A STUDY OF CHILD HEALTH DURING THE FIRST YEAR OF LIFE

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SUMMARY. A survey of 560 in-patients of the maternity ward of R. G. Kar Medical College Hospital admitted in 1959–60 was conducted to study maternal and infant health conditions in the class of city population who usually seek hospital aid. Each patient was interviewed only once and the information collected at the time of interview supplemented by the information obtained from the hospital records provided the necessary data for this study. This paper deals only with the data relating to infant health such as infant mortality, morbidity and development and the factors associated with them. The data on maternal health conditions and the associated factors collected in this enquiry shall be dealt with in a subsequent paper.

1. Scope and coverage of the enquiry

Of late, there has been an increasing tendency among all sections of the city population to avail of modern methods of medical care. Hospitals are the only large institutions from which one can obtain medical treatment free of cost or for a nominal charge and bulk of the city population being extremely poor, seek hospital aid for its cheapness, if not for any other virtue. This is particularly true in the case of patients seeking obstetrical care. A striking feature observed in recent times among such cases is the rapid increase in the proportion of normal deliveries. This, however, does not imply that hospital admissions are representative of the general gravid population. Nevertheless, the authors are of the view that the hospital cases provide a very useful frame for the selection of a sample for the study of maternal and child health. The hospital records contain valuable information on conditions obtained during pregnancy and labour and type of operation performed. Besides these, the birthweight, gestation period and infant death occurring during the lying-in period are also recorded. Therefore, if a sample is selected judiciously from the hospital frame and information collected by a properly designed follow-up of the patients at their homes to supplement the information already available from the hospital records, the necessary data can be obtained to answer a variety of problems in the field of maternal and child health. The present study is in the nature of an exploratory one and was carried out on these lines, although precise results could not be presented, it is hoped that the experience obtained from this study may be of some guidance in future large-scale investigations.

This study is based on a survey of about 500 women who were admitted as in-patients in the labour wards of R. G. Kar Medical College Hospital, Calcutta in the year 1959-60. The annual admissions to the labour wards of this hospital had been steadily increasing in recent years and at present the total number admitted including abortion cases is about 4,000 a year. A sizeable proportion (31%) of the cases were drawn from the remote suburbs of Calcutta and most of those cases were

unbooked. It is virtually impossible to send investigators all over the district to contact such cases. Further, these cases were mostly admitted on emergency grounds and as such cannot be considered as representative of the normal gravid population. Therefore, it was decided to exclude these cases from the coverage of this enquiry. Also, those cases with incomplete addresses had to be dropped for obvious reasons. For this study, therefore, the frame of reference for the selection of the sample had to be restricted to cases recorded in the hospital admission register with clearly identifiable Calcutta addresses. As a consequence of such a restriction a large proportion of the emergency cases have been excluded. What is left over for the selection of the sample is expected to be more approximate to the gravid population of such social classes as usually resort to hospital aid.

There is still another aspect in which hospital cases vary from the usual gravid population and that is in the inordinately large proportion of primi-gravida cases. In order, therefore, to bring the sample cases in conformity with the general gravid population, a smaller sampling fraction was adopted for the primi-gravida cases. The following table gives the percentage distribution by parity of cases (excluding abortions and still births) selected in the sample and in the reference frame described earlier.

TABLE 1. PERCENTAGE DISTRIBUTION OF CASES BY PARITY IN THE SAMPLE AND REFERENCE POPULATION

parity	percentage	
	sample	reference population
(1)	(2)	(3)
1	28.2	35.2
2	15.0	11.3
3	15.0	11.7
4	10.6	12.5
5	7.6	9.8
6 and above	23.6	19.5
	100.0	100.0

*Reference population comprises of all cases with Calcutta addresses excluding abortions and still births.

Still births and abortions were treated as a separate category in this study. The two main objectives of this enquiry were (a) to study the association between the post-natal complications as recorded by the investigators and the conditions prevailing during the ante-natal period and labour, and (b) to study the infant health conditions (morbidity, mortality and development) as revealed in the survey and its relation to birthweight (as recorded in the hospital) and social status, housing condition, maternal and infant diets etc. (as obtained by survey).

• The first objective requires that mothers are contacted during or immediately after puerperium to ensure the accuracy of the reports on post-natal health conditions of the mothers. Further, as it is customary for daughters to go to their parents' home for their confinements and return to their husbands a few months after delivery, a large number of cases are likely to be lost if the enquiry is instituted long after the date of delivery. On the other hand, the second objective could be achieved satisfactorily only if for at least an adequate number of cases the contacts are established after the infants had a full year's exposure. This dual purpose could have been easily achieved if all the cases admitted in the year preceding the survey and included in the reference frame were covered by the enquiry. But in view of the limitations imposed by the resources at our disposal we resorted to the choice of a sample based on an optimum distribution of exposures. The following table shows the distribution of sample cases according to the time of contact for investigation.

TABLE 2. DISTRIBUTION OF CASES BY TIME OF CONTACT

time of contact (no. of months after delivery)	percentage of cases
(1)	(2)
upto 3.5	40
3.5–7.5	21
7.5–12.0	39

Also, it was essential for the purpose of obtaining reliable estimates of the association between post-natal complications and conditions prevailing during pregnancy and labour that some sort of stratification was effected at the very outset. For this purpose all cases for which the hospital records showed pregnancy complications and/or obstetrical complications and/or instrumental deliveries were grouped together into one stratum and the remaining cases, for which, no such abnormalities were recorded, were grouped together into another stratum and a smaller sampling fraction was adopted for the normal cases. The following table gives the proportion of normal cases in the sample and reference population by parity groups.

TABLE 3. PROPORTION OF NORMAL CASES IN EACH PARITY GROUP AMONG SAMPLE AND REFERENCE POPULATION

parity	percentage of normal cases	
	sample	reference population
(1)	(2)	(3)
1	29.1	30.3
2	52.7	76.2
3	62.7	64.4
4	62.3	75.3
5	53.9	78.1
6 and above	54.2	77.1
all parities	49.3	58.9

A number of patients who came from outside Calcutta had referred to some relatives' addresses within Calcutta, although they did not stay there after they were discharged from the hospital. Of the 670 patients with Calcutta addresses entered in the hospital admission register and selected for the survey 110 (16%) proved to be so when the male investigators attempted to contact them. These 110 cases were treated as outsiders and no attempt was made to collect any information regarding them. Again among the remaining 560 patients who stayed in the city after leaving the hospital, 121 left for their own homes before the male investigators could contact the households. In such cases, the male investigators merely obtained the information on the survival of the infants for the period of stay of the patients in the city or for such time as the informants could accurately report. The remaining 439 patients were found to be residing in the selected households at the time of the male investigators' visit. The investigators then secured the entire information required in the household schedule from the head of the household and fixed up an appointment for the subsequent visit of the nurse. Unfortunately, 17 of these patients left the household before the nurses could contact them for filling up the patient schedule. The following table gives the distribution of patients by the type of information collected.

TABLE 4. DISTRIBUTION OF PATIENTS BY TYPE OF INFORMATION COLLECTED

nature of termination	patients left		patients[3] present in both visits
	before[1]	after[2]	
(1)	(2)	(3)	(4)
abortions	8	0	33
still births	9	0	13
live births	108 (4 twin births)	17	376 (16 twins and 1 triplet)
all terminations	121	17	422[4]

[1] Male investigators: only infant survival known after.

[2] Male investigators visit but before nurses visit: only household schedule filled up.

[3] Information complete; both household and patient schedules filled up.

[4] Of the 422 cases, for which patient schedules were filled up, 35 (27 live births and 8 abortions) were rejected as the reliability of the information obtained by the nurses concerned was questionable. The field work of this nurse was discontinued.

2. METHOD OF ENQUIRY

This enquiry was conducted in two phases. In the first phase, male investigators contacted the selected households and enquired first, whether the patient stayed in the household after leaving the hospital and whether she was still staying in the household. If she has left the above household after staying for some time, the informant was asked to report about the survival of the child for the period over which he

could furnish reliable information. In the majority of such cases, the informants were close relatives of the patient (father, brother, etc.) and were able to report the conditions up-to-date. In case frequent communications with the patient's family were lacking the survival of the infant only for the period of stay of the patient in the given address was noted. If the patient was continuing her stay in the same household at the time of the male investigator's visit, then the household schedule was filled up. This schedule furnished information about the age, sex, educational status, occupation, income etc. of all the members of the household (including the patient and the child). Further, the particulars about the migratory status of the household and housing conditions were also obtained. A facsimile of the household schedule is given in the appendix.

The second phase of investigation was carried out by interrogating the patients themselves. For this purpose six nurses were given intensive training by the medical adviser to this survey. Fortunately, these trained nurses could establish cordial relations with the patients which were helpful in eliciting the information required in the patient's schedule. The items of information entered in the patient's schedule have been broadly grouped as (a) amenorrhoea, lactation and new conceptions; (b) ante-natal and post-natal visits; (c) maternal and infant diet; (d) previous terminations and hospitalisation; (e) *maternal health*: (i) ante-natal complications are reported by the patients (hospital findings were entered separately after field enquiry); (ii) post-natal complications and medical care; (iii) chronic conditions; (f) *infant's health* : (i) birth weight and gestation period (entered from hospital records); (ii) survival and if dead, cause of death; (iii) morbidity and medical care; (iv) development (age in months at the time of dentation, sitting and standing).

