 *(14,310)*
Estate	81 *(2,162)*	53 *(1,988)*	36 *(1,541)*

* Child mortality refers to the period 1948-1970.

The neonatal rate is the number of neonatal deaths per 1000 live births; the post-neonatal is the number of post-neonatal deaths per 1000 who survived the first month; child mortality is the number of child deaths per 1000 who survived the first year of life. In each table, the figure in parenthesis after each estimate refers to the denominator of the ratio from which these estimates have been made, that is, in neonatal mortality it refers to the total number of live births in each category; in post-neonatal mortality it refers to the number of live births minus neonatal deaths; and in child mortality, the number of live births minus the number of infant deaths. Source: Fertility Survey.

There are small but significant differences in rural-urban mortality, but estate mortality is clearly very much higher than the rest of the country among infants, and clearly needs further investigation. The differentials in infant mortality in the estates and the rest of the country are also seen in the Registrar General's statistics (Table 2).

The Fertility Survey also provides data on mortality trends by place of residence. Neonatal and post-neonatal mortality trends were compared for the birth cohort 1948-1958 and that of 1959-1974, and child mortality for the cohort of 1948-1958 and 1959-1970.

Table 8 Neonatal, Post-Neonatal and Child Mortality Rates, by Place of Residence: 1948-1958 and 1959-1974

(Deaths Per 1000)

Place of Residence	Mortality	1948-58	1959-74*
Urban	Neonatal	33 *(1,035)*	30 *(3,239)*
	Post-Neonatal	30 *(1,001)*	26 *(3,143)*
	Child	35 *(972)*	22 *(2,280)*
Rural	Neonatal	39 *(4,908)*	34 *(13,717)*
	Post-Neonatal	23 *(4,715)*	17 *(13,246)*
	Child	47 *(4,605)*	25 *(9,704)*
Estate	Neonatal	81 *(557)*	80 *(1,605)*
	Post-Neonatal	49 *(511)*	54 *(1,476)*
	Child	31 *(487)*	38 *(1,054)*

* Child mortality refers to the period 1959-1970.
Source: Fertility Survey

Estate mortality remains stable or even increased during this period, and will be discussed in a separate chapter. There were sharp declines in Urban and Rural child mortality but the declines in neonatal and post-neonatal mortality were small, although the differential between Urban and Rural neonatal mortality seems to have narrowed. But Urban post-neonatal mortality yet remain significantly higher than that in Rural areas.

1.7 STANDARD ERROR OF ESTIMATES

In view of the possibility of large non-sampling errors, particularly in measuring explanatory variables by indirect means, there would have been little point in doing refined calculations of the standard errors of the mortality rates tabled in this study. Therefore only rough measures of errors have been estimated (Appendix II) and the following examples illustrate their use.

Example 1.

Illiterate mothers have a neonatal mortality rate of 61 per 1000 for parity one births and 43 per 1000 for parities 2 to 6. (Table 22). Is this difference significant? Following the notations used in Appendix II.

$$\mu_1 = \frac{61}{1000} \qquad \mu_2 = \frac{43}{1000}$$

$$\eta_1 = 1500 \qquad \eta_2 = 5494$$

$$\eta^* \simeq 1200 \text{ (Table A in Appendix II)}$$

$$\bar{\mu} = \tfrac{1}{2}(\mu_1 + \mu_2) = \frac{52}{1000} = .052$$

$$\text{Standard Error}(61-43) = \text{S.E. } (18) = 1000\sqrt{\frac{\bar{\mu}}{\eta^*}} \simeq 6.3$$

(Table B in Appendix II)

The difference in mortality of 18 is greater than $1.96\sigma = 12.4$ and is significant at the 95 per cent level.

Example 2.

Child mortality rates where the mother had 1-5 years of schooling was 32 per 1000 while it was 38 where mothers had no schooling, (Table 44). Is this difference significant?

$$\mu_1 = \frac{32}{1000} \qquad \mu = \frac{38}{1000}$$

$$\eta_1 = 8810 \qquad \eta_2 = 6293$$

$$\eta^* \simeq 3600 \qquad \bar{\mu} = .035$$

$$\text{Standard Error}(38-32) = \text{S.E. } (6) = 1000\sqrt{\frac{\bar{\mu}}{\eta^*}} \simeq 3.2$$

(Table B in Appendix II)

The difference in mortality of 6 is less than $1.96\sigma = 6.4$ and is not significant at the 95 per cent level, but the difference is greater than $1.7\sigma = 5.6$ and is significant at the 90 per cent level.

2 Neonatal Mortality

An investigation of the causes of infant and child mortality must necessarily recognize that in addition to the common factors which have an impact on mortality levels of all age groups of the infant and child population, there are other factors which are specific to particular age groups. Furthermore, not only is the relative significance of the causes of death in such particular age groups different, but, as is well-known, death rates between age groups are widely different.

As many of the deaths in the first year of life take place in the first few days, demographers analyse mortality in the first seven days, if statistics are available. Sri Lanka death registration statistics indicate that nearly three-fourths of neonatal deaths occur in the first seven days (Table 9). In this study, which is essentially based on the Fertility Survey, data on deaths of infants aged seven days and under were not separately classified; therefore, the neonatal death rate is used as an indicator of the level of mortality due to problems occurring during the first few days of life. Since neonatal deaths account for 60 per cent of all infant deaths it is clearly necessary to analyse neonatal mortality separately.

Table 9 Number and Per Cent Distribution of Registered Infant Deaths According to Age at Death, Sri Lanka: 1966

Number and Per Cent	Age at Death			
	0-7 Days	8 days and < 1 Month	1 Month and < 12 Months	Total
Number	8,815	3,192	7,992	19,999
Per Cent	44	16	40	100

Source: Administration Report of the Registrar General of Ceylon on Vital Statistics for 1966. Reports for the years after 1966 have not yet been published.

The level of neonatal mortality varies with the significance of several factors important to infant survival: congenital conditions, health of the mother, conditions during the delivery of the child, and the care and attention given the child during the first few days of life.[6] High infant mortality also occurs when mothers are suffering from malnutrition, and when mothers are attended by untrained midwives.

Deaths from diarrhoeal infections common in later childhood are generally low during this period, since breastfeeding protects the infant from infections transmitted through contaminated food and water. In Sri Lanka, approximately 95 per cent of infants are breastfed,[7] and are thus to that extent protected from such infections.

Table 10 Neonatal Mortality, Sri Lanka, 1960-1974

(Deaths Per 1000 Live Births)

Year	Estate*	Non-Estate	Total
1960	62.0	32.2	34.2
1961	60.8	29.6	31.7
1962	63.4	30.4	32.5
1963	62.6	31.6	33.5
1964	65.8	32.2	34.3
1965	65.0	31.3	33.3
1966	61.3	33.0	34.6
1967	60.1	27.4	29.2
1968	60.0	29.4	31.0
1969	67.4	30.0	32.0
1970	64.9	27.7	29.7
1971	66.7	27.7	29.7
1972	70.0	28.4	30.3
1973	70.6	28.1	29.9
1974	67.9	27.4	29.1

* Refers only to estates under the Planters Association Health Scheme.

Source: Administration reports of the Registrar General, Bulletin on Vital Statistics. Report of the Medical Director of the Planters Association Estates Health Scheme.

[6] United Nations. Determinants and Consequences of Population Trends, pp. 126-128. New York, 1973.

[7] World Fertility Survey, Sri Lanka, 1975. Table 4.1.1.

Table 11 Number and Per Cent Distribution of Deaths of Infants Less Than One Month Old According to Cause of Death, Sri Lanka: 1966

Cause of Death	0-7 Days		8 Days or More and Less Than 1 Month		Total Less Than 1 Month	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
Spina bifida and Meningocele and all congenital malformations	134	1.5	49	1.5	183	1.5
Tetanus	107	1.2	96	3.0	203	1.7
Birth injuries, post-natal asphyxia and atelectasis	900	10.2	42	1.3	942	7.9
Convulsions	903	10.2	409	12.8	1312	10.9
Infections of the new born	755	8.6	502	15.7	1257	10.5
Immaturity and congenital debility	5341	60.6	1559	48.9	6900	57.5
Other causes	675	7.7	535	16.8	1210	10.0
Total	8815	100.0	3192	100.0	12007	100.0

Source: Administration Report of the Registrar General for Ceylon for 1966.

Although national neonatal mortality seems to have stabilized during the last few years, a sectional classification indicates that estate neonatal mortality has increased slightly while non-estate neonatal mortality has shown a tendency to decrease.

The cause of infant deaths in the first few weeks of life as recorded by the Registrar General are shown in Table 11. Fifty-seven per cent of the deaths of infants less than one month old are classed as due to immaturity and congenital debility.

The proportion of deaths from infections of the new born and from convulsions is also high, as is the proportion from tetanus and birth injuries, post-natal asphyxia and atelectasis. During the earlier part of the century when there were many untrained midwives the number of deaths from this cause was very high among some groups in the population. Death rates from neonatal tetanus were well over 25 per 1000 live births and deaths of mothers from sepsis were also very high.

Trained midwives and the hospitalization of mothers during delivery led to the decline in mortality from this cause.[8] The causes of neonatal mortality in Sri Lanka at present are very similar to those in England and in Wales in the late 1930's. The death rate from congenital malformations is low in Sri Lanka compared to England and Wales, and it is possible that some deaths from this cause are being classified under the category immaturity and congenital debility (Table 12).

Table 12 Neonatal Mortality, by Cause of Death: Sri Lanka, 1966, and England and Wales, 1937

(Deaths Per 1000 Live Births)

Cause of Death	Sri Lanka	England and Wales
Infections of the new born and from convulsions	6.96	2.16
Immaturity, and congenital debility	18.69	16.95
Tetanus,birth injuries, post-natal asphyxia and atelectasis	3.10	4.39
Spina bifida and meningocele and all congenital malformations	.50	3.68
Other causes	5.37	2.58
Total	34.62	29.76

Source: Administration Report of the Registrar-General of Ceylon 1966. Registrar General's Statistical Review of England and Wales for 1937, Table 12, Part 1, Medical

The death rate from infections of the new born and from convulsions is somewhat high compared to that in England and Wales and indicate that a search for the causes of neonatal mortality should take into account not only variables describing the condition of the mother during pregnancy, and the quality of the medical care received during delivery, but also environmental conditions surrounding the mother and child which lead to the spread of infections.

Attempts to set out a model of the main causes of death during the first month of life are depicted in Figure 1. Factors which can influence neonatal mortality are of four types:

The first are those which in policy terms can be remedied by preventive measures. Thus, for example, the absence of lavatory facilities, contaminated water, untrained midwives, the spread of infection by flies or a mother suffering from malnutrition fall within this group.

The second set of factors is related to curative measures. In many cases a sick child could be saved if taken to a hospital. Since medical treatment is free in Sri Lanka, action to save an infant should not prove difficult in urban Sri Lanka even for the poorest classes, but in the villages and estates such action would sometimes depend on the availability of a motor vehicle, the proximity to a medical institution, and even if both were available, on whether the family has money to spend on hiring a vehicle and has the understanding to realize the seriousness of the child's condition.

There is a third group of factors which cannot be strictly classified according to the preventive or curative category; these are demographic variables, the age of the mother, the birth order, and the length of the interval between two successive births.

Finally, in the case of neonatal mortality, there is a fourth group: deaths due to congenital causes.

A theoretical model representing the cause of neonatal mortality can be constructed and then tested for its validity against data from a particular country. The strength of the relationship will depend on the particular socio-economic level and cultural background of the country. Cultural background is important because much will depend on the status of the pregnant woman in the particular society or social group and on her claim to some type of priority in the event of a shortage of food. Since a perpetual shortage of food is an ever prevalent condition among certain groups of the population in many countries of the Third World, this factor should not be ignored.

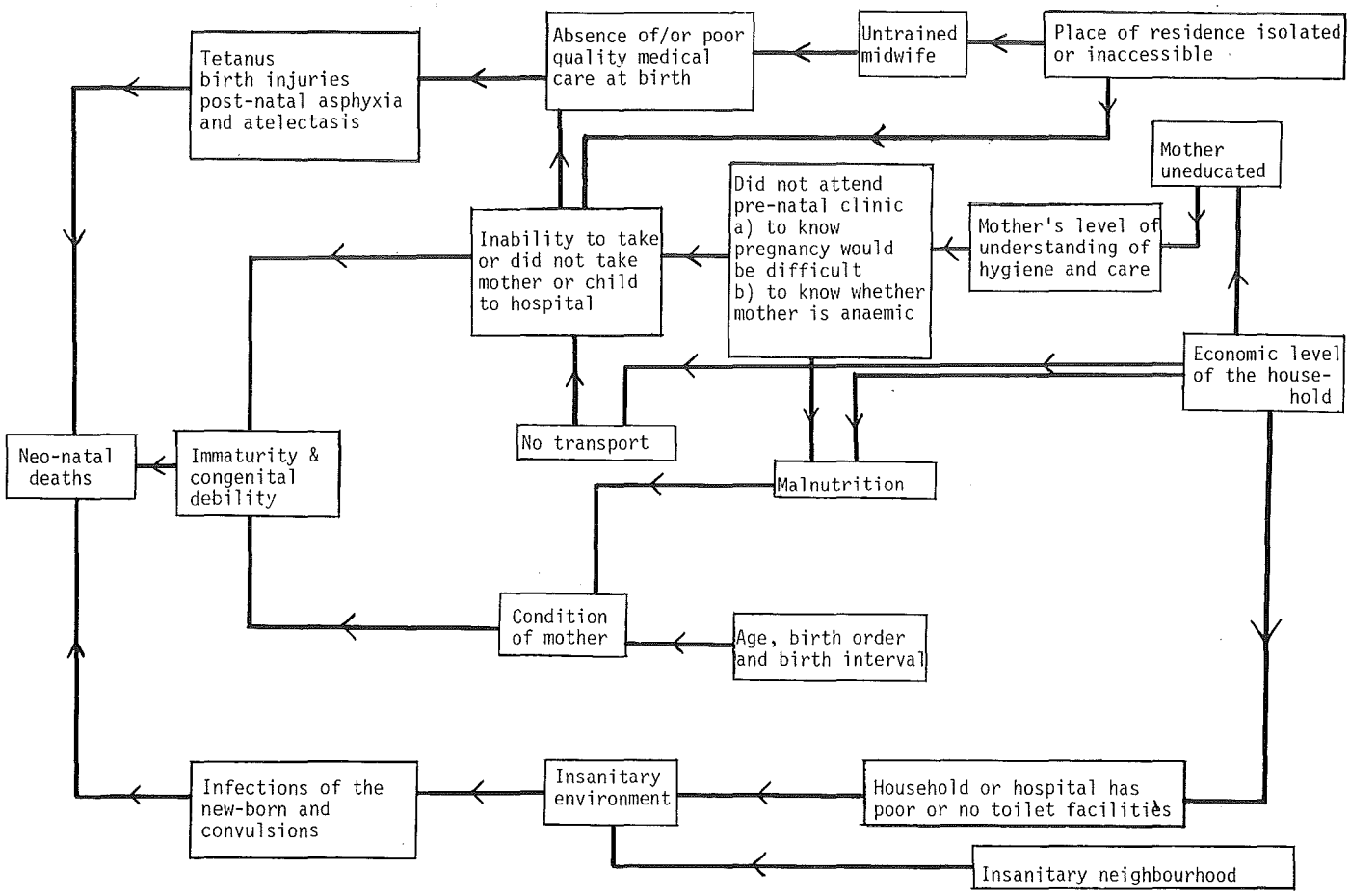
In Sri Lanka, given the limited range of data available in the World Fertility Survey it was not possible to undertake a study of mortality that would take into account the complex interaction of so many different explanatory factors.

One of the main problems with the survey data is lack of indicators to represent certain of the explanatory variables. For example, there is no information as to whether a birth took place in a medical institution or whether delivery was by a trained midwife or without any trained medical staff. There is also no direct indicator to ascertain whether the mother was suffering from malnutrition. In some instances it may be possible to use indirect indicators to measure these variables. The nutritional condition of the mother would in most instances be strongly correlated to the economic level of the household, which can be represented by the occupation of the husband or the husband's level of education. Similarly, it is possible to argue that the educational level of the mother is a reasonable guide to indicate whether she had the understanding to attend a maternity and child welfare clinic for pre-natal checks. Such understanding which would in the main indicate that she would almost certainly have been attended, at the very least by a trained midwife, even if she was not warded in a hospital or maternity home. Also a pregnant mother attending such a clinic would be given supplementary foods, such as iron tablets, if she was anaemic.

Health Ministry figures (Table 66) indicate that approximately 70 per cent of the mothers had some form of medical attention during the period of delivery, it may be noted that this figure is not very distant from the survey figure of 66 per cent of the births to mothers who claimed to be literate (i.e. could read, say, a newspaper or a magazine).

[8] For a detailed discussion of the factors leading to the decline in infant and maternal mortality in Sri Lanka before the Second World War, see S.A. Meegama, 'The Decline in Maternal and Infant Mortality and its Relation to Malaria Eradication', *Population Studies* 23,2 (July, 1969).

FIGURE 1 Factors Affecting Neonatal Mortality



In the case of the probable demographic determinants of neonatal mortality, problems of selecting a suitable variable do not arise, for data are available on the age of the mother when the child was born, on the child's birth order, and on the length of the interval between successive births.

As Figure 1 indicates, there are serious problems in the attempts to disentangle the various factors which influence the level of mortality. Poverty (economic level of the household) is generally the cause of malnutrition, lack of lavatory facilities, and low level of education. Poverty is not only a major factor affecting the preventive aspects determining neonatal mortality, but it also has an effect on the access to curative services.