A facsimile of the patient's schedule is also given in the appendix.

This study has been divided into two parts, one dealing with infant and the other with maternal health. In the present paper, the results presented are concerned with infant health only and those concerned with maternal conditions shall be dealt with in a subsequent paper.

3. Infant health : statistical analysis and results

The assessment of infant health has been made in terms of mortality, morbidity, physical and mental development. In this study morbidity has been assessed in terms of inception rates. Measurements of physical and mental growths have been made with respect to age at dentation and ages at sitting and standing respectively.

Infant mortality. Excluding abortions and still births altogether 499 patients have been included in this study. Some of these patients had plural births (20 twins and one triplet), thus making up the total live births followed up to 521.

The months of life completed by these infants at the time of visit varied very widely. Only about 17% of the infants had a full year's exposure. The distribution of the period after birth at which observations were made is given below :

TABLE 5. DISTRIBUTION OF LIVE BIRTHS BY TIME OF VISIT

time of visit (after delivery)	number of infants (surviving or dead)	time of visit (after delivery)	number of infants (surviving or dead)
(week)		(months)	
1	30	6	21
2	14	7	30
3	13	8	23
4	21	9	22
(months)		10	19
2	64	11	40
3	68	12	98
4	40		
5	18	total	521

If the infant was surviving at the time of visit, its exact exposure upto that date is known from the date of birth entered in the hospital records. If, however, the infant died, his age at death is entered in months by interrogating the mother. If the mother had left before she was contacted, the male investigator obtained the information of infant's survival upto a specified period from the household head.

The infant mortality rate adopted in this study is based on the actual exposures. Consequently, the statistical analysis became quite laborious when we attempted to relate the infant mortality to a variety of social and environmental factors. The line of analysis adopted is given below.

Line of analysis. Let n_i be the total number of contacts made between $(i-1)$-th and i-th month and of this let S_i be the number surviving at the time of visit and let d_{ij} $(j = 1, 2 \ldots i)$ be the number who died between $(j-1)$-th and j-th month. Each one among the S_i survivors contributed a unit exposure to each of the successive months $(0-1)$, $(1-2)$, and ... $[(i-2)-(i-1)]$ and a partial exposure in $[(i-1)-(i)]$ month. For the sake of simplicity the above partial exposure in $[(i-1)-i]$ month is regarded here as a unit exposure. Moreover, each one of the infants who died in $[(j-1)-j]$ month of life contributed a unit exposure in each of the successive months upto the month $[(j-1)-j]$. Further, each one of them is reckoned as a death in calculating the survival ratio from $(j-1)$-th to j-th month.

Summing up the exposures contributed by infants contacted at various periods we have the total exposure in month $[(k-1)-k]$ given by

$$E_{k-1,\,k} = \sum_{i=k}^{18} S_i + \sum_{i=k}^{18} \sum_{j=k}^{i} d_{ij}$$

and the total deaths in $[(k-1)-k]$ month given by

$$D_{k-1,\,k} = \sum_{i=k}^{18} d_{ik}$$

Thus the probability of survival from $[(k-1)]$-th to k-th month is given by

$$S_{k-1,\,k} = \frac{E_{k-1,\,k} - D_{k-1,\,k}}{E_{k-1,\,k}}$$

$$= \frac{\left[\sum_{i=k}^{12} S_i + \sum_{i=k}^{12}\sum_{j=k}^{i} d_{ij} - \sum_{i=k}^{12} d_{ii}\right]}{\sum_{i=k}^{12} S_i + \sum_{i=k}^{12}\sum_{j=k}^{i} d_{ij}}$$

Calculating the successive survival ratios in this manner we obtain the probability of survival of the first year of life as the product $\prod_{k=1}^{12} S_{k-1,\,k}$ and thus the infant mortality rate is given by $1000\left(1-\prod_{k=1}^{12} S_{k-1,k}\right)$. This procedure has been adopted for all estimates of infant mortality rate discussed in the following paragraphs.

Causes of infant mortality. The new-born infant having survived the stresses of birth and made the sudden change from complete physiological dependence to an extra-uterine life now has to adopt itself to the stresses and strains that go with an independent existence. How far it succeeds in this struggle is partly determined by the factors of the external environment and partly by the child's inherent ability to cope with the antagonistic influence of such factors. A number of infants are so devitalised even at the time of birth that there is only a slender chance of their surviving the first few days of life even with the best care that can be bestowed. The birth of such weak babies are mostly ascribable to causes present before or during birth. The external environment cannot, of course, affect the foetus directly. But indirectly it affects the foetal development in a variety of ways and also brings about the termination of pregnancies before term. It has been shown in a number of studies conducted elsewhere that poor social conditions and poor physique and health among mothers are important predisposing factors of prematurity. Added to the extreme poverty and squalor that affect the overwhelming majority of the population in India, the utter lack of obstetrical and ante-natal facilities swell the number of premature and devitalised infants in this country.

Studies conducted in UK and other western countries have shown that deaths occurring in the first month of life are mostly ascribable to causes present before and during birth, (obstetrical causes), of which prematurity is the most important one. But deaths occurring at subsequent periods of the first year of life (post-neonatal deaths) are in the majority of cases ascribable to conditions present in the external environment. Overcrowding, inadequate child care, poor diet, insanitary conditions, lack of medical facilities and lack of health consciousness which characterise the poorer social classes are closely associated with the incidence of infectious diseases which take a heavy toll of infant lives in the post-neonatal period. Studies on time trends and contemporaneous differentials conducted in western countries have established beyond doubt the broad significance of the above factors in the variation of post-neonatal deaths.

The present study conducted by us also reveal that the majority of deaths in the neo-natal period are ascribable to causes present before or during birth, whereas those in the post-neonatal period are mostly caused by infections, malnutrition etc. In Table 6 the distribution of deaths by causes during neo-natal and post-neonatal periods obtained from our investigation is compared with that obtained for England and Wales by the Registrar General.

TABLE 6. NEO-NATAL AND POST-NEONATAL DEATH RATES PER 1000 LIVE BIRTHS BY CAUSES

neo-natal death rate			post-neo-natal death rate		
sl. no. cause	present survey	England and Wales (1959)	cause	present survey	England and Wales (1959)
all causes	100.00	15.8730	all causes	42.30	6.3433
prematurity unqualified	28.85	3.6413	causes of prenatal or natal origin	0.00	1.8009
birth injury with or without prematurity.	5.77	2.4698	pneumonia	2.82	1.9753
asphyxia or atlectasis with or without prematurity	19.23	3.5879	diptheria	2.82	0.0000
toxaemia and other maternal conditions with prematurity	3.85	0.1509	bronchitis	0.00	0.4911
toxaemia and other maternal conditions without prematurity	3.85	0.0267	gastro-enteritis	11.28	0.3449
congenital mal-formations	1.92	2.8425	dysentry	5.64	0.0054
haemolytic diseases of newborn with or without prematurity	0.00	0.4742	other infections	2.82	0.4469
haemorrhagic diseases of newborn with or without prematurity	0.00	0.2859	malnutrition	5.64	0.0094
diarrhoea of the newborn with or without prematurity	3.85	0.0588	other specified diseases	2.82	0.7354
pneumonia of the newborn with or without prematurity	3.85	1.0018	symptoms and illdefined conditions	5.64	0.0295
illdefined diseases of newborn with or without prematurity	0.00	0.3887	accidents	0.00	0.5046
other conditions with prematurity	0.00	0.1696	unknown	2.82	0.0000
other infections	5.77	0.2004			
other non-infectious diseases (specified)	0.00	0.4047			
ymptoms and illde-fined conditions without prematurity	3.85	0.0174			
accidents	5.77	0.1523			
unknown	13.46	0.0000			

Despite the enormous difference in the absolute value of the rates between our series and that of England and Wales, there is a remarkable similarity in the distribution of deaths by causes.

The environmental factors operate jointly in a definite pattern set by the social circumstances and a precise assessment of the significance of each of these factors independently is beset with difficulties. An appropriate method of study in this situation should be to carry out the statistical analysis on the basis of multiple classification involving all the relevant variables. This was not possible in the present study because of the limited size of our sample. We had selected for this study only a few environmental factors which admitted precise classification of the subjects into markedly different categories and further no attempt was made to split the infant mortality rate into neo-natal and post-neonatal death rates. In the following paragraphs some of the important biological and environmental factors associated with infant mortality are discussed.

Prematurity. The hospital records give both the period of gestation and the birthweight of the infants. Since it is difficult to elicit accurate information about the period of gestation, particularly from illiterate patients, greater reliance is placed in this study on the birthweight, which is obtained by direct measurement. In an earlier study (Mukherjee and Biswas, 1959) it was shown that among 1038 patients of the R. G. Kar Medical College Hospital, who could precisely state the date of last menstrual period, the pregnancy was terminated before the 38th week in 30.5% cases and that among those the gestation period showed a remarkably close correspondence with birthweight. In view of the above finding and following the international convention we have adopted for this study the classification according to birthweight to represent different grades of maturity reached at the time of birth.

The 521 cases selected for this investigation comprised solely of those who stayed in the city after leaving the hospital whereas the general hospital population included, besides the city residents, a number of outsiders of whom a large proportion were unbooked cases. Further the sample included proportionately fewer primigravida cases. Consequently, the proportion of prematurely born infants in the sample was smaller despite the fact that abnormal cases were given additional weight in sample selection (a variety of complications have been taken into account for stratifying the cases as abnormal or normal and only a few of them are known to be predisposing factors of prematurity). The following table gives the distribution of infants by birth weight in the general hospital population and in the sample.

A few investigations into the causes of prematurity conducted in certain hospitals in UK (Grundy and Lewis-Fanning, 1951) have shown that in about half the cases prematurity could be attributed to obstetrical abnormalities of which the most important are maternal toxaemia and haemorrhage (25%), multiple pregnancy (20%) and congenital malformations (5%). In the remaining half no satisfactory causes could be found; the pregnancy was clinically normal and either an unexpectedly small

TABLE 7. PERCENAGE DISTRIBUTION OF INFANTS BY BIRTHWEIGHT

birthweight (in lbs.)	general hospital population (percentage)	sample selected for this investigation (percentage)
(1)	(2)	(3)
1—2	2.02	0.38
2—3	1.00	1.15
3—4	3.13	1.34
4—5	10.02	3.64
5—6	32.26	16.86
6—7	36.21	33.52
7—8	12.59	28.74
8 and above	2.76	14.37

baby was born or labour started prematurely for no obvious reasons. In our study quite a number of babies were born after full term, although their birthweights were low. In about half the cases the pregnancies were normal. The incidence of prematurity was appreciably high among multiple pregnancies and among cases in which ante-partum haemorrhage (accidental haemorrhage, placenta previa, threatened abortions etc.) were reported. Curiously enough the incidence of prematurity among pre-eclamptic toxaemia cases was low.

TABLE 8. ASSOCIATION OF PREMATURITY WITH PREGNANCY COMPLICATION

conditions present before birth	premature infants[1]		mature infants[2]	
	number	percent	number	percent
(1)	(2)	(3)	(4)	(5)
A pre-eclamptic toxaemia, eclampsia, hypertension	2	5.9	42	8.6
B multiple pregnancy	9	26.5	28	5.7
C multiple pregnancy with A	3	8.8	3	0.6
D haemorrhage (antepurtum and threatened abortions)	3	8.8	17	3.5
E cases without any of the above conditions	17	50.0	397	81.5
	34	100.0	487	99.9

[1] Birthweight below 5 lbs. [2] Birthweight 5 lbs or higher.

These results, being based on a very small sample, should be accepted only with reservation. But a common feature which is revealed by both these investigations, the one conducted in UK and the present one, is that about half the cases of prematurity arises from unexplained causes and it is mainly these that are shown up in the social class differentials. Mukherjee and Biswas (1959) have pointed out in their investigation that there were striking differentials in the incidence of prematurity at low gestation periods between patients admitted in paying and non-paying wards, the former including a greater proportion of those who could afford to pay. Marked differentials in the incidence of prematurity (premature infant being defined as one having birthweight less than 5½ lbs) have also been observed among social classes in Great Britain.

TABLE 9. INCIDENCE OF PREMATURITY BY SOCIAL CLASSES IN GREAT BRITAIN (Grundy and Lewis-Fanning)

	social class				
	1 and 2	3	4	5	all classes
	(1)	(2)	(3)	(4)	(5)
rate per 100 live births	5.3	6.3	7.5	8.3	6.5

In our study also a striking social class gradient in the incidence of prematurity was observed. Table 10 gives the percentage distribution of infants by birthweight in each of the following three social classes: I : (a) father matriculate or above (b) family income greater than or equal to Rs. 200 ; II : only one of the conditions in (a), (b) in I is satisfied; III : (a) father below matric, (b) family income less than Rs. 200.

TABLE 10. INCIDENCE OF PREMATURITY BY SOCIAL CLASSES (present survey)

	social class					
	I		II		III	
birthweight (in lbs.)	no. of infants	percentage	no. of infants	percentage	no. of infants	percentage
(1)	(2)	(3)	(4)	(5)	(6)	(7)
less than 5	4	3.54	9	6.24	15	9.74
greater or equal to 5	109	96.46	135	93.74	139	90.26
total	113	100.00	144	100.00	154	100.00

On a more detailed analysis of the above data it was found that the housing conditions, standards of maternal care and a number of other factors which are implied by the social position of the patients are closely associated with the incidence of prematurity.

Standards of maturity. Many prematurely born infants are blighted within a few days or even hours after birth and consequently prematurity is the major factor to be considered in interpreting social class differentials in neo-natal mortality. Since the premature infants require special care and environment for their survival it is quite important to draw a line of demarcation between premature and functionally mature infants. In western countries the definition adopted is based on birthweight, a child having a birthweight less than 5½ lbs being considered as premature. The definition based on birthweight may not be entirely satisfactory since a few babies with birthweight below 5½ lbs might have attained functional maturity. The average weight of babies delivered in Indian hospitals is only 6 lbs. A large number of full term babies delivered in those hospitals have low birthweights and yet show practically no characteristics of functional immaturity. It is therefore pertinent to enquire as to what should be adopted as the criterion for the definition of prematurity in the circumstances obtained here at present. For this purpose it seems desirable that the definition of prematurity must take fully into consideration the chance of survival of infants when no special care has been bestowed on it. Most of the patients included in our enquiry belong to the poorest social class in this city. It is hardly possible for them to give any extra attention to their infants even if they be immature. Also, no additional medical care is possible within hospitals for reasons well known. It can, therefore, be expected that the mortality rates among the premature infants obtained at present reflect more truly their chance of survival in uncontrolled conditions. Table 11 gives the infant mortality rates by birthweight

TABLE 11. INFANT MORTALITY RATES BY BIRTHWEIGHT

birthweight (in lbs.)	number of infants in the sample	probability of surviving the 1st year of life	infant mortality rate per 1000 live births
(1)	(2)	(3)	(4)
1—2	2	0.0000	1000.0
2—3	6	0.0000	1000.0
3—4	7	0.0000	1000.0
4—5	19	0.3684	631.6
5—6	88	0.7837	216.3
6—7	175	0.9110	89.0
7—8	150	0.9247	75.3
8 and above	74	1.0000	0.0
total	521	0.8577	142.3

The level of mortality falls abruptly after the birthweight has reached the critical level of 5 lbs. It was desirable to analyse the mortality rates by finer intervals of birthweight around the level of 5 lbs to obtain more precisely the turning point at which hazards peculiar to prematurity ceases. But this was not possible in this study due to the inadequate size of the sample. If the level of 5 lbs is applied, 6.51% of the infants selected in the survey will be classified as prematures, whereas by the western standard of 5½ lbs, 16.09% of the infants will be classified as premature.

When the wherewithal for the care of the really premature infants is itself very doubtful in this country, there is no virtue in swelling the number of prematures by adopting standards which are too high for this population.

In Section 1 it was pointed out that the general hospital population included a large number of unbooked cases, mostly arriving from distant suburbs of the city and seeking admission on emergency grounds and thus swelling the proportion of premature infants. The reference population (those with Calcutta addresses) too had a considerably higher proportion of prematures, although for a different reason, namely, the greater inclusion of primi-gravida cases. If, therefore, we were to apply the survival rates of the birthweight classes as in Table 11 on the general hospital population we may be obtaining considerably higher infant mortality rates than the one observed in the survey sample. In fact the application of the above survival rates gave for the birthweight distribution of the general hospital population and the reference population infant mortality rates of 236.3 and 197.3 respectively.

Parity Maternal age and parity have long been considered as important biological factors affecting still birth and infant mortality rates. It has been observed that the still birth rates rise steeply with maternal age at each parity and also that they are higher for primi-gravida than for other parities. Physiological deterioration of maternal tissues is considerably mitigated by the influence of parity and since age and parity rise together, the resultant variation in foetal mortality over parities is often distorted by maternal age. In the case of post-neonatal death rates, however, the direct influence of maternal age and parity on the vitality of the infants has become weak and environmental causes now predominate. Women with fewer children can give better care to their imfants and this explains to a great extent the rise in post-neonatal mortality rates with parity. This variation has little to do with parity as a biological characteristic. In the case of neo-natal mortality rates the pattern of variation over parities is intermediate between those of still birth and post-neonatal mortality rates, because both obstetric and environmental causes directly affect neo-natal mortality rates. It has been observed in an investigation conducted by Mckeown and Gibson (1951) that the incidence of prematurity was highest among first born babies, was somewhat low for the next two parities and was again high for the fourth and higher parities.