From an analytical viewpoint, poverty determines several of the factors influencing the level of mortality. As far as possible the specific data available on the various factors should be used in attempting to sort out the individual effect of each on neonatal mortality. For some factors this can be done, as in the case of lavatory facilities or the level of education or literacy of the mother; for others there are no direct data, and the only variable which could be used as an indicator of, say, malnutrition is one which would in general describe the economic level of the household.

According to the model described in Figure 1, there are three main factors which could significantly affect neonatal infant mortality. They are:

a) The health of the mother
b) Absence or poor quality of medical care at birth
c) An insanitary environment

Further, as discussed earlier, there are also significant differentials in mortality by place of residence (Table 8). With the data available in the Fertility Survey, some of the above factors can be measured by direct indicators, others by indirect indicators, and some cannot be measured at all. Several points concerning explanatory variables need to be noted:

a) Certain factors cannot be measured by the data collected in the survey. An insanitary neighbourhood can be a particularly dangerous source of infection because of flies, even if household characteristics are advantageous in all other respects. Also, the question on water supply in the survey does not differentiate between protected and unprotected wells, the latter being very much open to contamination. There is no way of measuring and taking into account the impact of such factors.
b) Certain explanatory variables, such as poverty, can be measured in so many different ways, for instance, by the occupation of the husband, husband's education, assets, the amenities in the house, type of roof, walls, lavatory facilities, etc.
c) Certain explanatory variables, such as poverty or the mother's level of understanding, represent more than one factor. By using this type of variable it is not possible to explain the relative influence of a particular factor on neonatal mortality.
d) Certain explanatory variables, such as availability of toilet facilities and almost any of the available variables

measuring poverty or the level of living of the household, are intercorrelated, and due account of this must be taken in the analysis.

e) Many variables measured in the survey relate to present circumstances, which may not have applied at the time of birth or death of child.

Taking into account these cautionary comments a preliminary analysis was done to examine the variation in neonatal mortality according to a number of explanatory variables.

2.0.1 LEVEL-OF-LIVING OF THE HOUSEHOLD

If Husband's Occupation is taken as an indicator of economic well-being, the following variations are seen in neonatal mortality from Table 13.

Table 13 Neonatal Mortality, by Husband's Occupation: 1948-1974

(Deaths Per 1000 Live Births)

Husband's Occupation	All	Rural
Professional, Technical, Administrative, Managerial	22 *(1,343)*	18 *(859)*
Clerical	33 *(835)*	25 *(450)*
Sales' Workers	27 *(2,178)*	25 *(1,415)*
Self-Employed Workers in Agriculture, Animal Husbandry, Forestry, Fishing and Hunting.	37 *(7,714)*	35 *(7,156)*
Non-Self-Employed Workers in Agriculture, Animal Husbandry, Forestry, Fishing and Hunting.	63 *(3,887)*	47 *(2,233)*
Other Service Workers	25 *(1,677)*	20 *(1,151)*
Skilled Production and Transport Workers.	37 *(4,476)*	39 *(3,220)*
Unskilled Production and Transport Workers.	42 *(2,683)*	47 *(1,948)*

Source: Fertility Survey

The differences are what could generally be expected, the professionals and other white collar workers such as clerical and sales workers have the lowest levels of mortality. The high mortality in the category of non-self-employed agricultural workers, that is the agricultural proletariat is significant but this is mainly due to the estate workers being included in this category. If their contribution is removed by examining the pattern of mortality in the rural Sri Lanka it is seen that there is no difference between the mortality levels of the agricultural proletariat and that of the unskilled production and transport workers (Table 13).

However, the U.N. classification of occupations, which has been broadly followed in classifying the WFS data, obscures to a great extent some of these differentials. To take an extreme example, the category of sales workers includes those working in small teashops or groceries where in addition to being poorly paid they also hold their jobs subject to the will and pleasure of the owner. On the other hand, this group also includes salesmen working for great multinationals (e.g. a drug company) whose salaries are several times higher than those paid to senior government officials; between these are several other groups such as small merchants. There is thus considerable variation in the type of socio-economic status included in such a group which goes under the simple title of Sales Workers.

Table 14 Per Cent Distribution of Respondents in Rural Sri Lanka According to Husband's Occupation, by Husband's Educational Level

Husband's Occupation	Husband's Educational Level (Years of Schooling) <6	6+
Professional, Technical, Administrative, Managerial	7	93
Clerical	3	97
Sales Worker	37	63
Self-Employed Workers in Agriculture, Animal Husbandry, Forestry, Fishing and Hunting.	59	41
Non-Self-Employed Workers in Agriculture, Animal Husbandry, Forestry, Fishing and Hunting.	77	23
Other Service Workers	33	67
Skilled Production and Transport Workers.	49	51
Unskilled Production and Transport Workers.	70	30

Source: Fertility Survey

That sales workers are a heterogeneous group is seen if husband's occupation is classified by husband's level of education. Heterogeniety is also apparent for those in self-employed agriculture, which includes such diverse socio-economic types as a man cultivating half an acre of paddy and a wealthy landed proprieter who is the owner of 50 acres of coconut land. The clerical workers seem to be a much more homogeneous group. According to this criterion even non-self-employed agricultural workers and unskilled production workers are not very homogeneous groups as is seen in Table 14. Even among those who are classified as unskilled workers there are 30 per cent who had more than 5 years of education.

Thus, as an indicator of the level of living, husband's occupation as defined above might not be the most appropriate measure. A variable which could be more appropriate is husband's level of education. Even here, there are problems. Approximately 30 per cent of those who had more than a primary education remain unskilled workers. Also, as is common through out the world, some of the most successful men have had very little formal education, and in this instance Sri Lanka is no exception; some of her most successful entrepreneurs and merchants have had little or no schooling.

Such persons however account for only a few individuals and are not likely to introduce serious distortions to the data. Also very few educated unemployed would have been drawn into the sample since few such people would have married; of the 6175 currently married women in the survey only 66 had unemployed husbands. It is also possible that husband's education may not be a good indicator of levels of living, if it is used for younger age cohorts which would have faced the stagnant employment markets of the late 60's and 70's. Problems could have arisen, since the younger educated husbands who entered the job market after the mid-1960's would not on average, have attained the same level of jobs as was available to older husbands in the survey. However, classifications of neonatal mortality by this variable show sharp differentials in mortality (Table 15), which persisted even when the estate workers are omitted.

Table 15 Neonatal Mortality, by Husband's Educational Level: 1948-1974

(Deaths Per 1000 Live Births)

Husband's Educational Level (Years of Schooling)	All	Non-Estate*
None	60 *(2,478)*	53 *(2,140)*
1-5	43 *(11,507)*	38 *(10,221)*
6-9	32 *(8,269)*	31 *(7,807)*
10-11	21 *(1,923)*	21 *(1,865)*
Higher Education	13 *(824)*	14 *(805)*

* The sample is too small to provide estimates of mortality in the estates by five categories of husband's educational level.
Source: Fertility Survey

2.0.2 MOTHER'S LEVEL OF UNDERSTANDING

Mother's level of education or literacy has been taken as a variable indicative of her level of understanding of hygiene and health care and of the need not only to attend pre-natal and post-natal clinics but also to see that trained medical personnel attend her and her child during and after birth. Variations in neonatal mortality are seen when all mothers are considered.

Table 16 Neonatal Mortality, by Mother's Educational Level: 1948-1974

(Deaths Per 1000 Live Births)

Mother's Educational Level (Years of Schooling)	All	Non-Estate
None	49 *(7,258)*	41 *(5,994)*
1-5	38 *(10,674)*	34 *(9,913)*
6-9	35 *(5,208)*	35 *(5,101)*
10-11	15 *(1,432)*	15 *(1,402)*
Higher Education	23 *(490)*	24 *(492)*

Source: Fertility Survey

When the estate mothers are omitted there does not seem to be any difference in mortality between the mothers who had no education and those with 6-9 years of education. This is surprising since mother's level of education in addition to what is being measured is also to some extent an indicator of levels of living. When mortality is classified by literacy of mother there is no difference in mortality in the rural sector, but the differences are significant in both the urban and estate areas.

Table 17 Neonatal Mortality, by Mother's Literacy and by Place of Residence: 1948-1974.

Mother's Literacy	All	Place of Residence		
		Urban	Rural	Estate
Literate	34 (16,588)	26 (3,409)	35 (12,541)	58 (638)
Illiterate	48 (8,462)	50 (865)	37 (6,073)	90 (1,524)

Source: Fertility Survey

There does not seem to be any significant difference in neonatal mortality between literate and illiterate mothers in rural Sri Lanka. The possibility that association of literacy with other explanatory variables is suppressing the effect of this variable will be investigated further in the analysis.

2.0.3 IMPACT OF ENVIRONMENT

As unsanitary environment can influence neonatal mortality in several ways. If the child is born in a dwelling with poor or no toilet facilities, infections could be transmitted to the new-born by flies or, for that matter, through the mother who in all probability would also have unhygienic habits. An infant born in a medical institution can be infected during the few days of its stay, since some hospitals and maternity homes in Sri Lanka do not have flush systems of sewerage disposal, and to make matters worse, do not have stable supplies of water throughout the year.

Table 18 Neonatal Mortality, by Type of Toilet Facilities and by Place of Residence: 1948-1974

(Deaths Per 1000 Live Births)

Type of Toilet Facilities	Place of Residence		
	All	Urban	Rural
Flush system	26 *(1,088)*	23 *(718)*	34 *(346)*
Bucket	41 *(834)*	34 *(720)*	39 *(81)*
Water seal	30 *(3,765)*	30 *(1,284)*	25 *(2,270)*
Cess pit	34 *(10,601)*	35 *(691)*	33 *(9,327)*
None	49 *(8.763)*	32 *(862)*	43 *(6,591)*

Source: Fertility Survey

Except in the first column 'All' the sample sizes in the first two categories of toilet systems are too small for comparisons; there are, however, significant differences in mortality in the rural sector between households which have no toilets as against others, but surprisingly there do not seem to be any significant differences in urban mortality based on type of toilet facilities. A further examination of urban mortality controlled for variations in other factors is not possible, using this type of analysis because of the small sample size.

2.0.4 PARITY

Birth order can influence neonatal mortality in two ways; the infants' health at higher parities could be affected since it is very probable that the mother would be enfeebled. The first birth could also be exposed to higher risk because of the mother's inexperience in child care, or due to specific conditions that make childbearing difficult. This, for example, could be the case where an operation was needed to deliver the child. Mortality in such instances will be higher among the one third of mothers who did not give birth to their children in medical institutions where facilities are generally available to deal with such situations.

Table 19 Neonatal Mortality, by Parity: 1948-1974, 1948-1958, and 1959-1974.

(Deaths Per 1000 Live Births)

Parity	1948-1974	1948-1958	1959-1974
1	46 *(5515)*	52 *(1843)*	44 *(3672)*
2	35 *(4852)*	33 *(1580)*	37 *(3272)*
3	35 *(4042)*	35 *(1222)*	34 *(2820)*
4	38 *(3221)*	47 *(850)*	34 *(2371)*
5	35 *(2470)*	42 *(508)*	34 *(1962)*
6	32 *(1833)*	34 *(274)*	32 *(1559)*
7+	43 *(3131)*	49 *(224)*	38 *(2907)*

Source: Fertility Survey

Figures for 1948-1974 indicate that mortality was higher for parity one and for higher parity births. It is possible that higher mortality of first order births was because proportionately more such births occurred in the late 1940's and the early 1950's when infant mortality was higher than in more recent years, because older women in the sample would have had their first births in the earlier years. This potential bias can be removed by examining the figures for period 1959-1974 when mortality levels had decreased. But the figures for period 1959-1974 indicate that parity one mortality still remains high (Table 19).

Table 20 Neonatal Mortality, by Parity and by Place of Residence: 1948-1974

(Deaths Per 1000 Live Births)

Parity	Urban	Rural	Estate
1	30 *(1,038)*	45 *(3,956)*	87 *(521)*
2-6	30 *(2,846)*	32 *(12,158)*	79 *(1,414)*
7 +	41 *(390)*	39 *(2,514)*	79 *(228)*

Source: Fertility Survey

Significant parity differentials remain for the rural sector when neonatal mortality is classified by Type of Residence, and as Table 21 indicates, these differentials persist even for the period 1959-1974.

Table 21 Neonatal Mortality in Rural Sri Lanka, by Parity: 1948-1958 and 1959-1974

(Deaths Per 1000 Live Births)

Parity	1948-1958	1959-1974
1	54 *(1,348)*	41 *(2,592)*
2-6	33 *(3,377)*	31 *(8,745)*
7 +	57 *(176)*	38 *(2,332)*

Source: Fertility Survey

For the estates, the sample size is too small to give a meaningful interpretation to parity differentials. However, it seems that urban parity one mortality is about the same level as parity 2 to 6. It is possible that these figures represent the real situation; medical services in urban areas are more accessible to the poorer groups of the population than in rural areas. These figures for urban mothers could also hide a difference in parity one mortality due to social class, which cannot be examined due to problems of sample size. The existence of a social class differential is to some extent indicated when parity is classified by mother's literacy and husband's level of education (Tables 22 and 23).

Table 22 Neonatal Mortality, by Parity and by Mother's Literacy: 1948-1974

(Deaths Per 1000 Live Births)

	Mother's Literacy	
Parity	Literate	Illiterate
1	41 *(4, 013)*	61 *(1,500)*
2-6	31 *(10,915)*	43 *(5,494)*
7 +	35 *(1,663)*	52 *(1,469)*

Source: Fertility Survey

At every parity level neonatal mortality is higher among the children born to illiterate mothers, while the observed pattern in parity differentials remains whether the mother is literate or not.

Table 23 Neonatal Mortality, by Parity and by Husband's Educational Level: 1948-1974

(Deaths Per 1000 Live Births)

	Husband's Educational Level (Years of Schooling)	
Parity	< 6	6 +
1	62 *(2,733)*	32 *(2,765)*
2-6	42 *(9,185)*	27 *(7,224)*
7 +	46 *(2,068)*	35 *(1,064)*

Source: Fertility Survey

At every parity level, neonatal mortality is higher when the husband has had less than 5 years of schooling or no education, but it is interesting to note that the parity differentials are small when the husband had more than 5 years of education, or when the mother is literate.

2.0.5 AGE OF MOTHER WHEN CHILD WAS BORN

The age of the mother could have an influence on neonatal mortality, the older the mother the higher the probability of her being aneamic, or suffering from such diseases as diabetes, heart disease, etc.; such conditions could have an influence on the health of the unborn child.[9]

Table 24 Neonatal Mortality, by Age of Mother at Birth of Child: 1948-1958, 1959-1974 and 1948-1974

(Deaths Per 1000 Live Births)

Age	1948-1974	1948-1958	1959-1974
< 20	50 *(4,093)*	44 *(1,797)*	54 *(2,297)*
20-24	35 *(7,846)*	39 *(2,795)*	33 *(5,051)*
25-29	35 *(6,866)*	41 *(1,653)*	33 *(5,213)*
30-34	31 *(4,116)*	58 *(256)*	30 *(3,861)*
35-49	55 *(2,141)*	-	55 *(2,141)*

Source: Fertility Survey

The figures indicate a higher neonatal mortality among older mothers; they also indicate a higher mortality among very young mothers. Neonatal mortality was classified by period in order to examine whether there was a bias as in the case of parity due to the presence in the sample of older women who would have had children when they were young when infant mortality was high. But the figures for 1959-1974 indicate that the relationship between age of mother and neonatal mortality cannot be explained by this type of bias.

It is interesting to examine whether the differences by age of mother are due to association between parity and age of mother when the child was born.

Earlier it was seen that mortality of the first born was higher. More than 50 per cent of births to mothers less than 20 years of age are parity one births.

[9] See Chamberlain, Geoffry. The Safety of the Unborn Child, Baltimore, Maryland, 1969.

A classification of neonatal mortality by parity and by age of mother at time of birth is revealing.

Table 25 Neonatal Mortality, by Age of Mother at Birth of Child and by Parity: 1948-1974

(Deaths Per 1000 Live Births)

Parity	Age of Mother			
	<20	20-34	35-49	All
1	50 *(2,346)*	45 *(3,125)*	0 *(43)*	46 *(5,514)*
2-6	49 *(1,745)*	32 *(13,798)*	58 *(875)*	35 *(16,418)*
7 +	—	35 *(1,905)*	55 *(1,222)*	43 *(3,127)*
All	50 *(4,091)*	34 *(18,828)*	55 *(2,140)*	

Source: Fertility Survey

Table 25 indicates that the infants most exposed to risk are those born to older mothers at higher parities. Among very young mothers neonatal mortality is higher for every parity than for mothers aged 20-34, indicating that mother's age at birth of child does have an effect on neonatal mortality; the very young mothers and the older mothers have higher mortality than the 20-34 age group. Among very young mothers, parity one mortality is not significantly higher than mortality for other parities.

2.1 SEARCH FOR CAUSES

The foregoing analysis of neonatal mortality indicates significant variation according to different variables. As was seen earlier, some of this variation could increase, lower or disappear if due account is taken of association between the explanatory variables.

The explanatory variables discussed were:

a) Economic Level of the Household, as represented by Husband's Educational Level.
b) Level of Understanding of Hygiene and Health Care of the Mother, as represented by her educational level or literacy.
c) Environmental Conditions, as represented by toilet facilities.
d) Birth Order
e) Age of Mother at Time of Birth of Child.
f) Place of Residence.

Tables 26 to 38 describe the variations in neonatal mortality when it is classified by 2 or more of the above variables.

Table 26 Neonatal Mortality, by Husband's Educational Level and by Type of Toilet Facilities: 1948-1974.