TABLE 12. INCIDENCE OF PREMATURITY BY BIRTH ORDER
(Mckeown and Gibson)

birth order	1	2	3	4 and above
	(1)	(2)	(3)	(4)
percent premature	7.04	5.84	4.87	6.16

In an earlier section we had observed that prematurity and associated causes account for a substantial proportion of neo-natal deaths and their origin is partly biological and partly environmental. Taking neo-natal and post-neonatal death rates

together (the infant mortality rate) we may observe that both biological and social factors are of significance but when the purpose is to study parity as a biological characteristic it is essential to disentangle it from social class variation.

An attempt on these lines was made in one of our earlier investigations (Poti, Raman, Biswas and Chakravorti, 1959) in which only those women who had at least 5 pregnancy terminations were considered. In this analysis the question of social selection did not arise because the bases for successive birth orders were represented by the same set of women. However, in the present context the significance of secular trend cannot be overlooked, the birth of higher parities being more or less very recent events might have obtained better medical attention.

TABLE 13. INFANT MORTALITY RATES BY BIRTH ORDER
(Pilot health survey in West Bengal—1955)

birth order	infant mortality rates per 1000 live births	
	rural	urban
(1)	(2)	(3)
1	244.00 (500)	205.13 (156)
2	228.00 (500)	202.53 (158)
3	198.02 (505)	121.02 (157)
4	157.37 (502)	132.08 (159)
5	134.92 (504)	87.50 (160)
6	118.13 (304)	123.81 (105)
7	101.21 (247)	51.28 (78)
8 and above	96.67 (300)	148.15 (100)

Note: Figures in parenthesis refer to the number of infants. Slight inequality in these numbers upto para 5 is due to the incidence of still births and multiple pregnancies. Because the criterion for inclusion in the analysis was that the mothers should be at least of the 5th para, the numbers decrease after the 5th.

Both in the urban and rural populations a systematic decline in infant mortality rate with rise in parity can be observed from the above table. In the present investigation also a general tendency for infant mortality rates to decrease with parity has been noticed. However, a deviation was observed in parities 4 and 5 in which a higher infant mortality rate was observed. Since this investigation relates to the hospital population, who are mostly drawn from poor social classes, a striking variation in social class composition among the parities was not expected. However,

there is a certain amount of variation among the parents with respect to their education and ability to obtain medical care in times of need. It is, therefore, pertinent to examine, how far the birth order differentials obtained in this study, could be ascribed to social class variation.

The figures shown in Table 14 clearly indicate that the deviation observed in parities 4 and 5 could be ascribed to the higher proportion of lower social class subjects included in them.

TABLE 14. INFANT MORTALITY RATE BY BIRTH ORDER

(present survey)

birth order	social class composition (in %)			infant mortality rate per 1000 live births
	I	II	III	
(1)	(2)	(3)	(4)	(5)
1	26	44	30	151.5
2 and 3	31	34	35	136.6
4 and 5	22	26	52	148.6
6 and above	29	35	36	124.2

In this analysis the question of secular trend does not arise because all the births considered had occurred in the same year. As stated earlier the quality of infant care is usually better in the case of families with fewer children. If this has any significant influence on infant mortality we should expect an increase in mortality with rise in parity. On the other hand, the present investigation indicates a reverse trend in infant mortality rates, thus providing a clue to certain vital factors associated with birth order. The primi-parous women admitted to the hospitals are of very tender age and the collected evidence clearly indicates that the foetal vitality in respect of these cases is inordinately low.

Housing. It was shown in an earlier section that about 60% of the post-neonatal deaths are caused by infections and since movements of infants are usually restricted such infections must have been originated from within the dwelling place itself, or from its immediate neighbourhood. Insanitary conditions and overcrowding are, therefore, considered as important factors contributing to infant deaths, particularly in the post-neonatal period.

Since low social status and poor housing go hand in hand numerous other environmental factors like poor diet, lack of care, etc, associated with the former get entangled with the latter. Mortality differentials with respect to standard of housing cannot, therefore, be wholly ascribed to sanitary conditions. Detailed study on the morbid conditions resulting from infections can possibly throw some light for an assessment of the effect of these latter factors on infant health.

In the conditions obtained now, overcrowding is almost universal among the lower strata of society to which most of subjects of this enquiry belong. Hence no useful purpose is likely to be served by collecting information on this point. However, we observed a wide range of variation in the sanitary conditions, in respect of 3 items of sanitary amenities availed of by the families, namely, (a) source of water supply (b) toilet and (c) bathroom. Based on these criteria two distinct groups could be formed. The first one comprised of families who had separate arrangements for all the three facilities and the second one comprised of those who shared all the three facilities with other families living within the premises. Besides these two major groups there were a number of very small groups of families who had arrangements for one or two facilities exclusively for themselves and in respect of the other facilities had to share with other families within the premises or even resort to municipal taps, toilets, etc. For the purpose of this analysis these small groups have been amalgamated with one or the other of the two major groups mentioned above on the basis of rental value of the dwelling place. Infant mortality rates relating to these two groups are worked out and shown in Table 15. The increase in mortality with the lack of essential sanitary amenities is quite evident from the figures given in the table.

TABLE 15. INFANT MORTALITY BY HOUSING STANDARDS

housing standard	number of infants	infant mortality rate per 1000 live births
(1)	(2)	(3)
(a) sanitary facilities adequate	136	110.8
(b) sanitary facilities inadequate	275	146.0

Maternal diet. Several nutritional investigations have been conducted to assess the effect of maternal diet on foetal development. Tidsall (1945) and others have obtained interesting results from their study of the effect of pre-natal diet on duration of labour, infant morbidity and mortality. From among two groups of women coming to a pre-natal clinic and both on poor diet and identical as far as nutritional intake is concerned, one was selected and given specified quantities of supplementary items like eggs, milk, cheese etc. and the other was maintained without any of these supplements during the period of pregnancy. It was observed that the duration of labour was considerably reduced in the case of the group on supplementary diet, by about 25% and 15% among primipara and multipara respectively. In respect of infant morbidity also there was striking improvement. The incidence rates in a 6-month period in the supplementary diet group were pneumonia (1.5%), bronchitis (1.5%), tetany (0.0%), rickets (0.0%) and anaemia (9.4%), whereas in the control group, they were 5.5%, 4.2%, 4.2%, 5.5% and 25.0% in the same order. There were no miscarriages, still births or infant deaths in the supplementary diet group. On the other hand, in the control group 9% resulted either in miscarriage or in still birth and 2½% in infant death. In another study Burke (1942) stated that the birthweights of the infants were observed to steadily rise with protein intake during the pre-natal period.

In the present investigation since almost all the subjects were on a poor diet normally the emphasis was laid on specific additions made during the pre-natal period to the normal diet of the patient rather than on the total quantities consumed. If the patient reported to the nurse investigator that her intake of food was supplemented by at least moderate quantities of fish, milk, eggs etc. during pregnancy, her pre-natal diet was rated as A (adequate) and in case no such additions were made her diet was rated as B (inadequate). How birthweight varied with the standard of pre-natal diet is shown in the table below.

TABLE 16. DISTRIBUTION OF BIRTHWEIGHT BY STANDARDS OF PRE-NATAL DIET

I. average birthweight according to daily intake of proteins during pre-natal period (Burke's data)

sex of the infants	average daily intake of protein in grams					
	less than 45	45—54	55—64	65—74	75—84	85—above
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	birthweight in pounds and ounces					
boys	7— 6	7— 0	7— 7	8— 0	8—5	9— 2
girls	5—14	6—14	7— 8	7—12	8—1	8— 8

II. distribution of infants by birthweight in two pre-natal diet groups (present study)

pre-natal diet groups	birthweight in lbs				
	5	5—6	6—7	7 and above	total
(1)	(2)	(3)	(4)	(5)	(6)
A adequate	3 (2.5%)	23 (19.2%)	42 (38.1%)	52 (43.3%)	120 (100%)
B inadequate	23 (9.7%)	69 (29.2%)	90 (38.1%)	54 (22.9%)	236 (99.9%)

One in ten of the infants born to women in poor pre-natal diet group were premature (brithweights less than 5 lbs) compared to one in forty among those born in adequate pre-natal diet group. In the former group even the marginal class 5-6 lbs is represented in considerably larger proportion.

In the previous section we had observed a systematic increase in infant mortality with decrease in birthweight. One should, therefore, expect a considerably higher infant mortality rate among infants in the inadequate pre-natal diet group. The results given in Table 17, no doubt, support this view.

TABLE 17. INFANT MORTALITY RATE BY PRE-NATAL DIET GROUPS

prenatal diet group	number of infants	infant mortality rate per 1000 live births
(1)	(2)	(3)
A adequate	120	79.6
B inadequate	236	129.6

Ante-natal care. The number of visits made by the patients during the ante-natal period either to private physicians or to hospitals, the purpose and time of such visits etc. were reported by the patients to the nurse investigators. Considering the low level of health consciousness among the subjects it was quite surprising to observe that the overwhelming majority of them had made at least one visit. A few among those who visited the hospital only once did so for the purpose of consultations prior to obtaining admission. But even after excluding such cases a large majority of the patients were reported to have visited at early statges of pregnancy and quite frequently. However, on a detailed examination of these cases, it was observed that most of the patients had visited the clinics for treatment of some severe maladies from which they were suffering and only very few of the visits were undertaken as a routine preventive measure. Consequently, the group of women reported to have made 'adequate' number of ante-natal visits tended to include a large proportion of complicated cases which partly explains the observed tendency for the infant mortality to rise with the frequency of ante-natal visits.