(Deaths Per 1000 Live Births)

Type of Toilet Facilities	Husband's Educational Level (Years of Schooling)		
	None	1-5	6 +
Flush or Water Seal	58 *(242)*	33 *(1,272)*	26 *(3,320)*
Bucket or Cess Pit	51 *(995)*	38 *(5,245)*	28 *(5,179)*
None	67 *(1,241)*	52 *(4,982)*	34 *(2,515)*

Source: Fertility Survey

For each type of toilet facilities, mortality by husband's level of education progressively decreases as level of education rises. Also, for each level of husband's education, mortality by type of toilet facilities progressively increases reaching a maximum in households which have no toilet facilities except in one instance when the sample size is small (Table 26).

Table 27 Neonatal Mortality, by Husband's Educational Level and by Mother's Educational Level: 1948-1974

(Deaths Per 1000 Live Births)

Husband's Educational Level (Years of Schooling)	Mother's Educational Level (Years of Schooling)		
	None	1-5	6 +
None	62 *(1,446)*	61 *(924)*	28 *(108)*
1-5	49 *(4,165)*	38 *(5,685)*	47 *(1,658)*
6 +	35 *(1,645)*	31 *(4,015)*	25 *(5,355)*

Source: Fertility Survey

For each level of mother's education, mortality by husband's level of education progressively decreases as level of education rises (Table 27). The only exception is when mother's level of education is greater than 5 and the husband has no education, but the sample size for this cell is small and the estimate subject to great error. However, when the husband's educational level is 1-5 years, neonatal mortality is higher among mothers with more than 5 years of education than for mothers with only a primary education, and not significantly different from that among mothers with no education.

Table 28 Neonatal Mortality, by Husband's Educational Level and by Mother's Literacy: 1948-1974

(Deaths Per 1000 Live Births)

Mother's Literacy	Husband's Educational Level (Years of Schooling)		
	None	1-5	6 +
Literate	56 *(868)*	41 *(6,684)*	26 *(8,993)*
Illiterate	62 *(1,610)*	47 *(4,814)*	38 *(2,023)*

Source: Fertility Survey

Mother's literacy has a more persistent association than does educational level, for neonatal mortality is higher among illiterate mothers at every level of husband's education (Table 28). The differentials in neonatal mortality between literate and illiterate mothers also remain when controlled for type of toilet facilities. Comparison of mortality among illiterate mothers indicates an anomaly among the group with flush or water seal toilet facilities, but the estimate is based on a small sample (Table 29).

Table 29 Neonatal Mortality, by Mother's Literacy and by Type of Toilet Facilities: 1948-1974

(Deaths Per 1000 Live Births)

Type of Toilet Facilities	Mother's Literacy	
	Literate	Illiterate
Flush or Water Seal	24 *(4,156)*	63 *(699)*
Bucket or Cess Pit	33 *(7,985)*	40 *(3,442)*
None	45 *(4,444)*	52 *(4,318)*

Source: Fertility Survey

It may also be better to use the literacy variable because in the survey literacy was defined on the person's ability to read 'say a newspaper or magazine'. Ability to read may be a more direct indicator of understanding of hygiene and health care than level of education. 72 per cent of the births were to mothers with no education or only a primary education and the latter in Sri Lanka is a poor predictor of a person's capacity to read and understand. Further classification of neonatal mortality by mother's level of education controlling for other factors would run into problems of sample size since the number of births to women with more than a primary education is relatively small.

Tables 26 to 29 indicate that neonatal mortality differs by Husband's level of education, Mother's literacy, and Type of toilet facilities available to the household. Earlier it was found that neonatal mortality also differed by type of place of residence, by mother's age at time of birth of child, and by parity. Would these differences in mortality rates remain if the data were classified by all these variables. The small sample in the urban and estate sectors does not permit such comparisons, but it is possible to do this for the rural sector where the sample is relatively large.

Analysis by five explanatory variables, each of which is divided into different categories would mean that there could be at least 540 cells.

Even if the sample size permitted, it would be difficult to interpret and search for causes by examining 540 different proportions according to the type of analysis being followed.

In this particular instance, sample size definitely imposes certain constraints on the number of different permutations of these five variables which can yield statistically meaningful results.

Accordingly, as a first step, rural neonatal mortality was classified by the three socio-economic variables, and each of these variables was recoded to have only two values.

		Category 1	Category 2
a)	Husband's Educational Level	a) 6-9 years b) 10-11 years c) University d) Other higher education	a) No schooling b) 1-5 years
b)	Toilet Facilities Available to Household	a) Flush b) Bucket c) Water seal d) Cesspit	a) No toilet facilities
c)	Literacy of Mother	a) Literate	(a) Illiterate

Such classification imposes serious restrictions on the use which can be made of this tabulation. To take a particularly extreme example, by including a flush system of sewerage disposal or the water seal system with the cess pit type, our instruments of analysis become blunt, for they represent two different types of environment. Nevertheless, there can be no doubt that the environment in a household which has no toilet facilities is widely different from the environments which have been grouped together.

Even given the restrictive conditions which affect this method of analysis it is yet worth noting that some interesting results emerge from a tabulation based on this model. For simplicity of exposition the following symbols are used to indicate each variable by its level:

Variable	Symbol
1) Literate Mother	L_1
2) Illiterate Mother	L_2
3) Households Having Some Type of Toilet Facilities	T_1
4) Households Having No Toilet Facilities	T_2
5) Husbands with More Than Five Years of Education	H_1
6) Husbands with Five or Less Years or No Education	H_2

As it is seen, variables which have 1 affixed to them are qualitatively better than those to which 2 has been affixed.

Table 30 Neonatal Mortality in Rural Sri Lanka, by Husband's Educational Level, by Mother's Literacy, and by Toilet Facilities: 1948-1974

(Deaths Per 1000 Live Births)

Variable Combination Ranked According to Level of Mortality	Neonatal Mortality
a) H_1 L_1 T_1	26 *(5,009)*
b) H_1 L_2 T_1	32 *(819)*
c) H_2 L_2 T_1	33 *(2,237)*
d) H_1 L_1 T_2	36 *(1,303)*
e) H_2 L_1 T_1	39 *(3,929)*
f) H_1 L_2 T_2	41 *(600)*
g) H_2 L_2 T_2	43 *(2,402)*
h) H_2 L_1 T_2	48 *(2,261)*

Source: Fertility Survey

It will be noted that the lowest level of neonatal mortality of 26 per 1000 live births is in that group which has the higher level of husband's education, the mother is literate, and has some type of toilet facilities. This is consistent with the model which was proposed. On the other hand, the highest mortality of 48 per 1000 live births is in that group where there are no toilet facilities, where the husband's educational level is low but where the mother is literate. This is not entirely consistent with the model which has been specified, but the distortion is not serious, for the group where mothers are illiterate has the second highest mortality of 43 per 1000.

It might also be noted that the three lowest mortality groups are those which have toilet facilities, while the three highest mortality groups are those which have no toilet facilities. On the other hand the higher level of husband's education occurs in only two of the three lowest mortality groups, and similarly husband's education level is lower in only two of the three highest mortality groups.

With regard to the other variable literacy of mother, literate mothers are found in only one of the three lowest mortality groups, while illiterate mothers are in two of the three highest mortality groups.

On this reckoning it would seem that the three explanatory variables should be ranked in the following order for

their impact on neonatal mortality:
a) Toilet Facilities
b) Husband's Educational Level
c) Literacy of Mother

Another rough method of examining the relationship of each of these variables would be to compare the change in mortality levels with the change in each variable while keeping the other two variables constant.

Table 31 Influence of Toilet Facilities on Neonatal Mortality in Rural Sri Lanka, Holding Other Variables Constant: 1948-1974

(Deaths Per 1000 Live Births)

Variable Combination	Neonatal Mortality
a) T_1 H_1 L_1	26 *(5,009)*
b) T_2 H_1 L_1	36 *(1,303)*
c) T_1 H_2 L_2	33 *(2,237)*
d) T_2 H_2 L_2	43 *(2,402)*

Source: Fertility Survey

It would seem from a comparison of (a) and (b) that when other conditions are good, as measured by husband's education and mother's literacy, infant mortality is substantially lower when a household has toilet facilities, and that even when conditions are bad, as measured by the other variables, the availability of toilet facilities leads to a substantial reduction of mortality, as is seen by comparing (c) and (d). A comparison of (b) and (c) also indicates that mortality is about the same in households where other conditions are poor, but which have toilet facilities, and in households where other conditions are good, but where there are no toilet facilities.

Table 32 Influence of Husband's Educational Level on Neonatal Mortality in Rural Sri Lanka, Holding other Variables Constant: 1948-1974

(Deaths Per 1000 Live Births)

Variable Combination	Neonatal mortality
a) H_1 L_1 T_1	26 *(5,009)*
b) H_2 L_1 T_1	39 *(3,929)*
c) H_1 L_2 T_2	41 *(600)*
d) H_2 L_2 T_2	43 *(2,402)*

Source: Fertility Survey

The variations by husband's education are interesting. When other conditions are good, as measured by availability of toilet facilities and literacy of mother, the variable husband's education has a very strong influence on neonatal mortality. Comparing (a) and (b) the group where the husband has secondary or higher education, neonatal mortality is only 26, while it increases to 39 when the husband has no education or only primary schooling. On the other hand, when conditions as measured by other variables are bad, the level of husband's education does not seem to have any significant impact on mortality.

Table 33 Influence of Mother's Literacy on Neonatal Mortality in Rural Sri Lanka, Holding Other Variables Constant: 1948-1974

(Deaths Per 1000 Live Births)

Variable Combination	Neonatal Mortality
a) L_1 H_1 T_1	26 *(5,009)*
b) L_2 H_1 T_1	32 *(819)*
c) L_1 H_2 T_2	48 *(2,261)*
d) L_2 H_2 T_2	43 *(2,402)*

Source: Fertility Survey.

When conditions as measured by other variables are good or bad, there is no significant difference in neonatal mortality between literate and illiterate mothers.

As has been stated, parity and age of the mother at the time of birth of child has a marked influence on neonatal mortality. Parity one and higher parities have higher mortality than parity 2 to 6, and the very young and older mothers have higher neonatal mortality rates than mothers in the age group 20-34. Some interesting figures emerged when rural neonatal mortality was classified by the following variables (a) husband's educational level, (b) toilet facilities, and (c) age of the mother at the time of birth of the child. The first two variables were defined as earlier; the new variable was defined as follows:
A_1 = Age of Mother 20-34 years
A_2 = Age of Mother Less Than 20 Years or Greater Than 34 Years

This particular classification was done on the basis of the data analysed earlier which indicated higher neonatal mortality among very young mothers and among older mothers. This new variable also reflects the impact of parity on mortality, since there is a strong correlation between parity and age of mother at time of birth of child.

Table 34 Neonatal Mortality in Rural Sri Lanka, by Toilet Facilities, by Husband's Educational Level, and by Age of Mother at Birth of Child: 1948-1974

(Deaths Per 1000 Live Births)

Variable Combination	Neonatal Mortality
a) H_1 A_1 T_1	23 *(4,610)*
b) H_1 A_1 T_2	32 *(1,388)*
c) H_2 A_1 T_1	36 *(4,624)*
d) H_2 A_1 T_2	37 *(3,287)*
e) H_2 A_2 T_1	37 *(1,550)*
f) H_1 A_2 T_1	39 *(1,218)*
g) H_1 A_2 T_2	51 *(515)*
h) H_2 A_2 T_2	63 *(1.375)*

Source: Fertility Survey

This combination of variables seems to be more sensitive in indicating neonatal mortality differentials than the earlier combination. First, mortality varies more widely from a low of 23 per 1000 live births to 63 per 1000 live births, in contrast to the earlier combination when it varied from 26 to 48. Second, mortality is lowest in the group which has toilet facilities, where husband's educational level is higher and where the mother's age at time of birth is between 20-34. Mortality is highest in the group which has

no toilet facilities, where husband's educational level is low, or where the mother's age at time of birth of child is very low or high. (Table 34).

Table 35 Influence of Husband's Educational Level on Neonatal Mortality in Rural Sri Lanka, Holding Other Variables Constant: 1948-1974

Deaths Per 1000 Live Births)

Variable Combination	Neonatal Mortality
a) H_1 A_1 T_1	23 *(4,610)*
b) H_2 A_1 T_1	36 *(4,624)*
c) H_1 A_2 T_2	51 *(515)*
d) H_2 A_2 T_2	63 *(1,375)*

Source: Fertility Survey

It will be seen from (a) and (b) in Table 35 that when other conditions are good, as defined by mother's age and availability of toilet facilities, a change in husband's educational level leads to a significant rise in neonatal mortality from 23 to 36 per 1000 live births; when conditions are bad, as defined above, a change in husband's educational level leads to a change in mortality from 51 to 63, as seen by comparing (c) and (d) (Table 35).

Table 36 Influence of Age of Mother at Birth of Child on Neonatal Mortality in Rural Sri Lanka, Holding Other Variables Constant: 1948-1974

(Deaths Per 1000 Live Births)

Variable Combination	Neonatal Mortality
a) A_1 H_1 T_1	23 *(4,610)*
b) A_2 H_1 T_1	39 *(1,218)*
c) A_1 H_2 T_2	37 *(3,287)*
d) A_2 H_2 T_2	63 *(1,375)*

Source: Fertility Survey

Age of mother at time of birth of child, which also reflects the parity effect, seems to have an even greater influence on neonatal mortality than husband's education. It changes from 23 to 39 as seen in (a) and (b) of Table 36, when age of mother changes and when conditions are good, as defined by other variables, and changes from 37 to 63 when conditions are bad, as shown in rows (c) and (d) (Table 36).

Table 37 Influence of Toilet Facilities on Neonatal Mortality in Rural Sri Lanka, Holding Other Variables Constant: 1948-1974

(Deaths Per 1000 Live Births)

Variable Combination	Neonatal Mortality
a) T_1 A_1 H_1	23 *(4,610)*
b) T_2 A_1 H_1	32 *(1,388)*
c) T_1 A_2 H_2	37 *(1,550)*
d) T_2 A_2 H_2	63 *(1,375)*

Source: Fertility Survey

By comparing (a) and (b), and (c) and (d), in Table 37 it is seen that the availability of toilet facilities has a strong influence on neonatal mortality when other conditions are good or bad, as defined by the other variables.

The above analysis illustrates that husband's educational level, availability of toilet facilities, and age of mother at time of birth of child all have a strong influence on neonatal mortality.

The analysis so far has concentrated on examining whether neonatal mortality rates are correlated with some of the explanatory variables which were included in the model described in Figure 1.

It is possible that further knowledge regarding the nature of neonatal mortality could be obtained if an attempt were made to identify whether some mothers were more prone to having neonatal deaths. In particular, it would be useful to inquire whether there are mothers who had more than one neonatal death, and if so, to investigate whether they can be identified by any particular characteristic.

Table 38* Mothers (Entire Sample) Who Had at Least One Live Birth, by Place of Residence and by Number of Neonatal Deaths

Number of Neonatal Deaths Experienced by a Mother	Place of Residence			
	Urban	Rural	Estate	All
0	1,053	3,890	472	5,415
1	87	409	71	567
2	15	88	32	135
3	2	19	7	28
4	1	5	5	11
5	1	1	3	5
Total	1,159	4,412	590	6,161

Source: Fertility Survey

*Tables 38 to 40 refer to all neonatal deaths recorded in the survey and are not restricted to deaths of 1948-1974 cohort.

746 of the 6161 mothers who had at least one live birth had at least one neonatal death; 179 of these mothers had two more neonatal deaths (Table 38).

Table 39 Distribution of Neonatal Deaths, by Number of Neonatal Deaths Experienced by a Mother and by Place of Residence

Number of Neonatal Deaths Experienced by a Mother	Place of Residence			
	Urban	Rural	Estate	All
1	87	409	71	567
2	30	176	64	270
3	6	57	21	84
4	4	20	20	44
5	5	5	15	25
Total	132	667	191	990

Source: Fertility Survey

Of the 990 neonatal deaths in the sample, 423, or 43 per cent, occurred among mothers who have had at least two or more neonatal deaths. This means that 179 or 3 per cent of the total sample of 6161 mothers who had at least one birth contributed to 43 per cent of neonatal mortality in

the sample. (Note, however, that mothers who have had no children or one or two only at the time of the survey in 1975 could later in life have more than one neonatal death).

Given this startingly high figure that 3 per cent of mothers contributed to so much of neonatal mortality, there can be no question that from the point of view of health policy, there is much to be gained by identifying these mothers by their socio-economic and other characteristics.

The number of mothers with two or more neonatal deaths by place of residence is seen in Table 40. Since exposure status of each of these women in relation to neonatal mortality would vary according to the number of births they had, these figures cannot be used to find out whether neonatal mortality, say in the estates, is higher because neonatal mortality is high among a particular group of mothers.

Table 40 Percentage of All Neonatal Deaths Occurring to Women With at Least Two Neonatal Deaths, by Place of Residence*

Urban	Rural	Estate	All
34	39	63	42

*Refers to mothers with at least two live births

Source: Fertility Survey

Table 40 indicates that even among mothers with at least two live births a very high proportion of neonatal deaths occur among mothers with at least 2 neonatal deaths; this is higher in the estate sector than in the rest of the country, but the figure is high even for the urban and rural sectors, and it would seem that in urban, rural, and estate, neonatal mortality rates are high because of the conditions prevailing in a small number of households.

2.2. CONCLUSION

Neonatal mortality is still high in Sri Lanka. Even in 1974, according to registration figures, it was 29 per 1000 live births, the lowest it has ever reached. Estate neonatal mortality is particularly high and varies between 60 to 80. Even among the non-estate population the survey figures indicate very high neonatal mortality among some groups of the population. The non-estate rate varies from 14 per 1000 live births in families where the husband had a higher education to 53 per 1000 where the husband had no education (Table 15).