TABLE 18. INFANT MORTALITY RATE BY ADEQUACY OF ANTE-NATAL VISITS

ante-natal visit	number of infants	infant mortality rate per 1000 live births
(1)	(2)	(3)
group A at least one visit before the 4th month and one after the 7th month of pregnancy	68	131.5
group B one or more visits not distributed as in group A	181	113.1
group no visits made or visited just once in connexion with admission to this hospital	107	78.6

Social class. Standards of housing and sanitation, maternal diet, and infant care, the wherewithal to procure timely medical aid and numerous other characteristics are implied by the term 'way of living'. The problem of finding a unique criterion to account for the variations and mutual interactions of such factors is indeed complex. However, attempts have been made in many earlier studies to adopt the criterion of social status defined in an appropriate way to represent some aspects of the 'way of living', particularly those concerned with variations in infant mortality. In this connexion it may be appropriate to mention a few of the important results obtained in a national survey conducted in Great Britain in 1948 [Douglas and others, (1949), (1951-52)]. The main objective of this was to assess the social class differences in infant health and survival. The social classification adopted was the one followed in the

family census, based on the occupational status of the parents. The rise in post-neonatal (1—12 months) deaths with lowering of social status was indeed striking. Incidence of infections during this period showed a steep social class gradient and both in respect of untreated cases and case fatality, the manual workers class showed considerably higher ratios. In the case of neo-natal mortality rates also striking differentials were observed. Approximately half of the neo-natal deaths occur among premature births and as stated in an earlier section the incidence of prematurity falls steeply with rise in social status. The authors of the above study have shown that after excluding premature infants the social class differences in neo-natal mortality rates are considerably reduced. The following table gives the infant mortality rates by social classes before and after exclusion of premature infants.

TABLE 19. MONTHLY DEATH RATES PER 100 SURVIVORS BY AGE AND SOCIAL CLASS (Douglas, 1948)

birthweight class	infants age (in months)	professional and salaried	blackcoated	manual workers	agricultural workers
(1)	(2)	(3)	(4)	(5)	(6)
all birthweights	(1 or less)	18.89	23.34	25.83	27.30
	1—12	0.62	0.68	1.81	1.36
birthweight over 5½ lbs	(1 or less)	8.76	10.06	12.62	11.33
	1—12	0.64	0.65	1.65	1.06

In our investigation the social classification was based on two criteria, namely, family income and education of fathers as follows :

Social class. high : father matriculate or above and income equal to or higher than Rs. 200 per month; middle : (a) father matriculate or above but income less than Rs. 200 per month or (b) father's education below matriculation but income equals or exceeds Rs. 200 per month; low : father's education below matriculation and income less than Rs. 200 per month.

In this classification the 'middle' group is somewhat heterogeneous, some of the subjects being in close proximity to 'high' and others to 'low' social classes. But this leaves each of the two extreme groups 'high' and 'low' homogeneous and distinct from each other. In Table 10 we had shown that the incidence of prematurity increased systematically with lowering of social status. Also, in the case of sickness inception rates which shall be dealt with in a later section, a steep gradient is discernible. In view of these, infants belonging to the lower social classes are exposed to a considerably higher risk than those in the higher classes as is seen from the table below.

TABLE 20. SOCIAL CLASS VARIATION IN INFANT MORTALITY RATES

social class	number of infants	infant mortality rate per 1000 live births
(1)	(2)	(3)
high	113	79.7
middle	144	130.7
low	154	174.7

Infant morbidity. In this enquiry information on infant morbidity was obtained by the nurse investigators only if the infant was surviving on the date of visit. If the child was dead, the investigator was merely required to note the cause of death and age at death. As stated in the earlier section, each patient was visited only once and the age of the child at the time of contact varied widely. For instance, out of 365 infants for whom information on morbidity has been collected 128 or 35% were contacted at the tenth month or later and 109 infants or 30% were contacted at the third month or earlier. The total exposure of the former group was 1517 months and 132 cases of illnesses were reported, yielding an inception rate of 9 cases per 100 months whereas among the 109 infants of the latter group who were exposed for a period of 245 months, 73 cases were reported, yielding an inception rate of 30 cases per 100 months. The former group of children had certainly undergone the initial stages of life as those in the latter group and further they had been exposed for more than 1000 months after the third month of life and yet the total number of cases reported in the former group only slightly exceeded the number that one should have expected if they had been contacted before the third month as was done for the latter group. Obviously we have to infer that the mothers contacted at later stages must have failed to recall many cases of minor illnesses of their children which occurred in early infancy.

In this study the first year of infant life was divided into critical intervals (0—1 week), (1 week—1 month), (1 month—3 months), (3—6 months) and (6—12 months) and each mother was asked to report the onset of any diseases suffered by her infant by successive intervals as above. This procedure helped the respondents to some extent in recalling past illnesses and place the point of onset in broad age intervals. In case the infant was dead, the incidence of the morbid conditions preceding the death was allocated to the appropriate age interval. The cause of illness and medical care availed of were recorded in exactly the same form as reported by the mothers. Nomenclature and classification codes were inserted later in the office. A number of cases reported in this survey were mere symptons like fever, cold or cough. If in such cases no medical care was availed, they were ignored. There were 33 such cases.

The following table gives the inception rates for all causes of morbidity combined by critical periods of infant life.

TABLE 21. INCEPTION RATES (NUMBER OF CASES/100 MONTHS OF EXPOSURE) BY AGE PERIODS—ALL CAUSES OF MORBIDITY COMBINED

age period (in months)	exposure in months	number of cases	inception rate
(1)	(2)	(3)	(4)
0— 1	353	82	23.23
1— 3	648	72	11.11
3— 6	694	79	11.38
6—12	875	84	9.60
total	2570	317	12.33

The inception rate for the first month of life is nearly double the average rate for the year. If under-reporting due to memory lapse had affected these rates, it is the rate for the first month which should have been affected most because all the infants irrespective of their ages at which they were contacted contributed to the exposure and cases in that period and for the older infants such events related to the remote past. We may, therefore, infer that the gradient of inception rate over successive periods of infant life would have been even steeper if memory lapse had not occurred.

The reasons underlying the inordinately high inception rate in the neo-natal period and the sudden fall after that period may be clearly explained only if we analyse the total morbidity by causes in each of the periods. The following table shows the incidence in each age interval by various classes of diseases.

TABLE 22. DISTRIBUTION OF ILLNESSES BY CAUSES

time of on set in months after birth	diarrhoea and dysentery	infantile diarrhoea	respiratory diseases	measles and chicken pox	diseases of the eyes, ear, throat etc.	diseases of the skin	other infectious diseases	malnutrition	respiratory symptoms	other symptoms	total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
0— 1	5	12	4	3	8	4	1	10	27	8	82
1— 3	11	—	9	3	2	6	1	4	31	5	72
3— 6	18	—	12	6	5	5	1	1	21	10	79
6—12	24	—	14	6	4	5	4	—	17	10	84
total	58	12	39	18	19	20	7	15	96	33	317

It may be observed that 12 cases of infantile diarrhoea had been reported in this survey which have been wholly allocated to the neo-natal period. Out of 15 cases of severe mal-nutrition and rickets 10 cases have been reported to have occurred in the neo-natal period. It was noticed that of these only 2 had a birthweight lower

than 5 lbs. It was observed that where lactation had failed or was very inadequate, mothers had a tendency to report rickets among their children. Out of 120 cases for which mere symptoms were reported 35 cases had occurred in the first month of life, and majority of these were respiratory symptoms like cold, fever and cough. Gastro-enteritis and respiratory symptoms together account for a major portion of the inception rate in the neo-natal period. Both these causes arise from the insanitary conditions and overcrowding prevailing among the poorer classes of the population. The lack of means to provide proper infant diet when lactation has failed leads to severe mal-nutrition. It may, therefore, be inferred that the origin of the causes of the excessive morbidity observed in the neo-natal period are chiefly social and are mostly preventable by a well-directed movement for promotion of environmental hygiene and health education.

If the morbidity for the entire period is considered, respiratory symptoms like cold, cough and fever emerge as the largest group which accounts for 96 cases or 30% of the total incidence. The 39 cases of respiratory diseases include 19 cases of pneumonia, 10 cases of bronchitis, 8 cases of whooping cough and 1 case each of diptheria and TB. If the class of respiratory symptoms and the class of respiratory diseases shown in the previous table are amalgamated to form a single class, then it would account for as many as 135 cases or 43% of the total incidence.

In the investigation conducted by Grundy and Lewis-Fanning (*loc. cit.*) they have observed that the respiratory diseases accounted for 47.8% of the total incidence (if whooping cough cases are added to these the proportion rises to 52.8%). In our investigation diarrhoea and dysentery come to be the second major group of causes of illnesses which accounted for 58 cases or 18.3% of the total incidence. In Great Britain the total inception rate was 89 cases per 100 infant years or 7.42 cases per 100 months whereas in this investigation we have observed an inception rate of 12.35 cases per 100 months. In the following table the distribution of illnesses by major groups of causes obtained in our investigation is compared with that obtained by Grundy and Lewis-Fanning for Great Britain.