Age of mother and birth order both have a strong influence on neonatal mortality, so does the economic level of the household. On the other hand, mother's level of education or literacy when controlled for other variables seems to have very little influence on neonatal mortality. Environmental conditions as measured by toilet facilities seem to have an effect on neonatal mortality even when controlled for other factors.

The correlation between neonatal mortality and toilet facilities may indicate a causal relationship, given the unhygienic conditions prevalent in most homes, hospitals, and maternity homes. It should also be noted that even in 1973, over 40 per cent of rural households did not have any type of toilet facilities. There is no question that the new born infant would be exposed to many hazards from infections in such conditions. However, it is also possible that this correlation between neonatal mortality and toilet facilities derived from the Fertility Survey data could to some extent be reflecting problems of measurement. In developed countries, almost all households have toilet facilities, and in such instances husband's education would be a much better indicator of the economic level of the household.

In Sri Lanka, many households have no toilet facilities, some have very primitive type of toilets, and others have the modern flush systems for disposal of sewerage. It is possible in such a context that toilet facilities are a better indicator of the economic level of the household than husband's education. In Sri Lanka and in many Asian countries where agriculture is the predominant activity, there is a surplus of educated people in relation to job opportunities. The level of the education of the husband may not be a good indicator of the economic level of the household. In such a situation, the variable toilet facilities could reflect not only environmental conditions but also the economic level of the household. The relationship found between neonatal mortality and toilet facilities should be interpreted in this context and should be the subject of further study.

3 Post-Neonatal and Child Mortality

Mortality among children after the first month of life generally reflects the impact of environmental and socio-economic conditions.

Judging from the cause of death statistics of the Registrar-General, it would seem that six broad groups of diseases account for most of post-neonatal and child mortality (Table 41).

a) Dysentery, Gastro-enteritis and Other Diarrhoeal Diseases
b) Ankylostomiasis and Other Diseases Due to Helminths
c) Respiratory Infections
d) Avitaminosis, Other Deficiency States, and Anaemias
e) Immaturity and Congenital Debility
f) Convulsions

Both post-neonatal and child mortality have declined across a broad range of diseases over the period spanned by the study. But these diseases are yet the main causes of post-neonatal and child mortality. They accounted for 66 per cent of post-neonatal deaths in 1971 as against 67 in 1953, and for 62 per cent of child deaths in 1971 as against 73 in 1953.

It should also be noted that for both age groups, the mortality decline from respiratory and diarrhoeal diseases is less than the average for all diseases.

It should, however, be borne in mind, in looking at these cause of death statistics, that although international rules for the certification of medical causes of death provide for the identification of the underlying cause (e.g. malnutrition) rather than the secondary condition immediately prior to death (e.g. pneumonia), there may sometimes be failure to distinguish primary and secondary causes, especially in some rural areas when medical practitioners are not available, and this may lead to errors in classification of deaths by cause.

Infant and child deaths from convulsions, which is a major cause of post-neonatal and child mortality, has been the subject of some comment. The only description by a qualified physician regarding this disease which could be traced was that of the Medical Officer of Health, Colombo, when, in discussing trends in infant mortality in the city he commented[10],

'A progressive improvement is also recorded in the mortality from digestive diseases and convulsions, much of which latter is probably due to improper feeding'.

Convulsions denote more a symptom than a disease, and generally deaths classified under the heading are due to either diarrhoeal infections or malnutrition or to a combination of both. Post-neonatal and child mortality should take into account the ultimate cause of death, and the complicated nature of the interaction between different diseases and, in addition, the relationship between disease and nutrition. Essentially, many of the deaths of children in the developing countries can be avoided by relatively simple measures. Changes in hygienic and breast-feeding practices and the avoidance of infections arising from environmental causes can be accomplished at relatively low cost. Boiled water, lengthening of the period of breast-

[10] Administrative Report of the Colombo Municipality for 1925, p. 51, Colombo 1926.

Table 41 Post-Neonatal and Child Mortality Rates, by Main Causes of Death, Sri Lanka: 1953 and 1971

Cause of Death	Post-Neonatal Mortality (Per 100,000 Live Births)			Child Mortality (Per Million Children Aged 1 to 4 Years)		
	1953	1971	1971 Rate as Per Cent of 1953	1953	1971	1971 Rate as Per Cent of 1953
Ankylostomiasis and Other Diseases Due to Helminths	108	24	22	2,677	376	14
Pneumonia and Bronchitis	433	289	67	2,397	975	41
Dysentery, Gastro-enteritis and Colitis except Diarrhoea of the Newly Born	313	203	65	1,463	721	49
Convulsions	723	224	31	2,842	604	21
Avitaminosis, Other Deficiency States, and Anaemias	19	92	484	3,819	796	21
Immaturity and Congenital Delibity	318	173	54	—	—	—
Other Diseases	944	512	54	4,878	2,092	43
All Causes	2,858	1,517	53	18,076	5,564	31

Source: Administration Reports of the Registrar-General and unpublished data from the Department of Census and Statistics.

feeding, and construction of primitive latrines where there are none can lead to a reduction in mortality due to the spread of infectious bowel-based diseases. Similarly, the cost of curative services needed in terms of drugs, medical centers, and medical personnel is less expensive than that required for the treatment of some of the other less frequent types of disease. Most respiratory and bowel diseases can be cured if treated early by antibiotics and rehydration therapy. But the problem is more intractable if malnutrition is widespread and is due not to misinformation regarding dieting practices but to poverty. A clearer understanding of the relationship between these diseases and their causes can be seen, as in the case of neonatal mortality, from a model (Figure 2) describing the nature of the relationship.

After the neonatal stage the child is exposed to more infections than in the first month of life. Contaminated water has much greater impact on mortality after the neonatal stage, unlike in the first few weeks of life when breast-feeding is common and where food requiring the use of water is not used. The Medical Officer of Health of Colombo describing the modes by which disease is transmitted among the poorer classes in Colombo during the early years of this century comments[11]:

'Can any person be surprised that the child gets convulsions, when such irritants as contaminated condensed milk mixed with we do not know what kind of water are thrown into its stomach and bowels'.

The modes of transmission of respiratory diseases are also more varied in childhood, for children play in the rain and are generally much more exposed to the hazards of weather than infants. Similarly, where there are no latrines, there is a greater health risk as children may contract various infections by walking barefoot on polluted soil. Diseases caused by helminths can have a devasting effect in such instances by leading to non-absorption of food and then to malnutrition and perhaps to death of the child from a respiratory or diarrhoeal infection.

However, if the child is already suffering from malnutrition, the effect of catching a respiratory diarrhoeal, or helminthic disease can be even more devastating. There is very strong interaction between the socio-economic and environmental factors affecting post-neonatal and child mortality. Similarly, timely resort to medical treatment can save a child suffering from diarrhoeal and respiratory diseases. A child suffering from a severe attack of enteritis could be saved, if taken to a hospital or health centre which has rehydration facilities. However, as long as the underlying causes remain, the child will continue to contract the infection, until finally the child may become so weakened by disease that it succumbs to some infection.

As the model described in Figure 2 shows, there are several factors which affect the level of post-neonatal and child mortality. As in the case of neonatal mortality, some of these factors can be measured by the data collected in the survey.

3.0.1 EFFECT OF ENVIRONMENT

As mentioned earlier, after the neonatal stage the child is more exposed to infections caused by environmental conditions. Also the antibodies transmitted by the mother, which protect the child, gradually weaken, while the child has not yet built up his own resistance. Using toilet facilities as a measure of such effects, the survey data indicate the following:

[11] The Sanitation of Colombo, Sessional Paper 8 of 1910, Colombo 1910.

Table 42 Post-Neonatal and Child Mortality, by Type of Toilet Facilities*

(Deaths Per 1000)

Type of Toilet Facilities	Post-Neonatal	Child
Flush or Water Seal	16 *(4,713)*	21 *(3,739)*
Bucket or Cesspit	20 *(11,029)*	29 *(8,906)*
No Facilities	31 *(8,333)*	41 *(6,447)*

Source: Fertility Survey

* Throughout this chapter Post-Neonatal rates refer to the cohort born in the period 1948-1974 and child mortality to the cohort born in the period 1948-1970.

There are clear differentials in mortality levels according to type of toilet facilities, with the differences most marked between the population having flush or water seal type of latrines and that which has no facilities.

3.0.2 LEVEL OF LIVING

As discussed earlier and as illustrated in the models depicted in Figures 1 and 2, poverty is a key variable influencing mortality in childhood. The level of malnutrition and the frequency of respiratory and diarrhoeal infections, the exposure to the hazards of the weather due to lack of proper clothing or to poor housing conditions, are all influenced by this variable. The quality of the curative services available and sometimes even medical treatment is dependent on the economic standing of the household. Measured by husband's level of education, there are very wide variations in both post-neonatal and child mortality (Table 43).

Table 43 Post-neonatal and Child Mortality Rates, by Husband's Educational Level

(Deaths Per 1000)

Husband's Educational Level (Years of Schooling)	Post-neonatal	Child
None	33 *(2,329)*	46 *(1,908)*
1–5	24 *(11,007)*	37 *(8,944)*
6–9	23 *(8,004)*	25 *(6,289)*
10+	11 *(2,697)*	15 *(1,914)*

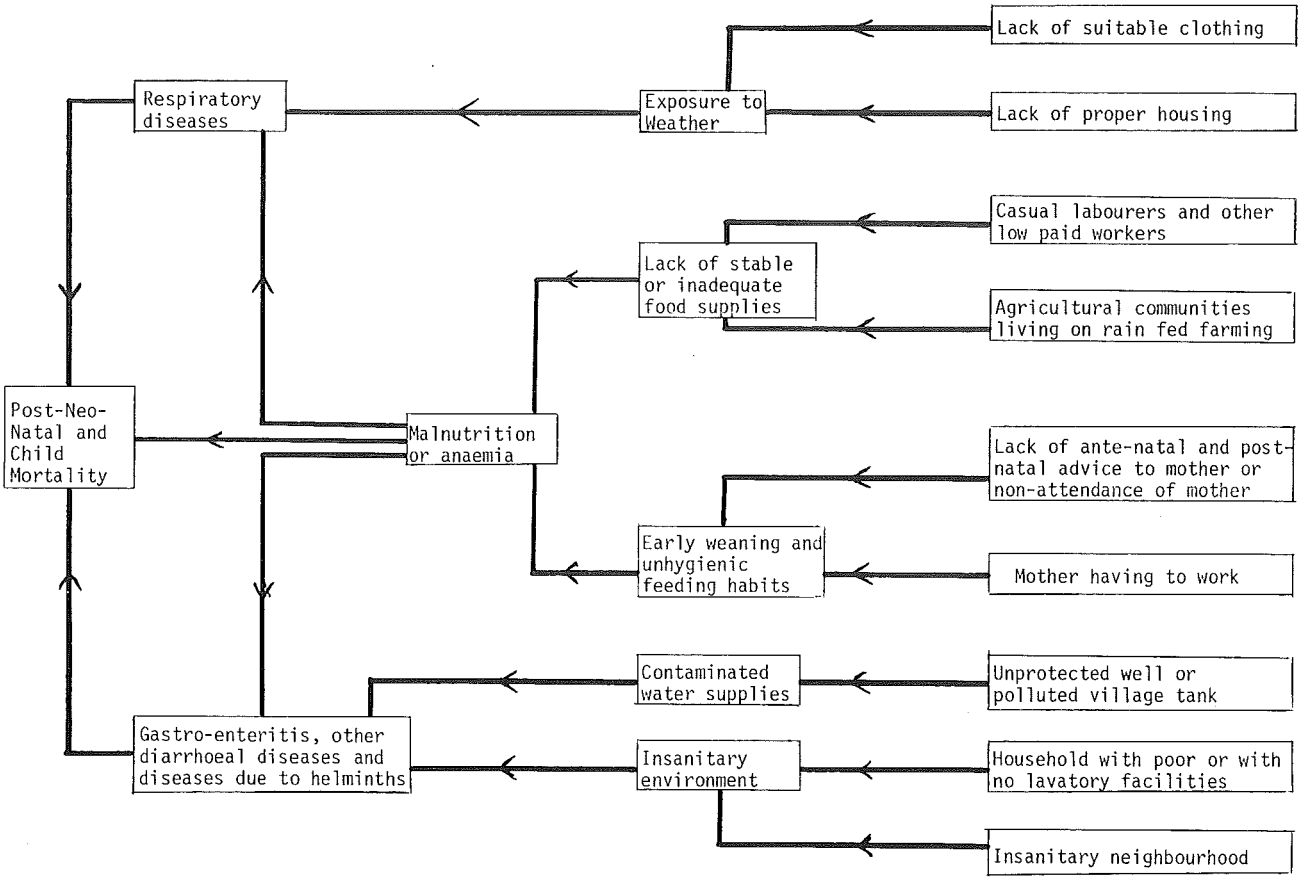
Source: Fertility Survey

3.0.3 MOTHER'S UNDERSTANDING OF CHILD CARE

Understanding of child care is a crucial variable determining the level of infant and child mortality after the neonatal stage. Even in a poor family a mother who knows something of elementary hygiene can protect her child very much more than the mother who is ignorant. It is far healthier to give a child rice gruel than to feed the far more costly condensed milk kept in a tin exposed to flies.

Also, given that medical treatment in time can save the lives of many children, a mother's understanding of the importance of medical care could be a crucial factor in persuading the mother to take her child for treatment without delay. This line of reasoning should not, of course, be taken too far, for even a mother without any education will realize when her child is suffering from severe diarrhoea

FIGURE 2 Factors Affecting Post-Neonatal and Child Mortality



or broncho-pneunomia. What could then be important is whether she has the means to obtain such treatment. This matter of means became even more important during the period 1970-1974, when the world economic crisis made economic conditions very difficult for Sri Lanka. Although theoretically there was free medical treatment for all, there have been occasions when hospitals have not even had analgesic tablets, let alone sophisticated drugs or rehydration facilities.

Bearing these comments in mind, if the mother's level of education or literacy is taken as an indicator of a broad understanding of health problems, the level of variation in mortality is as follows:

Table 44 Post-neonatal and Child Mortality Rates, by Mother's Educational Level

(Deaths Per 1000)

Mother's Educational Level (Years of Schooling)	Post-neonatal	Child
None	26 *(6,905)*	38 *(6,293)*
1–5	27 *(10,273)*	32 *(8,810)*
6–9	17 *(5,027)*	21 *(3,781)*
10+	12 *(1,890)*	7 *(1,231)*

Source: Fertility Survey

As Tables 44 and 45 show, there are significant variations in mortality, whichever indicator is used.

Table 45 Post-neonatal and Child Mortality Rates, by Mother's Literacy

(Deaths per 1000)

Mother's Literacy	Post-neonatal	Child
Literate	21 *(16,030)*	27 *(12,360)*
Illiterate	28 *(8,055)*	40 *(6,734)*

Source: Fertility Survey

3.1 SEARCH FOR CAUSES

The foregoing analyses indicates that all three explanatory variables seem to explain some of the differentials in mortality.

As has been discussed earlier, some of the relationships established between each of those variables and mortality levels could be spurious. Also, the analysis has not taken into account the place of residence of the household, and, in particular, that estate mortality, which has its own particular pattern, should be analysed separately. This reasoning could hold even for urban mortality, though in

Sri Lanka urban-rural differentials, especially in some of the variables which could have an effect on mortality are not so wide as in most other Third World countries.

As has already been done for neonatal mortality, the factor of residence can be controlled by examining the relationship of the other variables to mortality in the rural sector where the sample is large. This is more in the way of an illustrative analysis and does not necessarily imply that a relationship which seems to hold for the rural sector is true either for the urban or estate population.

Accordingly, as in the earlier analysis of neonatal mortality, each of the explanatory variables was recoded to have only two values, and both post-neonatal and child mortality were classified by combinations of these dichotomies.

3.1.1 RURAL POST NEONATAL MORTALITY

Aggregation of each variable to two categories, suppresses some of the variation in mortality levels, but even classification by these aggregated variables yields some significant differentials in post-neonatal mortality.

Table 46 Rural Post-Neonatal Mortality Rates, by Toilet Facilities and by Mother's Literacy.

(Deaths Per 1000)

Mother's Literacy	Toilet Facility	
	Yes	No
Literate	16 *(8,658)*	23 *(3,409)*
Illiterate	18 *(2,957)*	24 *(2,875)*

Source: Fertility Survey

Controlling for mother's literacy does not eliminate the differentials in mortality by toilet facilities; even among literate mothers, post-neonatal mortality is 16 for those living in houses with toilet facilities as against 23 for those which have no facilities. But when controlled for toilet facilities, mother's literacy does not influence mortality levels.

Table 47 Rural Post-Neonatal Mortality Rates, by Toilet Facilities and by Husband's Educational Level

(Deaths Per 1000)

Husband's Educational Level (Years of Schooling)	Toilet Facility	
	Yes	No
<6	18 *(5,943)*	25 *(4,452)*
6+	15 *(5,674)*	20 *(1,832)*

Source: Fertility Survey

As in the case of mother's literacy, controlling for husband's education does not eliminate the difference in mortality rates by toilet facilities. Would these differences be eliminated if mortality was classified by the three explanatory variables?

Mortality varies from a level of 15, when all conditions are good, to a level of 26, when all conditions are bad.

Table 48 Post-Neonatal Mortality in Rural Sri Lanka, by Husband's Educational Level, by Mother's Literacy, and by Toilet Facilities

(Deaths Per 1000)

Variable Combination*	Mortality Rate
a) H_1 L_1 T_1	15 *(4881)*
b) H_2 L_2 T_1	17 *(2164)*
c) H_2 L_1 T_1	18 *(3777)*
d) H_1 L_2 T_1	19 *(793)*
e) H_1 L_2 T_2	19 *(576)*
f) H_1 L_1 T_2	21 *(1256)*
g) H_2 L_1 T_2	25 *(2153)*
h) H_2 L_2 T_2	26 *(2299)*

*Note: 'H' for Husband's Educational Level, 'L' for Mother's Literacy, and 'T' for Toilet Facilities.

Source: Fertility Survey

The following figures are illustrative of the impact of toilet facilities on post-neonatal mortality.

Table 49 Variations in Post-Neonatal Mortality in Rural Sri Lanka, by Toilet Facilities, Holding Other Variables Constant

(Deaths Per 1000)

Variable Combination	Mortality Rate
a) T_1 L_1 H_1	15 *(4881)*
b) T_2 L_1 H_1	21 *(1256)*
c) T_1 L_2 H_2	17 *(2164)*
d) T_2 L_2 H_2	26 *(2299)*

Source: Fertility Survey

It would seem from a comparison of (a) and (b), that even when other conditions are good, as measured by husband's education and mother's literacy, mortality is lower in a household which has toilet facilities, and a comparison of (c) and (d) show, when other conditions are bad, that differentials in mortality are even higher between households with such facilities and those without. A more significant fact arising from these figures is shown in a comparison of (a) and (c); (Table 49), here the comparison indicates that in a household which has toilet facilities, mortality is low relatively, whatever the level of other conditions. Both husband's education and mother's literacy do not seem to have much of an influence on post-neonatal mortality (Table 50 and 51).

Table 50 Variations in Post-Neonatal Mortality in Rural Sri Lanka, by Husband's Educational Level, Holding Other Variables Constant

(Deaths Per 1000)

Variable Combination	Mortality Rate
a) H_1 L_1 T_1	15 *(4881)*
b) H_2 L_1 T_1	18 *(3777)*
c) H_1 L_2 T_2	19 *(576)*
d) H_2 L_2 T_2	26 *(2299)*

Source: Fertility Survey

Table 51 Variations in Post-Neonatal Mortality in Rural Sri Lanka, by Mother's Literacy, Holding Other Variables, Constant

(Deaths Per 1000)

Variable Combination	Mortality Rate
a) L_1 T_1 H_1	15 *(4,881)*
b) L_2 T_1 H_1	19 *(793)*
c) L_1 T_2 H_2	25 *(2,153)*
d) L_2 T_2 H_2	26 *(2,299)*

Source: Fertility Survey

3.1.2 CHILD MORTALITY

A similar analysis was done for child mortality. Although aggregation has suppressed some of the sharper differences, even classification by these aggregated variables yields significant differentials in child mortality (Tables 52 to 54).

Table 52 Rural Child Mortality Rates, by Toilet Facilities and by Husband's Educational Level

(Deaths Per 1000)

Husband's Educational Level (Years of Schooling)	Toilet Facility	
	Yes	No
6+	23 *(4,372)*	30 *(1,362)*
<6	34 *(5,016)*	44 *(3,508)*

Source: Fertility Survey

As Table 52 indicates, mortality differentials, although lowered, remain even when controlled for the effects of toilet facilities or husband's education. But the introduction of the variable Literacy of Mother removes some of these differentials.

Table 53 Rural Child Mortality Rates, by Toilet Facilities and by Mother's Literacy

(Deaths Per 1000)

Mother's Literacy	Toilet Facility	
	Yes	No
Literate	25 *(6,803)*	38 *(2,516)*
Illiterate	39 *(2,585)*	42 *(2,354)*

Source: Fertility Survey

Child mortality is virtually the same among:

a) Illiterate mothers, whether the household has toilet facilities (39) or does not have such facilities (42);
b) Households which have no toilet facilities whether the mother is literate (38) or not (42).

But it should be noted that even in households which have toilet facilities, child mortality is very much less when the mother is literate than when she is illiterate (Table 53).

That the variable Literacy of Mother has an independent impact is emphasized in Table 54 which shows there are significant differences in child mortality of literate and illiterate mothers even when controlled by husband's education. And as the figures indicate, if the mother is illiterate, the husband's level of education has little influence on child mortality.

Table 54 Rural Child Mortality Rates, by Mother's Literacy and by Husband's Educational Level

(Deaths Per 1000)

Mother's Literacy	Husband's Educational Level (Years of Schooling)	
	6+	<6
Literate	21 *(4,583)*	35 *(4,736)*
Illiterate	38 *(1,151)*	41 *(3,788)*

Source: Fertility Survey

Here the effect of all three explanatory variables on child mortality is complex, but even controlling for association between these variables, each at particular levels has an effect on child mortality. A further analysis is not possible due to problems of sample size.

As was established in the case of neonatal mortality, are there some mothers who are more prone to having post-neonatal and child deaths?

Mothers Prone to Post-neonatal Mortality

Of the 570 post-neonatal deaths in the sample, 173 occurred to mothers who had at least two or more neonatal deaths, i.e., thirty per cent of post-neonatal mortality in the sample were among 76 mothers (1.2 per cent of the total number of mothers in the sample).

Table 55* Percentage of All Post-Neonatal Deaths Experienced by Mothers With at Least Two Post-Neonatal Deaths by Place of Residence

Urban	Rural	Estate	All
29	26	45	30

* Refers to mothers with at least two live births
Source: Fertility Survey

As the foregoing table indicates a high proportion of post-neonatal deaths occurs among mothers with at least two post-neonatal deaths. The proportion is higher in the estates than in the rest of the country where the proportion is also quite high. Since mothers with at least two post-neonatal deaths are only a very small proportion of the mothers in the sample, it would seem that in urban and rural areas and in estates, post-neonatal mortality rates are high because of conditions in a small number of households.

Mothers Prone to Child Mortality

Of the 655 child deaths in the sample, 216 occurred to mothers who had at least two or more child deaths. Thirty-three per cent of the child deaths in the population were among 93 mothers (1.5 per cent of the total number of mothers in the sample).

As the foregoing table indicates, a high proportion of child deaths occurs among mothers with at least two child deaths. This proportion is lower in the estate sector unlike in the case of neonatal mortality and post-neonatal mortality, but as in the last two cases, it would seem that in the urban

Table 56* Percentage of All Child Deaths Experienced by Mothers With at Least Two Child Deaths, by Place of Residence

Urban	Rural	Estate	All
30	34	28	33

* Refers to mothers with at least two live births.
Source: Fertility Survey

and rural areas and in estates, child mortality rates are high because of the conditions in a small number of households.

3.2 CONCLUSIONS

Economic level of the household, environmental conditions, and mother's understanding of health care, all seem to have an independent impact on child mortality, in contrast to neonatal mortality where mother's level of understanding did not seem to be an important factor. Post-neonatal mortality according to the survey data seems to be influenced mainly by environmental conditions although it is almost certain that aggregation has suppressed the effects of the other variables.

4 Infant and Child Mortality in the Estates

A separate analysis of infant and child mortality in the estate sector is included since it is very much higher there than in the rest of the country. The Fertility Survey underestimates the extent of this difference, for it will be seen in Chapter 5 that there was under-reporting of female infant deaths in the survey.

Table 57 Infant and Child Mortality, for Estate and Non-Estate Areas, Sri Lanka: 1948-1974

(Deaths Per 1000)

	Infant Mortality			
Area	Neonatal	Post Neonatal	Total	Child*
Estate	81 *(2162)*	53 *(1988)*	134 *(2162)*	36 *(1541)*
Non-Estate	35 *(22900)*	19 *(22106)*	54 *(22900)*	31 *(17562)*

*Child mortality rates are for the period 1948-70.

The extent of the differentials is not only surprising but shocking, since some of the pioneering work in introducing trained midwifery services and providing sanitation and uncontaminated water other than in urban areas was done in the estates prior to the Second World War. But it is clear from Tables 2 and 8 that since then, infant and child health has not improved in the estates.

The Registrar General's statistics indicate that estate infant mortality has remained at a level between 95 and 115 per 1000 live births during the last 25 years (excluding the famine year 1974) and has shown a tendency to increase during the last few years (Table 2). The level of child mortality in the estates unlike in urban and rural areas, has also not declined during the last two decades (Table 8).

Why has this been so? Are the nutritional and environmental conditions and medical care in the estates very much worse than in the rest of the country?

4.1 NEONATAL MORTALITY

The Fertility Survey data indicates neonatal mortality rates well over 60 per 1000 live births in the estates. Although the Registrar General's report does not provide data on estate neonatal mortality, evidence of very high neonatal mortality is seen in statistics collected by the Ceylon Planters Association Estates Health Scheme. The scheme includes the larger plantations in the estate sector and covers approximately 60 to 65 per cent of the estate population as defined by the Registrar General (Table 58).

Table 58 Infant, Neonatal, and Post-Neonatal Mortality in Member Estates of Ceylon Planters Association Health Scheme

(Deaths per 1000 Live Births)

Year	Infant	Neonatal	Post-neonatal
1960	90.6	62.0	28.6
1961	87.0	60.8	26.2
1962	86.7	63.4	23.3
1963	90.4	62.6	27.8
1964	92.0	65.8	26.2
1965	89.4	65.0	24.4
1966	90.6	61.3	29.3
1967	83.2	60.1	23.1
1968	84.9	60.1	24.9
1969	100.7	67.4	33.3
1970	96.6	64.9	31.7
1971	92.6	66.7	25.9
1972	100.6	70.0	30.6
1973	103.8	70.6	33.2
1974	144.0	67.9	76.1

Source: Medical Director's Reports. Ceylon Planters Association Estates Health Scheme.

All sources of data indicate estate neonatal mortality figures of 60 to 70 per 1000 as against rates around 30 per 1000 in the rest of Sri Lanka, and they also show that the high infant mortality in the estates is mainly due to very high neonatal mortality.

Table 59 Infant Deaths Among the Indian Estate Population, by Age and by Cause of Death: 1949

	7 Days and Under		Under 1 Month		1 Month to 1 Year	
Cause of Death	Number	Per Cent	Number	Per Cent	Number	Per Cent
Convulsions	88	7.1	188	8.8	213	18.7
Tetanus	2	–	5	.2	1	–
Bronchitis and Pneumonia	18	1.4	55	2.6	341	29.9
Diarrhoea and Enteritis	3	–	11	.5	78	6.8
Prematurity and Debility	1105	88.5	1823	85.2	391	34.3
Other Causes	33	2.6	59	2.8	115	10.1
Total	1249	100.0	2141	100.0	1139	100.0

Source: Addendum to the Administrative Report of the Commission of Labour for 1949, Colombo 1950.

Table 60 Main Causes of Infant Mortality, Estate and Non-Estate, Sri Lanka: 1966

Cause of Death	Estate			Non-Estate		
	Deaths			Deaths		
	Total	Per Cent	Rate*	Total	Per Cent	Rate*
Ankylostomiasis, and Other Diseases Due to Helminths	9	.3	.2	5	.3	–
Pneumonia and Bronchitis	293	10.5	10.0	1,528	8.9	4.5
Gastritis, Duodenitis, Enteritis and Colitis Except Diarrhoea of the New Born	80	2.8	2.7	1,234	7.2	3.6
Birth Injuries, Post-Natal Asphxia, and Atelectasis	14	.5	.5	952	5.5	2.8
Infections of the New Born	79	2.8	2.7	1,191	6.9	3.5
Immaturity and Congenital Debility	2,023	72.5	69.2	5,813	33.8	17.1
Convulsions	190	6.8	6.5	2,350	13.0	6.9
Other	101	3.8	3.6	4,137	24.0	12.2
Total	2,789	100.0	95.4	17,210	100.0	50.6

* Deaths per 1000 live births

Source: Administration Report of the Registrar General of Ceylon 1966.

4.2 SEARCH FOR CAUSES

Why is neonatal mortality so high? Cause of death statistics for neonatal mortality are available only for 1949, and that, too, only for Indian immigrant labour. These data (Table 59) indicate that approximately 85 per cent of neonatal mortality is due to prematurity and debility.

Evidence of very high neonatal mortality due to the same cause is also confirmed by the Registrar General's statistics. Infant deaths from immaturity and congenital debility generally occur in the first few days or in the first month of life (Table 61). The infant death rate from immaturity and congenital debility is approximately 70 per 1000 live births in the estate sector as against 20 in the rest of the country (Table 60).

Table 61 Number and Per Cent Distribution of Infant Deaths from Immaturity and Congenital Debility, by Age, Sri Lanka: 1966

Number and Per Cent	0-7 Days	8 Days and <1 Month	1 Month and 12 Months	Total
Number	5,341	1,559	936	7,836
Per Cent	68.2	19.9	11.9	100.00

Source: Administration Report of the Registrar General of Ceylon, 1966.

If the death rate from immaturity and congenital debility is subtracted from the total, there is not much difference in the infant death rate from other causes as between the estates, where it is 26, and the rest of the country, where it is 34 (Table 60). In fact, the death rates for some causes are lower in the estates than in the rest of the country.

Why is the neonatal death rate from immaturity and congenital debility so high? The comments of the United Nations study are illuminating[12].

[12] United Nations, The Determinants and Consequences of Population Trends, New York, 1973, p. 126.

'The principal measure used in statistical studies to classify the new born infant by developmental maturity has been weight at birth. Analysis of data for January-March 1950 for the United States revealed that deaths of infants with low birth weights accounted for two thirds of all neonatal deaths. Chances of survival improved considerably with moderate increase in weight, with the optimum birth weight for survival being 3501-4000 grammes. When gestational age was introduced into the analysis it was found that the heavier babies at each gestation age level fared better than the lighter ones. . . studies in England and Wales, and Scotland revealed similar relationships. In the United States, low birth weight incidence has been shown to be related to a number of other variables, including urban or rural residence, size of locality, sex, plurality, (i.e., single or multiple births), birth order, age of mother, type of attendant at birth, and outcome of previous pregnancies although variation with age of mother and birth order has been shown to be only moderate'.

Very little useful analysis of the type just mentioned can be done on the fertility survey data in relation to estate mortality because of the small sample size in each category, which makes it impossible to search for real differentials. The nature of the problem is illustrated in Table 62.

Table 62 Estate Neonatal Mortality, by Husband's Educational Level: 1948–1974

(Deaths Per 1000 Live Births)

Husband's Educational Level (Years of Schooling)	Mortality
0.	110 *(328)*
1–5	88 *(1,286)*
6+	46 *(539)*

Source: Fertility Survey

The Fertility Survey data indicate that neonatal mortality varies by age of mother and parity. The per cent of births by parity and age of mother in the vulnerable groups is only slightly different in estate and non-estate sectors.

Table 63 Per Cent Distribution of Births to Estate and Non-Estate Mothers According to Parity and Age of Mother: 1948-1974

	Per Cent			Per Cent	
Parity	Estate	Non-Estate	Age of Mother	Estate	Non-Estate
1	24.1	21.8	<20	22.5	15.7
2–6	65.4	65.5	20–34	71.3	75.5
7+	10.5	12.7	34+	6.2	8.8
Total	100.0	100.0	Total	100.0	100.0

Source: Fertility Survey

The per cent of births exposed to greater risk according to parity is 34.6 per cent in the estates as against 34.5 in the non-estate sector, while by age of mother it is 28.7 in the estates and 24.5 in the non-estate sector.

According to the foregoing figures, birth order and age of mother are not factors which can explain the large difference in neonatal mortality between the two sectors. It is possible that these differences could be due to

a) Malnutrition among mothers
b) Lack of ante-natal care
c) Lack of trained midwives
d) Low level of institutional births.

4.2.1 MALNUTRITION AMONG MOTHERS

Malnutrition among mothers could be one of the main causes leading to the large number of infant deaths from immaturity and debility. The medical director of the estate health schemes commenting on estate maternal mortality says[13]

'The tendency to haemorrhage is mainly due to extreme anaemia of most estate mothers'.

The condition of the mother due to lack of adequate food could be one of the causes leading to high neonatal mortality in the estates.

The effect which malnutrition has on infant mortality was seen in the famine year of 1974. The shortage of food was due to two successive crop failures in Sri Lanka in 1973 and 1974. Limited food imports due to high prices consequent to a world wide shortage of food, resulting from poor harvests in the U.S.S.R. and India, led to a general shortage of food in Sri Lanka. The shortage resulted in the halving of the free rice ration in November 1973, a sharp increase in bread prices from 35 to over 80 cents, which was also accompanied by a scarcity in bread supplies due to limited imports of flour. The shortage was severely felt by the poorer classes throughout the country. The estate population was severely affected by this crisis. Infant mortality rose steeply in the estates (Table 2). Infant mortality which was around 100 per 1000 live births in the estates rose to 163 in 1974, while in the rest of Sri Lanka it remained stable. This is not to say that mortality among the poor in the rest of the country did not increase, but no statistics are available to measure this effect.

But is the anaemic condition of the mother the cause of high neonatal mortality? The available evidence does not seem to justify such a hypothesis. Although 1974 was a year of grave food shortages in the estates, if infant deaths from immaturity and debility were due to malnutrition among mothers, then the neonatal death rate should have risen in 1974. As Table 58 shows, it was not the neonatal rate but the post-neonatal rate which rose sharply in 1974. Also, if malnutrition among mothers is the main cause of immaturity and debility, then neonatal mortality should have risen in 1975 after the food shortages of 1974. But on the contrary the estate infant death rate came down to its usual level in 1975 (Table 2). On this evidence, malnutrition does not seem to be the key factor causing immaturity and debility.