TABLE 23. PERCENTAGE DISTRIBUTION OF ILLNESSES BY CAUSES
(Present survey and Great Britain)

cause	percentage to total incidence	
	(present survey)	Great Britain (1952-53) (Grundy and Lewis-Fanning)
(1)	(2)	(3)
1. respiratory diseases including respiratory symptoms	42.6	52.8
2. gastro-enteritis	3.8	9.0
3. measles and chickenpox	5.7	9.0
4. diseases of the eye, ear, throat etc.	6.0	7.9
5. diseases of skin	6.3	4.5
6. diarrhoea and dysentery	18.3	1.1
7. other infections	2.2	
8. accidents and injuries	—	1.1
9. all other diseases	15.1	14.6
all causes	100.00	100.00

Only for 365 infants whose mothers were present at the time of the nurse investigator's visit the information on morbidity could be collected. Among them 40 deaths had occurred. Majority of these deaths were ascribable to prematurity and other causes of pre-natal origin. Some deaths for which causes were unknown and instantaneous deaths caused by accidents do not provide any specific morbid condition preceding death. The remaining deaths were considered for the estimation of case fatality rates. 3 deaths occurred among 58 cases of diarrhoea and dysentery, yielding a fatality rate of 5.2% and 4 deaths occurred among 12 cases of infantile diarrhoea, yielding a fatality rate of 33.3%. In all the remaining groups of causes together only 8 deaths had occurred and we do not think it worthwhile to present any case fatality rates for such diseases. The distribution of illnesses by causes clearly indicate that a sizeable proportion of the total volume of morbidity is attributable to such infections as could be prevented by proper environmental hygiene. The significance of this factor is further supported by the results of an analysis of inception rate by social class.

TABLE 24. INCEPTION RATE (NUMBER OF CASES PER 100 MONTHS OF EXPOSURE) BY SOCIAL CLASS

social class	exposure in months	number of cases	inception rate
(1)	(2)	(3)	(4)
high	643	59	9.18
middle	907	116	12.79
low	1020	142	13.92
all classes	2570	317	12.33

The inception rate for the lowest social class is 13.92 which is 1½ times as high as that observed for the high social class (9.18).

Development of the infant. The first year of life is a period of rapid growth and development. As regards physical growth the change in body weight is remarkable. By the fifth month the body is doubled and at the end of the first year it is trebled and thereafter the rate of gain in weight slows down steeply. The same may be said about body length and circumference of the head, although the relative rates of growth are not so striking. These rates of growth serve as useful indicators in deciding whether the baby has been making 'normal progress' or not. The age at which the fontanelle closes and the age at which milk teeth erupt are also used to assess the progress of growth of the infant. Usually the first tooth is cut at about the 7th month and the delay is ascribable to some disturbance in calcium metabolism.

Measurement of mental growth is more complex as it has to be gauged by certain activities of the child. The acquiring of individual skills, such as sitting, standing, walking etc. can be ascribed to the maturation of the appropriate part of the nervous system. The ages at sitting, standing etc. are therefore considered as milestones, marking definite stages in particular fields of mental development. There are considerable variations among children in the age at sitting, standing and other manifestations of gross motor development but most of these variations are considered normal. Environmental factors, specially lack of practice, are important causes for delayed motor development. There are indications of an association between prematurity and mental retardation.

It would have been most desirable in this enquiry to assess physical growth in terms of body weight, particularly in view of the fact that the birthweights were already recorded in the hospital. Unfortunately due to practical difficulties in weighing infants in their homes at the time of investigator's visit no information could be collected on this important aspect of physical growth. The only information of physical growth that could be readily collected was the one on dentation. Even in this case the data merely related to the age at first eruption of teeth and not to sequence in which different types of teeth erupted.

In the case of mental growth we had to restrict the scope of the enquiry to the age at sitting and standing because these are usually remembered by the mothers. The ages at walking, talking etc. which are learned by the infants at more advanced ages had to be excluded from this enquiry because the mothers were visited before the end of the first year.

Each mother whose infant was surviving on the date of survey was asked whether her baby has already learned to sit without support. If she said 'yes' she was further asked to report the age of the infant at sitting in months. Attempt to obtain returns of age at sitting in weeks was considered futile because the information had to be elicited retrospectively in a single interview. The same procedure was adopted for eliciting information on the age at the first eruption of teeth (age at dentation) and the age at which the child could stand without help from others.

Dentation. Of the 318 surviving infants for whom the information on development has been obtained, 119 or 37% of the infants were interviewed before the 6th month. Except for one child who was born with teeth none in this group were reported to have had the first tooth cut by the time of interview. Starting from the 6th month the proportion of infants reported to have had already the first tooth erupted steadily increased. It was, however, observed that about 14% of the infants contacted at the 12th month had shown no signs of dentation and these were obviously extreme cases of delayed dentation. The following table gives the number of infants reported to have had dentation before the date of interview.

TABLE 25. NUMBER OF INFANTS WHO HAD DENTATION BEFORE INTERVIEW

age in months at interview	number of infants interviewed	number of infants who had dentation already	age in months at interview	number of infants interviewed	number of infants who had dentation already
$< 4\frac{1}{2}$	110	1	$8\frac{1}{2} - 9\frac{1}{2}$	17	5
$4\frac{1}{2} - 5\frac{1}{2}$	9	0	$9\frac{1}{2} - 10\frac{1}{2}$	12	9
$5\frac{1}{2} - 6\frac{1}{2}$	26	2	$10\frac{1}{2} - 11\frac{1}{2}$	24	22
$6\frac{1}{2} - 7\frac{1}{2}$	23	5	$11\frac{1}{2} - 12\frac{1}{2}$	80	69
$7\frac{1}{2} - 8\frac{1}{2}$	17	3	total	318	116

The median age at dentation can be obtained in the same manner as the median lethal dose is estimated from the dose response curve in bio-assay. Here the dose metameter is represented by the age at interview and the response is measured by the proportion reported as having had the first tooth cut before the date of interview. The curve representing the above relationship has been obtained by freehand graph and shown in Fig. 1.

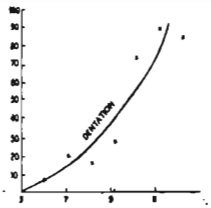

Fig. 1. Percentage of infants reported to have had dentation at various ages.

The median age at dentation obtained from this graph is 9.0 months. If the child has had dentation already the exact age in months at dentation was known. A very small minority of mothers could not report such ages. In what follows such cases of unknown ages at dentation were assumed to be distributed in the same manner as the known cases but of the same age at interview.

It should be borne in mind that in the estimation of the median age at dentation by the graphical method described above, we did not use the information, on when exactly the child had dentation. When the sample sizes are small, as for example in comparing two or more subgroups of infants, it may be worthwhile to avail of this additional information to obtain more accurate estimates.

One of the methods usually adopted for this purpose is the method of censored distribution of type I. (Hald, 1949 ; Grundy, 1952 and Gupta, 1952). Let n_{ij} be the number of infants contacted in the i-th month and n_i be the number reported to have not had dentation till interview and the number reported to have cut the first tooth exactly in the j-th month be $n_{ij}(j = 1, 2, \ldots, i)$

Thus we have $$n_i = \sum_{j=1}^{i} n_{ij} + \bar{n}_i.$$

If we discard the information on all infants contacted before any specified month, say, the t-th and pool together the data of all infants contacted at the t-th month or after we obtain a censored distribution given by

$$\sum_{i=t}^{12} n_i = S_1 + S_2 + \ldots + S_j + \ldots + S_t + \left[\sum_{i=t+1}^{12} \sum_{j=t+1}^{i} n_{ij} + \sum_{i=1}^{12} \bar{n}_i \right] \quad \ldots (1)$$

where $$S_j = \sum_{i=t}^{12} n_{ij}.$$

The l.h.s. of equation (1) gives the total number of infants contacted at the t-th month or later and among these $\left[\sum_{i=t+1}^{12} \sum_{j=t+1}^{i} n_{ij} + \sum_{i=t}^{12} \bar{n}_i \right]$ did not have the first tooth cut until the t-th month and

$$\sum_{j=1}^{t} S_j = \sum_{j=1}^{t} \sum_{i=t}^{12} n_{ij}$$

had it before the t-th month. Each term S_j in the r.h.s. of (1) represents the number of infants who had dentation exactly in the j-th month. This is a censored distribution of the age at dentation truncated at the t-th month. As stated earlier the infants contacted before the t-th month do not enter this picture at all, no matter whether they had the first tooth erupted or not. This implies the loss of the entire information from this sector and further removal of the point of truncation from birth means greater loss of information. On the other hand, if 't' is shifted towards the left, there will be greater lumping of the frequencies to the right of 't' and consequently we know less about the nature of the distribution. For the age at dentation the truncation point has been taken in this analysis as 10 months, which seemed a suitable compromise for the two opposing considerations. The mean and standard deviation of the original population from which the above is a censored sample has been obtained by the method of maximum likelihood. The estimating function for the sample mean (μ^*) and standard deviation (σ^*) are given in simple forms convenient for computation by Gupta (*loc. cit.*).