It could be argued, however, that the rise in post-neonatal deaths in 1974 was due to the presence of a larger than usual cohort of infants suffering from immaturity and debility who succumbed to various infections after the neonatal stage, but according to this reasoning there should have been at least a slight increase in infant mortality in 1975.

4.2.2 LACK OF ANTE-NATAL CARE

As was commented earlier, the principal statistical measure of development maturity is the birth weight of the infant. Reporting on the findings of the National Survey of Health and Development in England, Wales and Scotland based on a longitudinal study of 5000 births, Douglas states

'that on the basis of the use they have made of the ante-natal service one could separate out groups of families in which there was a very high mortality during the first months of life. Part of the reason for this high death rate lay in the fact that poor ante-natal care was associated with low birth weight; but even when children of the same birth weight were compared they were less likely to survive if their mothers had failed to make adequate use of the available ante-natal service'.[14]

Ante-natal care depends on two factors: one, there have to be regular clinics conducted in places accessible to the estate population; these facilities were lacking except in a few estates.

But even if regular clinics had been conducted, there would have been a shortage of para-medical personnel who could educate the estate mothers about the benefits of regular attendance at such clinics.

In 1969 the Medical Director of the Planters Association Estates Health Schem commented that

'Ante-natal and child welfare work is greatly affected by the shortage of midwives and this is probably the second major factor involved in the high infant mortality on estates'.[15]

It is possible that one of the major reasons for the difference in neonatal mortality between estates and the rest of the country is that of less ante-natal care in the estates.

[13] Fernando, L.U.R., Medical Director's Report for 1969, Planters Association Health Scheme, p. 12.

[14] Douglas, J.W.B., The Environmental Challenge in Early Childhood, Public Health, May 1964, p. 109.

[15] Fernando, Dr. L.R.U., Medical Director's Report for 1969, Planters Association Estates Health Scheme, p. 27.

In contrast, between 50 and 60 per cent of expectant mothers are under care in the rest of the country (Table 64).

Table 64 Percentage of Expectant Mothers Under Care in the Non-Estate Sector

Year	Expectant Mothers	Percentage Under Care
1961	215,319	59
1962	230,266	62
1963	224,956	62
1964	199,962	55
1965	179,884	53
1966	197,812	58
1967	188,274	56
1968	229,549	65

Source: Estimates from data in Priority Health Needs and Demands in Sri Lanka and Their Projections. Health Planning and Programming Division, Ministry of Health, Government of Sri Lanka, October 1973.

4.2.3 LACK OF TRAINED MIDWIVES

The shortage of trained midwives seems to be a major problem in the estates.

The former medical director of the Planters Association Health Scheme comments that

'There are only 165 registered midwives serving on the 532 estates covered. 143 estates have had to get along with unregistered midwives, indicating the extreme shortage of this category of paramedic. Even in the case of the registered midwives, many are past their prime having retired from government service and then taken on a job on an estate. This group generally spend their time either in the estate hospital or estate maternity home and do very little line visiting, as a consequence of their age and the difficulties of the terrain'.[16]

The quality of these midwives does not seem to have led to deaths from births injuries, tetanus, etc. (Tables 59 and 60), unlike during the period before the Second World War when infant deaths in the first few days of life were very high due to neonatal tetanus and other complications arising from the various customary practices of traditional midwives. The decline of some of the most unhygienic of these practices is also confirmed by the great decrease in maternal mortality in the estates as compared to what it was before the war; the present level is 2.5 maternal death per 1000 live births against approximately 15-20 per 1000 live births in the period 1930-1940. The director further comments on the 'innate reluctance on the part of estate labour to seek early ante-natal care of their own volition'.[17]

However, there is little possibility of even educating estate women about the benefits of attending post-natal and ante-natal clinics and on the fundamentals of health care, given the great shortage of trained midwives. The present situation regarding infant mortality in the estates is reminiscent of the early 1930's when estate infant mortality was around the level of 200 per 1000 live births. The mother and the infant were the helpless victims of traditional health practices, and it is surprising that infant mortality was not higher. Under the Medical Wants Act of 1912 estates were subject to periodic inspections by government medical officers, and one of them records as follows:

'The infant is given a little powdered nutmeg obtained by grating it against the curry stone 'to cut the phlegm' and with it disease-bearing germs are introduced into the infants stomach; frequent doses of castor oil and sugar are further administered to irritate the intestinal tract of the infant who is kept away from the breast for 3 days. It is unnecessary to describe here the various unhygienic things done. . . and it is no surprise to find a large number of the infants die of debility'.[18]

Such practices were prevalent because there were no trained midwives to replace the line 'Dhais', the traditional midwives who attended the expectant mothers, and whose advice was followed with regard to the rearing of infants. The conditions were so bad that Dr. Ludovic, one of the Inspecting Medical Officers, considered that '33 per cent of the infantile deaths could be prevented if qualified midwives were employed and obeyed'.[19]

The attitude of the estate population to innovation in these matters was also not encouraging, and it is recorded that a planter's wife (a qualified doctor) who tried to do ante-natal work was forced to give up as a result of the opposition of the labour force.[20] The persistence of tradition was also reinforced because the estate population was mainly drawn from the depressed castes of South India, who, due to a lack of education and isolation from the rest of society, were not able immediately to appreciate the advantage of modern medicine and health care. The reports of the Medical Officers of Health of the period contain many references to the 'Stubborn conservatism of the estate labourers'[21] and their failure to make use of the maternity rooms and their facilities available on the estates. There is no doubt that these comments were justified. What is questionable is whether this reluctance of estate mothers to adopt a new method of child care was so deeply ingrained, for, as Table 65 suggests, these women were quick to adopt more healthy measures when there were trained midwives to instruct and explain them. In the period 1935-1941, when the number of trained midwives on the estate nearly trebled, the infant mortality rate took a sharp downward plunge (Table 65).

[16] Memorandum sent in 1977 to Sri Lanka government by Dr. L.R.U. Fernando, former Director of the Planters Association Estate Health Scheme.

[17] Memorandum sent in 1977 to Sri Lanka government by Dr. L.R.U. Fernando, for Director of the Planter Association Estate Health Scheme.

[18] Report of the Director of Medical and Sanitary Services, 1929. Colombo, 1930, p. 27.

[19] Administration Report of the Controller of Immigrant Labour, 1926. Colombo, 1927, p. 17.

[20] Administration Report of the Controller of Immigrant Labour, 1930. Colombo, 1931, p. 22.

[21] Administration Report of the Director of Medical and Sanitary Services, 1931. Colombo, 1932, p. 40.

Table 65 Infant Deaths Per 1000 Live Births Among Indian Estate Population and Number of Trained Midwives on the Estates

Year	Infant Deaths Per 1000 Live Births	Trained Midwives
1924	247	n.a.
1925	216	n.a.
1926	209	n.a.
1927	228	n.a.
1928	211	n.a.
1929	213	n.a.
1930	194	93
1931	184	109
1932	188	89
1933	181	86
1934	200	82
1935	198	96
1936	172	121
1937	169	160
1938	171	170
1939	169	191
1940	149	241
1941	119	275
1942	120	283
1943	122	266
1944	129	239
1945	126	282
1946	134	275
1947	109	276
1948	112	277
1949	111	272

Source: Administrative Reports of the Controller of Immigrant Labour, Colombo.

It is interesting, however, to note that the mortality levels had stabilized by 1947 at a level around 110 and that the number of midwives working on the estates had also stabilized. It is noted that in 1943 of approximately 2,300 estates under the 'medical wants ordinance' about 550 had the services of a trained midwife. Although the 550 were on the larger estates which accounted for much of the estate population, a larger number of the estate population did not have such services. Of 26,278 births registered in estates visited by Inspecting Medical Officers in 1941, 10,245 were on estates having registered midwives, and of these, 6,644 were attended by registered midwives. The remaining 20,000 were not delivered by trained midwives.

It would seem from this figure and from the comments of the Director of the Planters' Association Health Scheme that the situation with regard to the availability of trained midwives is worse in the 1970's than it was in the 1940's.

4.2.4 INSTITUTIONAL DELIVERIES

The other hypothesis regarding the factors influencing the level of neonatal mortality is that those infants who are delivered in an institution, have the benefit of better health care facilities which can reduce the death rate of infants from immaturity and debility. Douglas commenting on the results of the study referred to earlier says,

'We know little about the cause of prematurity and there is no immediate hope of bringing about a rapid fall in its incidence. Experience shows that a more immediately practicable method to reduce neonatal deaths would be to improve the standard of care for premature babies and thereby increase their chance of surviving'.[22]

In the estates, the Medical Director comments that another factor responsible for the high infant mortality rate is the large number of non-institutional deliveries. Of the 532 estates in the Health Scheme, only 185 provided facilities for conducting deliveries in maternity wards attached to estate hospitals, but even in these 185 estates, 22 per cent of the births were non-institutional. In the other 347 estates, nearly all births, except for a few delivered in Government hospitals, were in the estate lines.[23] Infants born in the estate lines would have been exposed to greater risks of infection. The Director comments that

'giving birth to their infants in the unhygienic confines of their line rooms appears to be one of the major factors responsible for the high infant death rate on the estates'.[24]

In contrast, the number of births in the non-estate sector delivered in institutions was between 60 and 70 per cent (Table 66).

Non-institutional deliveries in the estates, which are in the colder areas of Sri Lanka, also would in many cases have deprived the infant of at least protection from the cold due to the non-availability of proper clothes and blankets.

Table 66 Percentage of Non-Estate Live Births Delivered in Hospitals and Maternity Homes and by Public Health Midwives: 1961-1968

	Live Births Delivered		
Year	In Hospitals and Maternity Homes	At Home by Public Health Midwives	Total
1961	65	17	82
1962	65	16	81
1963	66	16	82
1964	68	17	85
1965	66	13	79
1966	64	14	78
1967	70	13	83
1968	67	13	80

Source: Estimates from Data in Priority Health Needs and Demands in Sri Lanka and Their Projections, Health Planning and Programming Division, Ministry of Health, Government of Sri Lanka, October 1973.

A preliminary survey of statistics for 64 estates in the Nuwera Eliya district for the year 1977 indicates that infant mortality is lower in estates with maternity homes (Table 67), but further studies are required to examine whether there is a causal relationship.

22 Douglas, J.W.B., Children Under Five, p. 66.

23 Fernando, Dr. L.R.U., Medical Director's Report for 1969, Planters Association Health Scheme, pp. 25-26.

24 Ibid., p. 26.

Table 67 Infant Mortality, Nuwara Eliya District: 1977

(Deaths per 1000 Live Births)

	Number of Births	Number of Deaths	Death Rate
Estates with Maternity Homes	2,027	178	88
Estates without Maternity Homes	1,705	204	120

4.3 CHILD MORTALITY

Estate child mortality is higher than that in the rest of Sri Lanka, although the difference is much less than that for infant mortality. While infant mortality as estimated from the survey data cumulated for the period 1948-74 was approximately 150 per cent higher than that for the rest of the country, child mortality for the period 1948-70 was only 20 per cent higher (Table 57).

Table 68 Child Mortality, for Estate and Non-Estate Areas: 1948-1958 and 1959-1970

(Deaths per 1000)

Period	Estate	Non-Estate
1948-1958	31 *(487)*	45 *(5,577)*
1959-1970	38 *(1,054)*	25 *(11,985)*

Source: Fertility Survey.

The trend in child mortality is given in the foregoing table. Not only are the levels of mortality between the two populations different, but child mortality has declined rather sharply in the rest of the country, while estate mortality seems to have remained unchanged or even increased, although the latter is conjecture since the sample size is too small to make any definitive judgement.

Unfortunately, no estimates of the trend in the estate death rate of children aged one to four can be made from census and registration data since no census tabulations of the estate population by age have been done for any of the censuses after 1946.

Table 69 Child Mortality, for Estate and Non-Estate Areas, by Main Causes of Death: 1966

	Estate		Non-Estate	
Cause of Death	Number	Per Cent	Number	Per Cent
Ankylostomiasis and Other Diseases Due to Helminths.	90	10	1,076	11
Pneumonia and Bronchitis	328	38	1,512	15
Gastritis, Duodenitis, Enteritis, and Colitis	101	12	1,538	15
Convulsions	127	14	1,410	14
Mandama	8	1	1,098	11
Other Causes	217	25	3,378	34
Total	871	100	10,012	100

Source: Administration Report of the Registrar General, 1966.

A comparison of cause of death statistics between the estates and the rest of Sri Lanka could provide a clue to the reasons for the difference in the child mortality rates in the two populations. A valid comparison can only be done when rates are calculated, but it would seem that pneumonia and bronchitis are much more serious diseases in the estates than in the rest of the country. This is not surprising, given the level of malnutrition in the estates and the devastating effects of pneumonia and bronchitis among children suffering from malnutrition.

The high rates could also be due to the estates being at a higher altitude where the cold could make the probability of an attack of pneumonia or bronchitis greater than in the rest of the country (Table 5). The higher death rate could also reflect the lack of hospital treatment for some groups of estate children, due to distance as well as due to their not being covered by maternity and child welfare centres.

There is, however, one intriguing statistic in Table 69, deaths from Mandama, which term, according to the Registrar General,

> 'is very widely used in rural areas to describe vaguely, diseases supposed to be connected with malnutrition, and a very large number of deaths is attributed to it yearly. Practically all deaths returned as due to Mandama occur among children under 10 years of age'.[25]

The deaths from this cause are much higher in the rest of the country than in the estates. This could be a real differential reflecting malnutrition among specific groups of children in the poorest groups of the population in the rest of the country. No groups in the estates are as poor as the poorest groups in the rest of the country, for estate labour has in general assured employment and at least a roof over its head. Even so, it is difficult to believe that deaths from Mandama in the estates are as low as indicated in Table 69.

A survey of the nutritional state of pre-school children in Sri Lanka, done for the period September 1975-March 1976, by the U.S. Department of Health, Education, and Welfare, together with the Ministry of Health of Sri Lanka, makes the following comment:

> 'Acute under-nutrition or wasting suggests current or recent deficiency in food intake reflecting either food unavailability or impaired absorption resulting from diarrhoea or other acute diseases. . .Chronic under-nutrition or stunting implies past and long term nutritional inadequacies of food supplies, a more subtle nutritional deprivation that retards linear growth. . . Mortality and morbidity from chronic under-nutrition is not likely to be as measurable or as impressive as that of acute under-nutrition'.[26]

The survey figures on acute under-nutrition in estates and rural areas are shown in Table 70. They do not indicate that acute under-nutrition is less in the estates than in rural areas, rather they suggest that the per cent of pre-school children suffering from acute under-nutrition might be a little higher in the estates, differences in the proportions for all but one of the age groups being statistically significant at the 95 per cent level.

25 Administrative Report of the Registrar General of Ceylon, 1966

26 U.S. Agency for International Development, Sri Lanka Nutrition Status Survey, September 1975-March 1976, pp. 52-53.

Table 70 Percentage of Children With Acute Under-Nutrition, *for Estates and Rural Areas, by Age

Age (Months)	Rural Areas	Estates
6-11	4.8	6.7
12-23	10.5	13.5
24-35	6.6	9.2
36-47	4.2	9.1
48-59	4.6	7.1
60-71	6.4	4.9
6-71	6.3	8.6
Number of Children in Sample	12,301	1,130

* Weight-for-height less than 80 per cent of NAS reference.
Source: U.S. Agency for International Development, Sri Lanka Nutrition Status Survey, September 1975-March 1976, Table 15, p. 39.

Since there is acute under-nutrition among some of the population in both estates and the rest of the country, it is not possible for there to be only a few deaths from malnutrition in the estates. It could be that deaths from Mandama in the estates have been subsumed in the category deaths from gastritis, duodenitis, enteritis, colitis, and deaths due to convulsions.

A comparison between the estates and the rest of the country of variables which were seen to be co-related to mortality levels in the earlier analysis also gives some indication of why mortality is so high in the estates.

Table 71 Per Cent Distribution of Respondents According to Husband's Educational Level, by Place of Residence

Husband's Educational Level (Years of Schooling)	Urban	Rural	Estate
None	3.3	8.3	14.1
1-5	26.4	42.1	60.5
6-9	37.9	34.6	20.3
9+	32.3	15.0	5.1
Total	100.0	100.0	100.0

Source: Fertility Survey.

Approximately 75 per cent of the husbands in the estates who are in the main agricultural workers had no schooling or only primary education as against 50 per cent in the rural sector and 30 per cent in urban areas.

The variable Mother's Literacy shows an even larger variation, with only 35 per cent literate mothers in the estates as against 85 per cent and 75 per cent in the urban and rural sectors, respectively. The prospects for improving maternity and child welfare in the estates would be better if literacy levels among the younger women in the estates were comparable to those in the rest of the country, but this is not the case; only 43 per cent of the respondents aged less than 30 in the estates were literate as against 89 per cent and 82 per cent in the urban and rural areas (Table 72).

Table 72 Percentage of Respondents Who Are Literate, by Age and by Place of Residence

Age Group	Urban	Rural	Estate
<30	89	82	43
30-39	86	77	36
40-49	79	65	19
All	85	75	35

Source: Fertility Survey.

The other important background variable which was found to have an effect on mortality levels of infants and children was the availability of toilet facilities.

Table 73 Percentage of Births in Households With Toilet Facilities, by Place of Residence: 1948-1974

Toilet Facilities	Urban	Rural	Estate
Flush and Water Seal	46.8	14.1	10.9
Bucket and Cesspit	33.0	50.5	28.5
None	20.2	35.4	60.6
Total	100.0	100.0	100.0

Source: Fertility Survey.