These are $$\mu^* = \bar{x} + (\sigma^{*2} - S^2)/(x_k - \bar{x}) \quad \ldots (2)$$

and $$\sigma^* = (x_k - \bar{x})/Z \quad \ldots (3)$$

where x_k $\bar{x}$ and S are respectively the largest observation, mean and standard deviation of the part of the sample lying to the left of the point of truncation and Z is given by the two equations (4) and (5) below.

$$Z = \eta + \frac{\binom{n}{k-1}}{e^{\eta^2/2}} \left[\int_{\eta}^{\infty} e^{-t^2/2}\, dt \right]^{-1} \qquad \ldots (4)$$

and

$$\frac{S^2}{\delta^2 + (x_k - \bar{x})^2} = \frac{1 + \eta z - z^2}{1 + \eta z} \qquad \ldots (5)$$

where

$$\eta = \frac{x_k - \mu^*}{\sigma^*}$$

where k/n is the proportion of the part to the left of the point of truncation in the sample of size 'n'. The standard error of the mean etc. is obtained readily from the inverse of the information matrix.

$$\frac{-\sigma^2}{n} \begin{pmatrix} \dfrac{\partial^2 \log L}{\partial \mu^2} & \dfrac{\partial^2 \log L}{\partial \mu\, \partial \sigma} \\ \dfrac{\partial^2 \log L}{\partial \sigma\, \partial \mu} & \dfrac{\partial^2 \log L}{\partial \sigma^2} \end{pmatrix} \qquad \ldots (6)$$

L^* being the likelihood function of the censored sample. The above procedure is applicable only in the case when the variable considered is normally distributed. As the distribution of the age at dentation of children included in this sample was somwehat skew a logarithmic transformation of the age scale was necessary to make it conform to a normal distribution. The estimates obtained in the new scale were retransformed to original age scale and presented in the tables below.

Factors affecting physical development. The physical development of the child is largely conditioned by a number of factors such as the pre-natal conditions and the nutritional intake of the child. To assess the effect of pre-natal condition on physical growth of the children, they have been classified into 3 groups according to birth weight and for each group the average age at dentation has been estimated by the method described above. The estimated averages with their standard errors are presented in Table 26.

TABLE 26. AVERAGE AGE AT DENTATION BY BIRTHWEIGHT CLASS

birthweight class (in lbs.)	number of infants contacted at 10th month or later	age at dentation	standard error of the mean
(1)	(2)	(3)	(4)
less than 6	37	9.288	1.035
6 – 7	42	7.883	1.030
7 and over	37	8.370	1.037
total	116		

$$L^* = \frac{n!}{(k-1)!\,(n-k)!}\, e^{-\frac{1}{2\sigma^2}\sum_{i=1}^{k}(x_i-\mu)^2} \left[(\sigma\sqrt{2\pi})^{-1} \int_{x_k}^{\infty} e^{-\frac{1}{2\sigma^2}(x-\mu)^2}\, dx \right]^{n-k}$$

From the above table it appears that babies weighing 6-7 lbs at birth had a lower age at dentation than those weighing less than 6 lbs. On the other hand, as we proceed to the next higher birthweight class, 7 lbs and over, we notice a slight increase in the age at dentation, although the observed increase is statistically not significant.

To study the effect of infant diet on growth information on the quantities of of items included in the feeding during successive months after birth was obtained. Almost the entire sample of infants surveyed belonged to the poorer classes and their nutritional levels were indeed low. However, a classification based on milk intake, gave rise to two groups, one moderately adequate and the other inadequate in nutritional intake. Breast feeding without substitute was considered as adequate nutritional intake for the period concerned. For these two groups, the average age at dentation was estimated by the same procedure as before and shown together with their standard errors in Table 27.

TABLE 27. AVERAGE AGE AT DENTATION BY NUTRITIONAL LEVELS

nutritional level	number of infants contacted at 10th month or after	age at dentation in months	standard error of the mean
(1)	(2)	(3)	(4)
moderately adequate	60	8.610	1.028
grossly inadequate	56	9.669	1.027
total	116		

From the figures given in the above table it appears that dentation is delayed in the case of infants belonging to the grossly inadequate nutritional group. Failure of lactation and want of suitable substitute no doubt retard growth. Calcium metabolism is also affected. But these alone are not the factors concerned because a classification according to nutritional level also leads to one based on the social class. It was observed earlier that the proportion of infants with low birth weights was higher among the lower social class. Further it was in this class that a higher incidence of morbidity was recorded. As both these factors retard growth the higher age at dentation observed among the infants belonging to the grossly inadequate diet group cannot be entirely ascribed to nutritional deficiency.

Mental development. Development is a continuous process from conception to maturity and birth is merely an event in the course of development, though it signals the beginning of environmental influences. A prematurely born infant is developmentally behind a baby born at full term, although the former passes through the same sequence of mental developments.

Case histories of infants affected by various diseases of the nervous system and how such diseases had retarded mental developments in different fields have been reviewed by Illingworth (1960). He has stated that such variations are not confined to diseased cases only, because even those infants who gave no evidence of any impairment behaved so differently in their mental development that it is impossible to draw a dividing line between the normal and the abnormal. Accordingly he has given a series of averages for the ages at attaining different stages of mental development and has cautioned that deviations, however large they may be, do not necessarily indicate abnormality. It is pertinent here to quote some of these figures and observe how they compare with the results of this survey.

Sitting. Age 28 weeks; sits on floor with hands forward for support; age 32 weeks : sits momentarily on the floor without support; age 36 weeks : sits steadily on floor for 10 minutes, leans forward (but not sideways) and recovers balance.

Standing. Age 36 weeks : stands holding on to furniture—pulls self to stand; age 44 weeks : standing, lifts foot.

The acquiring of any of these skills does not occur at a point of time but it is a gradual process spread over a period of month or so.

In this enquiry the age at sitting has been reckoned as the age at which the child could sit steadily without support and the age at standing as the age at which the child could stand easily and balance for a while without help from others.

The median age at sitting and standing has been obtained by the same graphical method as the one adopted in the study on age at dentation. The distribution of infants according to their age at contact is shown in the first row of Table 28 and the number of infants in each age group who had already learned to sit is given in the second row. In the third row of the same table is given the number in each group who have already learned to stand.

TABLE 28. NUMBER OF INFANTS ALREADY LEARNED TO SIT AND TO STAND IN DIFFERENT AGE GROUPS

	age in months at the time of interview									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	below 4½	4½-5½	5½-6½	6½-7½	7½-8½	8½-9½	9½-10½	10½-11½	11½-12½	total
number of infants	110	9	26	23	17	17	12	24	80	318
number of infants already learned to sit	—	2	6	16	11	12	10	21	75	153
number of infants already learned to stand	—	—	—	1	2		5	11	55	78

Graphs drawn by free-hand to depict the variation of the proportion of infants who already learned to sit by the time they attained a given age and a similar one for those who learned to stand are shown in Fig. 2.

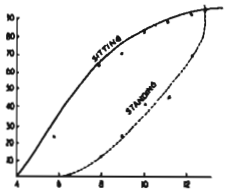

Fig. 2. Percentage of infants already learned to sit and stand.

By the 8th month of age nearly two-third of the infants already learned to sit and by the 10th month 5/6th of the infants have passed that stage. A very small minority could not sit even at the end of the year and these are cases of delayed motor development. Slightly over two-third of the children learned to stand by the 12th month of life. The median age at sitting and standing obtained from the above graphs are 7.00 and 10.93 months respectively. The age at standing appears to be slightly more advanced than that obtained for normal children by Illingworth (1960) and this is not entirely due to the fact that the survey sample included an appreciable number of children in the low birthweight class as will be seen from Table 29.

Just as in the case of the age at dentation, for the ages at sitting and standing as well, we can obtain censored distributions with suitable points of truncation. After examining the distribution of the ages at sitting and standing, 8th month and 11th month were selected as points of truncation for obtaining the censored distribution of the ages at sitting and standing respectively. In what follows the average ages at sitting and standing have been estimated by the same method as the one adopted in the study on dentation. A logarithmic transformation of the age scale was carried out for the same reason.

Factors affecting mental development. To assess the influence of birthweight the infants were grouped into birthweight classes as before and the average ages at sitting and standing with their respective standard errors were estimated and shown in Table 29.

TABLE 29. AVERAGE AGES AT SITTING AND STANDING BY BIRTHWEIGHT CLASS

birthweight class	number of infants contacted 8th month or after	age at sitting in month		number of infants contacted at 11th month or after	age at standing in months	
		mean	standard error of mean		mean	standard error of mean
(1)	(2)	(3)	(4)	(5)	(6)	(7)
less than 6 lbs.	42	7.752	1.023	35	14.381	1.038
6—7 lbs.	59	7.444	1.025	38	12.713	1.025
7 lbs and over	49	7.236	1.024	31	12.644	1.024
total	150			104		

From the above table it appears that as the birthweight increases both the age at sitting and the age at standing are steadily lowered which is suggestive of the influence of pre-natal factors on mental development during the first year of life.