In the survey figures, appoximately 60 per cent of the households in the estates sector have no toilet facilities as against 20 in the urban and 35 in the rural. But the figures for the estates are in conflict with those collected in the 1971 Housing Census, as in shown in Table 74, where the census indicates that in the estates only approximately 15 per cent of housing units are without toilets, as against the figure of 60 per cent obtained in the Fertility Survey. The figures are compatible for both the urban and rural sector, while there are serious differences in the figures for the estates (Table 74). The fertility survey figures are also not compatible with the data collected by the Central Bank of Ceylon (Table 75).

Table 74 Per Cent Distribution of Housing Units According to Type of Toilet Facilities, by Place of Residence

Type of Toilet Facilities	Urban		Rural		Estates	
	Survey	Census	Survey	Census	Survey	Census
Flush & Water Seal	46.2	42.0	14.1	12.1	10.9	42.1
Bucket & Cess Pit	33.6	37.7	50.5	45.4	28.5	42.3
None	20.2	20.3	35.4	42.5	60.6	15.6
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Fertility Survey and the 1971 Housing Census.

Table 75 Percentage of Estate Households with Toilet Facilities: 1953, 1963, and 1973

	Toilet Facilities		
Year	Own	Shared	None
1953	3	81	16
1963	21	64	15
1973	*	*	29

* Data on shared facilities were not collected in the 1973 Survey.
Source: Surveys of Ceylon's Consumer Finances, Central Bank of Ceylon.

The probable error could have arisen from the framing of the Fertility Survey question, 'What type of toilet facilities do you have?' Many of the estate household have communal toilet facilities (Table 75), and it is possible that many respondents who shared toilet facilities replied in the negative to this question.

4.4 CONCLUSION

Estate neonatal mortality was at a level between 60 and 80 per 1000 live births (Tables 57, and 58), which is a little higher than the rate among the worst-off groups among the rest of the population. For instance, the groups H_2 A_2 T_2 (Table 34) in the rural population had a neonatal mortality rate of 63.

There are several reasons for this situation. Firstly, there is a gross shortage of trained midwives and other paramedics in the estates. The lack of advice on health care has an effect on the infant death rate in many ways. Infants are not breastfed for a few days after birth; they are, instead, fed injurious and sometimes infected concoctions. The children are born in unhygienic surroundings even when maternity homes are available. Very few expectant women have the benefit of ante-natal care, and it is possible that malnutrition is common. Also, since most estate mothers work, there is early weaning. Finally, the majority of estates are at high altitude, and it is possible that the infants are not sufficiently protected from the cold. Although it may not be common today, in 1879 the Principal Civil Medical Officer of Ceylon commented that after an infant is delivered, 'In some cases the woman goes to work too soon, and the infant is also brought and exposed in a cloth to the influence of the sun and the rain'.[27]

27 Medical Wants of the Coffee Districts, Sessional Paper 5 of 1879, Colombo 1879, p. 182.

5 Sex Differentials in Infant and Child Mortality

Sex differences in childhood mortality are a feature of all populations. Such differences are also present in Sri Lanka.

Table 76 Male Infant and Child Mortality as Percentage of Female Mortality: Selected Countries

Country	Year	Infant	Child
Taiwan	1966	111.0	95.5
France	1965	128.9	125.0
Guatemala	1964	120.0	93.7
Mauritius	1966	119.7	97.3
Netherlands	1966	134.4	137.5
Norway	1965	125.0	142.9
England and Wales	1966	130.7	112.5
Sri Lanka	1971	119.2	85.0

Source: Estimated from Table V.7 in The Determinants and Consequences of Population Trends. United Nations, New York, 1973.

Infant mortality among males is invariably higher than that among females in almost all countries. Child mortality in the developed countries is also higher among males, but in several Third World countries, including Sri Lanka, child mortality is less among males than among females.

In Sri Lanka, mortality rates of males throughout infancy are higher than those of females, but the differences decrease when the infant grows older. (Table 77)

Table 78 Child Mortality in Age Group 1-4, by Sex, Census, Years.

(Deaths Per 1000)

Year	Male	Female	Male Mortality as Percentage of Female Mortality
1953	17.1	20.5	83.4
1963	8.3	9.8	84.7
1971	5.1	6.0	85.0

Source: Administration Reports of the Registrar General of Ceylon and unpublished data from the Department of Census and Statistics.

Male child mortality is less than female mortality and has continued to remain at around 83 to 85 per cent of female mortality for the last 25 years (Table 78). Is the higher female death rate due to higher underenumeration at the census of females in the age group 1-4 years?
It has been noted that:

> 'While infant mortality for females is invariably less than that for males, at ages 1-4 years, recorded death rates are higher for girls than for boys in such countries as Mauritius, Reunion, the United Arab Republic, Costa Rica, Guatemala, Mexico, Puerto Rico and Taiwan, as well as in Ceylon, India and Pakistan.'[28]

Do the Fertility Survey estimates of infant and child mortality by sex confirm the pattern shown in registration figures? There is basic agreement between the sex differences in mortality estimated from the Registrar General's figures for 1971 and those estimated from the Fertility Survey. The ratio of male to female mortality in childhood as estimated from the Fertility Survey is approximately the same as those in Tables 77 and 78 based on the Regsitrar General's and census statistics (Table 79).

Table 79 Ratio of Male to Female Mortality in Childhood.

(Deaths Per 1000)

Mortality	Registrar General's and Census Statistics 1971	Fertility Survey*
Neo-Natal	131	132
Post-Neo-Natal	108	107
Child	85	88

*Neo-natal and post-neo-natal figures relate to the period 1948-1974 and child mortality to 1948-1970.

Do these differences between male and female mortality remain when controlled by place of residence and by socio-economic variables?

5.1 PLACE OF RESIDENCE

Fertility Survey data indicate very significant differences between male and female neonatal mortality in urban, rural, and estate areas (Table 80). But the difference is very large in the estates, and it would seem that there has been under-

[28] U.N. The Determinants and Consequences of Population Trends, New York 1973, p. 115.

Table 77 Infant Mortality, by Age and by Sex, Sri Lanka: 1962-1966

(Deaths Per 1000)

Sex	7 Days and Under	Over 7 Days to 1 month	Neonatal	Post Neonatal	Total Infant
Male	28.1	10.2	38.1	22.9	60.1
Female	20.7	8.5	29.0	21.2	49.6
Male Mortality as Percentage of Female Mortality	135.8	120.0	131.4	108.0	121.2

Source: Administration Reports of the Registrar General of Ceylon.

reporting of female infant deaths, especially at the neonatal stage in the estates. Clear evidence of under-reporting is seen in a comparison of sex differentials in infant mortality as estimated from this survey and from the Registrar General's figures.

Table 81 Infant Mortality, by Sex and by Place of Residence

(Deaths Per 1000 Live Births)

Sex	Survey Estimates (1948- 1974) Estates	Registrar General (Year 1966) Estates	Non-Estates
Male	164	105	55
Female	105	85	46
Male Mortality as Percentage of Female Mortality	156	124	120

Source: Administration Report of the Registrar General of Ceylon and the Fertility Survey.

The survey estimate of differences is too large to be explained as due to sampling variations. Registration data available both for estates and the non-estate sectors (Table 81) indicate that male infant mortality is about 20 per cent higher than female infant mortality. Figures available for residents of Colombo Municipality also indicate that male infant mortality is approximately 20 per cent higher than among females.
At the post-neonatal stage, the difference between male and female mortality in urban and rural areas is not significant although this differential remains in the estate sector. Child mortality is higher among females for urban, rural, and estate areas as is the case for the national figures based on registration statistics.

Does the above pattern of infant and child mortality remain when the data are classified by socio-economic variables? Specifically, it is interesting to examine whether these differentials remain among higher socio-economic groups. The differntials according to husband's level of education are shown in Table 82.

Table 82 Infant and Child Mortality, by Sex and by Husband's Educational Level: 1948-1974

(Deaths Per 1000)

Sex	Husband's Educational Level (Years of Schooling) < 6	6 +
Infant		
Male	77.1 *(7,229)*	58.1 *(5.573)*
Female	67.7 *(6.798)*	39.4 *(5.489)*
Child*		
Male	40.2 *(5,574)*	23.0 *(4,131)*
Female	45.2 *(5,350)*	25.7 *(4,126)*

* 1948-1970
Source: Fertility Survey.

Male infant mortality is significantly higher than female mortality at every level of husband's education, but although the survey estimates of male child mortality are lower than those for female mortality at every level of husband's education, the differences are not significant.

Does the pattern change when controlled by place of residence? Surprisingly, in rural Sri Lanka the differentials are sharpest among those groups when the husband has had six or more years of schooling.

Table 83 Infant and Child Mortality in Rural Sri Lanka, by Sex and by Husband's Educational Level: 1948-1974.

(Deaths Per 1000)

Sex	Husband's Educational Level (Years of Schooling) < 6	6 +
Infant		
Male	62.1 *(5,624)*	57.9 *(3,884)*
Female	59.8 *(5,252)*	37.1 *(3,887)*
Child*		
Male	39.0 *(4,410)*	16.5 *(2,897)*
Female	44.6 *(4,173)*	26.3 *(2,885)*

* 1948-1970
Source: Fertility Survey

Table 80 Neonatal, Post-Neonatal, and Child Mortality, by Sex and by Place of Residence: 1948-1974.

(Deaths Per 1000)

Place of Residence	Neonatal Male	Neonatal Female	Male as Percentage of Female Mortality	Post-Neonatal Male	Post-Neonatal Female	Male as Percentage of Female Mortality	Child* Male	Child* Female	Male as Percentage of Female Mortality
Urban	35.9 *(2,148)*	25.5 *(2,122)*	141	29.0 *(2,032)*	29.1 *(1,923)*	100	25.4 *(1,617)*	31.8 *(1,635)*	90
Rural	39.6 *(9,512)*	33.1 *(8,658)*	120	20.3 *(9,143)*	19.6 *(8,842)*	104	34.4 *(7,302)*	37.0 *(7,057)*	93
Estate	103.0 *(1,136)*	56.1 *(1,034)*	184	61.6 *(1,023)*	49.2 *(976)*	125	34.7 *(779)*	57.8 *(606)*	60
All	44.6 *(12,796)*	33.8 *(11,814)*	132	25.3 *(12,198)*	23.6 *(11,741)*	107	32.9 *(9,698)*	37.4 *(9,298)*	88

*1948-1970
Source: Fertility Survey

When the husband's education is six or more years, child mortality is significantly lower among males than among females. However, the differentials in child mortality by sex do not hold when a measure more representative of household well-being is used.

Table 84 Child Mortality in Rural Sri Lanka, by Sex and by Socio-Economic Categories: 1948-1970.

(Deaths Per 1000)

Socio-Economic Category	Male	Female
1. Husband's Schooling Six or More Years, Mother Literate, Household Has Toilet	23.2 *(1,855)*	21.0 *(1,860)*
2. Husband's Schooling Less Than 6 Years, Mother Illiterate, Household Has No Toilet	49.8 *(943)*	48.9 *(961)*
3. All Others	35.9 *(4,507)*	41.4 *(4,248)*

Source: Fertility Survey

Controlling for the three variables, Husband's Educational Level, Mother's Literacy, and Availability of Toilet Facilities, it would seem that at both ends of the social scale there is no significant difference between male and female child mortality, while in the middle range, child mortality is slightly higher among females.

5.2 DIFFERENTIALS BY CAUSE OF DEATH

Mortality differentials by sex vary considerably by diseases.

Table 85 Neonatal Mortality in Sri Lanka, by Sex and by Disease: 1966.

(Deaths Per 1000 Live Births)

Disease	Male	Female	Per Cent Male to Female
Immaturity and Congenital Debility	20.2	17.2	117
Convulsions	4.5	2.6	173
Infections of the New Born	3.9	2.9	135
Birth Injuries, Post-Natal Asphyxia and Atelactasis	3.0	2.1	143
Spina Bifida, Meningocele and All Congenital Malformations	0.6	0.4	150
Other Causes	4.1	3.4	121
Total	36.3	28.6	127

Source: Administration Report of the Registrar General of Ceylon, 1966.

Neonatal mortality for every major disease is higher among females.

Table 86 Child Mortality in Sri Lanka, by Sex and by Disease: 1971.

(Deaths Per One Million)

Disease	Male	Female	Male as Percentage of Female
Dysentery, Amoebiasis, Enteritis, and Other Diarrhoeal Diseases	644	802	80.3
Ankylostomiasis and Other Diseases Due to Helminths	343	406	84.5
Avitaminosis, Other Deficiency States, and Anaemias	673	923	72.9
All Respiratory Infections	1,005	1,237	81.3
Convulsions	567	643	88.2
Accidents	270	257	105.1
All Other Causes	1,597	1,776	89.9
Total	5,099	6,044	84.4

Source: Estimated from unpublished statistics with the Department of Census and Statistics.

Child mortality for every major cause of death is higher for females than for males, except in the case of accidents.

5.3 CONCLUSION

Infant mortality is higher among males than among females, and child mortality is higher among females than among males nationally, according to registration data, as well as according to estimates from the Fertility Survey.

Estimates from the Fertility Survey indicate that infant mortality is higher among males for all groups of the population.

Child mortality shows interesting variations. Some indicators show female child mortality is significantly higher among the upper socio-economic groups (Table 83), while other indicators show no significant difference in child mortality by sex in this group of the population (Table 84).

6 Conclusions

The main features of childhood mortality in Sri Lanka as brought out in this study are:

a) The prevalence of very high neo-natal death rates as compared to other countries with broadly similar infant mortality levels.

b) Very much higher mortality levels at all stages of childhood in estates than in the rest of the country. Infant mortality rates in estates have fluctuated at a level between 85 and 115 per 1000 live births since the Second World War, and reached a peak of over 150 in the crisis year 1974.

c) Trend decline in neonatal, post-neonatal, and child mortality in the non-estate sector by socio-economic groups.

e) The existence of strong environmental effects on mortality at all stages of childhood.

f) Contrary to the general pattern, registration figures have always shown female child mortality to be higher than male child mortality in Sri Lanka and in a few other countries. The Fertility Survey estimates broadly confirm the pattern of differences shown in registration figures.

g) Higher neonatal mortality at parity one and higher parities among all groups in the population.

h) Higher neonatal mortality among children of very young and older women.

i) A very small proportion of mothers account for a high per cent of the neonatal, post-neonatal, and child deaths recorded in the survey.

j) Food shortages led to a sharp rise in post-neonatal mortality, but did not have any effect on neonatal mortality.

6.1 SEARCH FOR CAUSES

Given the limited data available to measure the many variables which could have an effect on childhood mortality as measured by neonatal, post-neonatal and child mortality, the analysis was necessarily confined to an analysis of differences in mortality by various socio-economic variables.

The study has identified two areas which are critical, and a better understanding of the inter-relationship between various factors is needed if policy measures are to be adopted with a view to reducing mortality levels.

The first relates to the high neo-natal mortality rates among the mass of the population. As was discussed earlier, the high neonatal mortality rates reflect high mortality in the first few days after birth.

Why is the death rate from prematurity and debility so high during the first seven days of life? Research on broad medical lines has to be undertaken to understand this phenomenon.

The other critical area relates to very high post-neonatal and child mortality from respiratory diseases and from the diarrhoea-malnutrition syndrome. As was shown earlier, the death rates during the entire period of childhood are very much higher in households which have no toilet facilities; the death rate is high even in households with the cesspit type of latrine.

6.2 NEONATAL MORTALITY

In the case of neonatal mortality, immaturity and debility account for nearly 60 per cent of all neonatal deaths (Table 11). It has already been shown that neonatal mortality varies by age of mother and birth order. The group exposed to high risk at the neonatal stage are the parity one and higher parity infants as well as infants born to very young mothers and to older mothers. As was commented earlier this relationship exists even in the developed countries.

Could a part of the decline in the neonatal death rate (Table 1) during the period under study be explained by the decline in the per cent of births belonging to this high risk group? The statistics do not indicate this, the per cent of total births to the high risk group of mothers has not changed significantly over time. It was 21.3 per cent in 1952 and 10.8 per cent in 1975 (Table 87).

Table 87 Per Cent Distribution of Total Births According to Age of Mother: 1952, 1966 and 1975.

Age of Mother	1952	1966	1975
<20	7.8	7.2	7.1
20-34	78.7	76.0	79.2
35+	13.5	16.8	13.7

Source: Administrative Reports of the Registrar General of Ceylon. Department of Census and Statistics, Statistical Profile of Children, 1977.

The factors which could have influenced the trend decline in neonatal mortality in the non-estate sector was the increase both of the proportion of mothers receiving ante-natal care and the proportion having institutionalized births. Both proportions were in the range 60 to 70 per cent by late 1960's, while in 1950 the proportion of instutionalized births was only 25 per cent.

6.3 POST-NEONATAL AND CHILD MORTALITY

The death rate from post-neonatal and child mortality declined during this period in the non-estate sector, child mortality declining very sharply. One aspect of the decline in child mortality was the decline in deaths from diarrhoeal diseases, convulsions, and from ankylostomiasis and diseases due to other helminths (Table 41). Poor sanitary facilities is one of the major factors causing these diseases.

The survey indicated a strong relationship between mortality levels and the availability of toilet facilities. Evidence

that the relationship is causal is strengthened in that the number of households without toilet facilities in the non-estate sector decreased during this period, when mortality declined (Table 88). But it should be noted that child mortality also decreased over a wide range of other diseases (Table 41) which had no causal links to sanitation. The decline in the mortality from diarrhoeal and helminthic diseases is thus due not only to improved sanitation but also to other factors.

Table 88 Per Cent of Households Without Toilet Facilities, Non-Estate Sector

Year	Per Cent
1953	56.0
1973	42.7

Source: Central Bank of Ceylon, Survey of Ceylon's Consumer Finances.