A classification according to infant diet generally leads also to a classification based on social class for reasons stated earlier. Further, a mother who nourishes her baby well may be expected to take better care of her child in other respects too. A dietary classification may, therefore, involve many environmental factors and some of these may affect the maturation process. In the following table are presented the estimates of the average ages at sitting and standing with their respective standard errors for two infant diet groups.

TABLE 30. AVERAGE AGE AT SITTING AND STANDING BY NUTRITIONAL LEVEL

nutritional level	number of infants contacted at 8th month or after	age at sitting in months		number of infants contacted at 11th month or after	age at standing in months	
		mean	standard error of mean		mean	standard error of mean
(1)	(1)	(2)	(3)	(1)	(2)	(3)
moderately adequate	83	7.236	1.019	56	12.690	1.035
grossly inadequate	67	8.523	1.030	48	12.757	1.023
total	150			104		

We observe from the above table that the age at sitting has been appreciably advanced in the case of the grossly inadequate diet group but the same thing cannot be said about the age at standing.

4. Conclusions

(1) The infant mortality rate for the selected sample of 521 infants was 147/1000 live births of which 100/1000 and 47/1000 were the neo-natal and post-neonatal components respectively.

The leading cause of death during the neo-natal period was prematurity unqualified and prematurity associated with other causes. A maturity standard in terms of birthweight was worked out taking into account the chance of survival and a level of 5 pounds was found to be reasonably satisfactory. Incidence of prematurity was considerably higher in the general hospital population because it included a number of unbooked cases arriving from distant suburbs. Further, it was observed that the proportion of premature infants was higher in the lower social classes.

Infant mortality tended to decline with parity. Also it varied inversely with standards of housing, maternal diet, father's income and education. Peculiarly enough, infants born to women who made adequate number of antenatal visits experienced higher mortality. Closer scrutiny, however, revealed that antenatal visits were mostly undertaken for treatment of maternal complications and not as a routine preventive measure.

(2) The inception rate for all causes of morbidity was 12.3 cases/100 months of exposure. Respiratory diseases was the leading group of causes of morbidity followed by diarrhoea and dysentery. Inception rate varied inversely with social class.

(3) (a) Physical growth was measured in terms of age recorded in this case was 9.00 months. Marked delay in dentation was observed both among the infants with low birthweight and among those who were given poor nourishment.

(b) Mental development was measured in terms of age at sitting and age at standing. The median age at sitting and standing were 7.00 months and 10,93 months respectively. Low birthweight was observed to retard motor development as indicated by the age at sitting and standing, the latter significantly.

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Appendix

INDIAN STATISTICAL INSTITUTE
FOLLOW-UP STUDY OF IN-PATIENTS OF MATERNITY WARDS
PART I : HOUSEHOLD SCHEDULE

name and address of the patient.....

name of the husband of the patient.....

(1) is the patient living in this household ? yes no

(2) if no in (1), what is her present address ?

(3) if no in (1), did she stay in this household after leaving the hospital ? yes no
if yes in (3)—(a) how long ?

(b) what was the condition of the mother and infant during her stay here and after ?

(survival of the mother and infant *must be obtained* and details about complications and medical care may *be obtained if the response is reliable*)

(4) if yes in (1), the following information must be collected :

name of the member	relation to the head of the household	sex	age	marital status	educational status	if earner	
						occupation	income
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

migratory status of the head of the household— *migrant* *non-migrant*

if migrant, enter district and state of origin.

actual duration of stay in years

rural town Calcutta city

housing conditions

house owned—rented	rental value	number of living rooms— store— kitchen—	separate 1 common 2 nil 3	bath	privy	water supply

appointment for medical investigation on.....at.....

signature of the Investigator
date :

PART II : HOSPITAL RECORDS

(to be filled in after field enquiry)

age	period of pregnancy	order of the gravidae	complications as reported in the hospital	duration of labour in hours	condition of mother	condition of infant	birth and weights of the infant
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

INDIAN STATISTICAL INSTITUTE

FOLLOW-UP STUDY OF IN-PATIENTS OF MATERNITY WARDS

PART III : PATIENTS' SCHEDULE

signature of the investigator & date

BLOCK (1)

1. patient's name and address

2. her relation to the head of the household

3. does her husband reside in this household ? yes no

4. husband's name— age

occupation education income

5. date of discharge from hospital cabin paying non-paying

nature of current termination live birth still birth abortion

associated complication

BLOCK (2)

1. period of confinement to bed after leaving the hospital months days

did you resume normal work after confinement yes no

if 'no' what were the restrictions—

how long the restrictions continued ? months days

2. after the current termination, did you menstruate ? yes no

if 'yes' date of first onset—

pain associated—

interval— in days—

since then did you miss any period ? yes no

if 'yes' remarks about new conception—

3. lactation— success— partial failure— complete failure—

if not, complete failure, are you lactating now ? yes no

if so, when it did cease completely—

4. did you have any complications in the (in months after child birth) last pregnancy ?

if 'yes' state its nature.

ante-natal visits* [ ]	stage of pregnancy in months when visits were made	treatment availed
first in hospital/physician		
second in hospital/physician		
third in hospital/physician		

* if no ante-natal visits were made, enter 'nil' in the space within brackets.

BLOCK 3 : POST-NATAL HISTORY

group	symptom	remarks	onset—days or months after child birth	continuance, if not duration	visits: hosp.	visits: physl.	treatment
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A. uterine sub-involution and retroversion	1. back-ache						
	2. white vaginal discharge						
	3. prolonged and frequent vaginal bleeding						
	4. red lochia						
B. genital tears	1. unsuited or unrepaired perineal tear						
	2. cervical tears						
	3. eversion of lips						
	4. incontinence faeces						
	5. complete perenial tears						
	6. recto-vaginal fistula.						
C. genital prolapse	1. bearing down sensation and something coming out per vagina with/without straining						
	2. abdominal pain-dragging in nature						
D. urinary symptoms	1. incontinence of urine true, stress, urge						
	2. frequency						
	3. buring sensation during urination						
	4. temperature						
	5. pain in the loins						
E. breast complications	1. painful enforgement of breast						
	2. abcess						
	3. mastitis (severe, painful engorgement with rise in temperature)						
	4. cracked, fissured or ulcerated nipples						
F. pelvic inflamation and puerperal sepsis	1. rise of temperature						
	2. pain in abdomen						
	3. red lochia						
	4. offensive or scanty lochia						
	5. irregular haemorhage						
	6. swelling in lower abdoman						
	7. painful swelling of 1 of the legs						
	8. chronic cervities with/without erosions						
G. other post-natal complications	1. obesity						
	2. anaemia						
	3. headache						
	4. insomnia						
	5. scanty urine						
	6. swelling of both legs						
	7. constipation, piles and gastro intestinal symptoms						
	8. puerperal insanity						
	9. obstetrical paralysis of the lower limbs						

(a) were any routine post-natal checks carried out by physicians (even without complications)
if 'yes' time of examination in weeks after childbirth
1st examination ( ) 2nd examination ( ) 3rd examination ( )

(b) were any advices on post-natal exercises given— yes no
if 'yes' state the method of exercises advised and whether they were practised yes no

(c) was any advice on family planning given— yes no
if 'yes' state details

(d) what is your normal diet, i.e., before pregnancy what was your usual diet ?
(state quantities of meat, fish, eggs and milk taken per day)
fruits and vegetables—
did you take any additional quantities of the above items
(1) during pregnancy state (including tonics)
(2) after child-birth—

BLOCK 4

Infant

1. sex 2. birth-weight 3. gestation period 4. surviving or dead

5. if surviving present age 6. if dead, age at death in month and days

7. cause of death (describing the train of events leading to death)

8. if surviving, give the health history of the infant below :

age	name of the disease with symptoms	attendance to physician, hospital etc.	treatment availed	result		
				cured	partially cured	not cured
0–1 week						
1 week–1 month						
1–3 month						
3–6 month						
6 month and above						

9. *Development*

(a) activity (age in months at which baby was sitting, standing etc., may be ascertained)

(b) sucking and breathing reflex— (c) bowels

(d) dentation (e) general appearance

10. *Feeding*

item	quantity per day	period in months
1. breast milk		
2. cow's milk		
3. other types of milk (state brand)		
4. cereals		
5. fruits		
6. fish		
7. meat		
8. eggs		
9. tonics		

BLOCK : PREVIOUS PREGNANCY HISTORY

age at marriage												
order of parity	1	2	3	4	5	6	7	8	9	10	11	12
age of the mother												
result of pregnancy												
complications in labour												
post-natal complications												
whether hospital delivery												

Chronic diseases of the mother (if any) : 1. T.B. ; 2. diabetes ; 3. heart disease ; 4. essential hypertension ; 5. nephritis 6. rheumatism ; 7. gastric troubles ; 8. others (state the exact cause) ;

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