6.4 RESEARCH PRIORITIES

The Fertility Survey provided sufficient material to probe and, where possible, to identify some of the factors which have a causal effect on mortality. However, in much of the work the indicators used were rough approximations of what they were supposed to measure. For example, the level of education of the mother or literacy of the mother was used as an indicator of the mother's capacity to understand those aspects of hygiene and health care relating to the health of the child, to regular attendance at maternity and child welfare clinics, and to obtaining medical care when her child was ill. The variable had only a small effect on infant mortality although it did have a strong effect on child mortality. If the data were available, a better measure of this factor would have been to see whether the mother had regularly attended ante and post-natal clinics.

In other instances, however, even such approximations could not be made either because of the absence of information regarding a particular factor or because of the unreliable nature of the data collected. This was the case with data relating to source of water supplies. Further studies need to be done in this area to identify the mechanism by which diarrhoeal disease is transmitted. Is it by eating contaminated food or through drinking contaminated water, and if so, what was the source of water supply?

The Fertility Survey did not provide any information as to whether a birth occurred in an institution or whether a birth was delivered by a public health midwife or some other person at home. It would have been useful to examine with a view to further institutionalization, whether infants born in institutions had a lower mortality rate than others, especially since institutional births on the average account for 65 per cent of total live births. This is relevant to Sri Lanka where several maternity homes have been lying vacant for years. Questions also need to be raised as to why there is a shortage of trained midwives in the estates. Given the very high unemployment among educated women, it should not prove difficult to train the numbers required each year.

Age of weaning could have a significant influence on post-neonatal and child mortality. Although the survey collected data on the last birth and the one before, the data showed considerable heaping at 12 and 24 months and were clearly not sufficiently accurate for purpose of analysis. Interpretation was also made more difficult because there was no information to identify those births where breast-feeding had stopped because of the death of the child and those where it was stopped due to other reasons.

Also given the relationship between child mortality and malnutrition, is there data other than that at the national level to identify broadly, both by socio-economic groups and by place of residence, those children who are suffering from malnutrition?

The other problem relating to health care is even more intriguing. The number of infants under the care of the Department of Health, that is, children who are visited by para-medical workers, has declined drastically (Table 89). But as commented upon by a WHO expert this decline has not led to a rise in infant mortality:

'It is significant that the sharp decline in the amount of health care delivered to infants was not accompanied by any rise in the infant mortality rate which remained almost constant during the period under review; this fact may cast some doubt on the efficiency and relevance of the health service delivered to the infant'.[29]

Table 89 Infants Under Care

	Under Care	
	Number	Per Cent of Total Births
1961	106,209	29.2
1962	89,473	24.1
1963	67,092	18.3
1964	67,614	18.7
1965	62,405	16.9
1966	57,833	15.7
1967	39,011	10.6
1968	33,930	8.8

Source: Ministry of Health, Health and Programming Division, Priority Health Needs and Demands in Sri Lanka and Their Projections, Government of Sri Lanka, October 1973.

It would be useful to examine whether the visits by para-medical workers serve any purpose. Although they do not seem to have any effect on infant mortality, it is possible that they could be better used to teach more hygienic practices to mothers, to encourage expectant mothers to visit ante-natal clinics, (at least 30 per cent of mothers do not visit such clinics), and to educate mothers especially about the cheaper nutritive foods available in their community.

It is also necessary to examine why a substantial number of expectant mothers does not have the benefit of ante-natal care. Why is it that the coverage is restricted to approximately 70 per cent of the mothers? Although these services were available only to a few estate mothers, even in the non-estate sector well over 30 per cent of expectant mothers seem to have been left out. Can these women be identified by characteristics useful for a health planner?

Another subject which should be further examined is the apparent concentration of a high proportion of infant and child deaths among a relatively small group of women in the sample.

29 Simionov, L.A., Better Health for Sri Lanka: Report on a Health Manpower Study. W.H.O. New Delhi, November, 1975.

Table 90 Number of Mothers With at Least Two Live Births, by Number of Infant and Child Deaths Individually Experienced and by Place of Residence

Number of Infant and Child Deaths Individually Experienced by a Mother	Place of Residence			
	Urban	Rural	Estate	All
0	725	2,625	264	3,614
1	176	745	116	1,037
2	44	212	65	321
3	16	50	15	81
4	6	21	11	39
5	2	7	2	11
6	0	3	1	4
7	0	0	1	1

Source: Fertility Survey.

Nine per cent of the 5,107 mothers with at least two live births had two children dying in the age group 0-4, and these deaths accounted for 52 per cent of the total deaths of children aged 0-4 born to these women. The proportion of mothers who would have at least two such infant or child deaths will, of course, be higher by the time the cohort of mothers in the survey complete the reproductive span. But there can be no doubt that there is a group of mothers whose children are in the high risk group (Table 91).

Table 91 Number of Mothers* With at Least Two Deaths of Children Aged 0-4 Per 1000 Mothers With at Least Two Live Births, by Husband's Educational Level, by Mother's Literacy, and by Place of Residence

Place of Residence	Husband's Educational Level (Years of Schooling)	Mother's Literacy	
		Literate	Illiterate
Urban	< 6	111 *(199)*	178 *(101)*
	6+	31 *(610)*	88 *(57)*
Rural	< 6	83 *(1,180)*	134 *(730)*
	6+	48 *(1,518)*	92 *(228)*
Estate	< 6	266 *(90)*	220 *(273)*
	6+	86 *(58)*	278 *(54)*

*The figures in parenthesis refer to the denominator of the ratio from which these rates have been estimated, i.e. each figure refers to the number of mothers with at least two live births.

Source: Fertility Survey.

The areas posed here for further research are not of an abstract nature unrelated to matters of public interest and public policy. It is only on the basis of such information that priorities can be set in health planning.

6.5 FUTURE PROSPECTS

By 1960, infant mortality in Sri Lanka was well below the levels then reached in most of the Third World countries and even in some of the poorer European countries.

But in 1976 nearly every one of the countries listed in Table 92 had lower mortality levels than Sri Lanka, most of them even had lower infant mortality levels than the non-estate sector of Sri Lanka (Table 2). Although there is no doubt that the decline in the prices of the exports of Sri Lanka and the swing of the terms of trade against her, especially during the 1960's to the mid 1970's, had an effect on living standards, especially among the poorer classes, this factor alone cannot explain the relatively slow rate of decline of the infant death rate during the last 15 to 20 years.

Providing more trained midwives does not cost much money since the facilities for training are already there. Further institutionalization of births should not prove too difficult since the country is covered by a wide network of hospitals and maternity homes which also could be used to provide rehydration facilities to treat children suffering from diarrhoeal disease. The cost of providing such facilities is small, but it requires fundamental changes in health policy. The need for a change in priorities can be illustrated by an example. In the mid 1970's, out of an allocation of Rs 3 million given to the Department of Health for a subsidized programme of lavatory construction in poor rural households, very little was spent because priority was not given to directing the implementation of this programme. The main thrust of health planning is still on providing highly skilled medical personnel and sophisticated facilities, sometimes at the risk of neglecting elementary needs, such as providing adequate ante-natal care, trained midwives, and elementary preventive services. The proper balance has yet to be struck between these different aspects of health care.

In the estates, the prospects for the future seem bright, for with nationalization, health care of the estate population has become the responsibility of the state. As a first step, polyclinics have been started on a systematic scale in some districts, and it will be useful to study their effect on infant and child mortality.

Table 92 Infant Mortality in Selected Countries, 1958-1960 and 1973-1976.

Year	Sri Lanka	Costa Rica	Mexico	Jamaica	Mauritius	Portugal	Yugoslavia	Romania
1958	64	75	80	62	67	84	86	71
1959	58	73	74	68	63	89	92	77
1960	57	80	75	51	70	78	87	76
1973	46	45	52	26	63	45	44	38
1974	51	38	48	26	46	38	41	35
1975	45	38	50	24	49	39	40	35
1976	44	34	55	20	40	n.a.	37	31

Source: U.N. Demographic Year Books.

With regard to the non-estate population, the new economic policies with their shift from welfare to the free market could affect quite drastically the standard-of-living of those groups in the population who do not have any bargaining strength. These are the unskilled and casual workers in the towns and the landless labour and small cultivators in the villages. Any health plan which is intent on maintaining the health standards of this group, even at present levels, let alone attempting to improve them, will have to concentrate on monitoring the progress of this under-priviledged group.

Appendix I Note on Completeness of Vital Registration and Cause of Death Statistics in Sri Lanka

Two surveys have attempted to estimate the completeness of birth and death registration in Sri Lanka[1]. The first done in 1953 indicated that approximately 88 per cent of births and death were registered in Sri Lanka[2]. Another survey in 1967 estimated that approximately 99 per cent of births and 92 per cent of deaths were registered in Sri Lanka[3]. The same survey indicated that birth and death registration was 100 per cent complete in the urban and estate sectors while there was under-registration in rural areas.

Cause-of-death statistics are available for the whole of Sri Lanka, but their degree of accuracy varies according to place of occurrence of the death. In 1966 approximately 35 per cent of all deaths in Sri Lanka occurred in urban areas, and of these about 90 per cent were certified by qualified medical practitioners. The per cent of infant deaths in Sri Lanka occurring in urban areas was even higher (41 per cent in 1966). Next in reliability are the estates, subject to the Medical Wants Ordinance of 1912, where deaths are certified by an apothecary. Approximately 14 per cent of all infant deaths in 1966 were in estates. The cause of death returns from rural areas are the least reliable since in most cases information is supplied by relatives of the deceased to lay registrars[4].

The interpretation of data based on vital registration according to place of residence is difficult. Every major hospital in Sri Lanka is located in an urban centre, and there is a tendency for many people, especially from rural areas, to come to towns for hospital treatment. Births and deaths among such patients are registered in the place of occurrence (i.e. in the urban area) and except in the case of births and infant and maternal deaths occurring in urban areas, there are no tabulations classifying these deaths by place of usual residence. (Table I). No figures however are available of urban residents who die in rural or estate areas.

Although the statistics of infant deaths occurring in urban areas of those who are usually resident there are available, these figures are not absolutely accurate. It is not unknown for rural people to provide an urban address of a relative or friend, when seeking treatment in an urban hospital, for fear that they would not be provided treatment, if they declare that they are from another locality.

Table 1 Maternal and Infant Deaths Occurring in Urban Areas by Resident Status

Deaths	Non-Residents	Usual Residents	Percentage of Resident to Total Deaths
Infant	3755	4403	54
Maternal	178	170	49

Source: Administration Report of the Registrar General, 1966.

However, the death of many infants and children usually resident in rural areas in urban hospitals means that diagnosis of cause of death is more reliable since it is certified by a qualified medical practitioner.

Although in 1966 only 22 per cent of all infant deaths were among those usually resident in urban areas, the per cent of all infant deaths occurring in urban areas was 41 per cent.

However, as was noted earlier in the text, in interpreting cause of death statistics it should be borne in mind that there may be failure to distinguish between primary and secondary causes, the underlying cause (e.g. malnutrition) and the condition immediately prior of death (e.g. pneumonia). This would be so especially in rural areas where most of the registrars have no medical qualifications.

1 See Nadarajah, T. Evaluation of Quality of Demographic Data, ESCAP Monograph No. 4 Population of Sri Lanka, Bankok, 1976.

2 Kannagara, I. Post Enumeration Survey 1953, Monograph No. I Department of Census and Statistics, Colombo, 1953.

3 Aponso, W.M.L.S. A Study of the Extent of Under-Registration of Births and Deaths in Ceylon. Department of Census and Statistics, Colombo, 1971.

4 Administration Report of the Registrar General for 1966, pp. 38-39.

Appendix II Standard Error of Estimated Mortality Differentials

Approximate estimates of the standard errors of the mortality differentials can be made by working on the basis that the sample is a simple random sample, since the effect of the sample design is often marginal for the sampling errors of differences between the sample means.

If μ_1 and μ_2 are mortality rates when μ_1 and μ_2 are small, it is reasonable to assume that they are approximately distributed according to the Poisson distribution. Then their variances can be estimated as

$$\text{Var}\,\mu_1 \simeq \mu_1 / \eta_1$$
$$\text{Var}\,\mu_2 \simeq \mu_2 / \eta_2$$

where η_1 and η_2 are the denominators on which μ_1 and μ_2 have been estimated. Then the variance of the difference is:

$$\text{Var}\,(\mu_1 - \mu_2) \simeq \frac{\mu_1}{\eta_1} + \frac{\mu_2}{\eta_2} \simeq \bar{\mu}\left(\frac{1}{\eta_1} + \frac{1}{\eta_2}\right) = \bar{\mu} / \eta^*$$

where $\bar{\mu} = \frac{1}{2}(\mu_1 + \mu_2)$

$$\eta^* = \frac{\eta_1 \eta_2}{\eta_1 + \eta_2}$$

Hence the Standard Error of $(\mu_1 - \mu_2) \simeq \sqrt{\bar{\mu} / \eta^*}$

Standard Error of 1000 $(\mu_1 - \mu_2) \simeq 1000 \sqrt{\bar{\mu} / \eta^*}$

Table A gives values of η^* for different values of η_1 and η_2

Table B gives values of $1000 \sqrt{\frac{\bar{\mu}}{\eta^*}}$ for different values of $\bar{\mu}$ and η^*

Table A Value of η^* by η_1 and η_2

η_1 \ η_2	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	6000	7000
500	250	333	375	400	413	429	438	444	450	455	462	464
1000	333	500	600	667	714	750	778	800	818	833	857	975
1500	375	600	750	857	938	1000	1050	1091	1125	1154	1200	1235
2000	400	667	857	1000	1111	1200	1272	1333	1385	1429	1500	1556
2500	413	714	938	1111	1250	1364	1458	1539	1607	1667	1765	1842
3000	429	750	1000	1200	1364	1500	1615	1714	1800	1875	2000	2100
3500	438	778	1050	1272	1458	1615	1750	1867	1969	2059	2211	2333
4000	444	800	1091	1333	1539	1714	1867	2000	2118	2222	2400	2545
4500	450	818	1125	1385	1607	1801	1969	2118	2250	2368	2571	2739
5000	455	833	1154	1429	1667	1875	2059	2222	2368	2500	2727	2917
6000	462	857	1200	1500	1765	2000	2211	2400	2571	2727	3000	3231
7000	467	875	1235	1556	1842	2100	2333	2545	2739	2917	3231	3500
8000	471	889	1263	1600	1904	2181	2435	2667	2880	3077	3429	3733
9000	474	900	1286	1636	1957	2250	2520	2769	3000	3214	3600	3934
10000	476	909	1304	1667	2000	2307	2592	2857	3103	3333	3750	4118
12500	480	926	1339	1724	2083	2419	2734	3030	3309	3571	4054	4487
15000	484	938	1364	1764	2143	2500	2838	3158	3462	3750	4286	4772
17500	486	949	1382	1795	2188	2561	2917	3256	3580	3889	4468	5000
20000	488	952	1395	1818	2222	2609	3192	3333	3674	4000	4615	5185

Table B Value of $1000\sqrt{\frac{\bar{\mu}}{\eta^*}}$ by η^* and $\bar{\mu}$

η^* \ $\bar{\mu}$	.0175	.020	.025	.030	.035	.040	.045	.050	.055	.060
250	8.4	8.9	10.0	11.0	11.8	12.6	13.4	14.1	14.8	15.5
300	7.6	8.2	9.1	10.0	10.8	11.5	12.3	12.9	13.5	14.1
350	7.1	7.6	8.4	9.3	10.0	10.7	11.4	12.0	12.5	13.1
400	6.6	7.1	7.9	8.7	9.4	10.0	10.6	11.2	11.8	12.3
450	6.3	6.6	7.4	8.2	8.8	9.4	10.0	10.5	11.1	11.5
500	5.4	6.3	7.1	7.8	8.4	8.9	9.5	10.0	10.5	11.0
750	4.8	5.2	5.8	6.3	6.9	7.3	7.8	8.2	8.5	8.9
1000	4.1	4.5	5.0	5.5	5.9	6.3	6.7	7.1	7.4	7.8
1250	3.7	4.0	4.5	4.9	5.3	5.7	6.0	6.3	6.6	6.9
1500	3.5	3.6	4.1	4.5	4.8	5.2	5.5	5.8	6.1	6.3
1750	3.2	3.3	3.7	4.1	4.5	4.8	5.1	5.4	5.6	5.8
2000	3.0	3.2	3.6	3.9	4.2	4.5	4.8	5.0	5.3	5.5
2250	2.8	3.0	3.3	3.6	4.0	4.2	4.8	4.7	4.9	5.2
2500	2.7	2.8	3.2	3.5	3.7	4.0	4.2	4.5	4.7	4.9
2750	2.5	2.7	3.0	3.3	3.6	3.9	4.0	4.2	4.5	4.7
3000	2.5	2.5	2.8	3.2	3.5	3.6	3.9	4.1	4.2	4.5
3250	2.2	2.5	2.8	3.0	3.3	3.5	3.7	3.9	4.1	4.4
3500	2.2	2.5	2.5	3.0	3.2	3.3	3.6	3.7	4.0	4.1
3750	2.2	2.3	2.6	2.8	3.1	3.3	3.5	3.7	3.8	4.0
4000	2.1	2.2	2.5	2.7	3.0	3.2	3.4	3.5	3.7	3.8
4250	2.0	2.2	2.4	2.7	2.9	3.1	3.3	3.4	3.6	3.8
4500	2.0	2.1	2.4	2.6	2.8	3.0	3.2	3.3	3.5	3.7
4750	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.3	3.4	3.6
5000	1.9	2.0	2.2	2.5	2.7	2.8	3.0	3.2	3.3	3.5