A LONGITUDINAL STUDY OF THE GROWTH AND DEVELOPMENT OF PREMATURELY AND MATURELY BORN CHILDREN

PART IV. MORBIDITY

BY

CECIL MARY DRILLIEN

From the Department of Child Life and Health, Edinburgh

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This paper, which is the fourth in a series presenting findings in a long term study of growth and development in a sample of nearly 600 prematurely and maturely born children, describes the health history of the group in the first 2 years of life. A description of the sample and methods of investigation is given elsewhere (Drillien, 1958).

The children were visited at six-monthly intervals, and a history taken of any illness necessitating medical attention or hospital admission. It is realized that what constitutes an 'illness' for the individual mother depends on her temperament, the type of home, and whether the child is first or later born. The middle class mother with a first baby tends to call in the doctor for minor ailments, while the poor working class mother with a large family may ignore quite obvious ill-health. For this

reason an illness has only been included in the subsequent analysis if there appeared to have been some degree of definite constitutional disturbance or pathology. It was also obvious that the better type mothers remembered and recorded their children's illnesses accurately, whereas the mother from a lower social grade tended to under-estimate the number of disease incidents. If differences are found in incidence of illness in different types of home, it is likely that the recorded differences are smaller than those actually occurring.

Patterns of Morbidity in the First Two Years

Fig. 1 illustrates the relative amount of medical illness suffered by different birth weight groups during four six-monthly periods. Fig. 2 divides the total morbidity into five sections: respiratory disease, infections of ear, nose and throat, gastrointestinal infections, specific fevers, and all other conditions. The prematurely born appear to suffer from more illness in the first year, especially from respiratory infections, in spite of the fact that there are more firstborn children in this group. In the second year there is little difference in the total amount of ill-health, the larger born children tending to have rather more illness, chiefly owing to an increase in incidence of specific fevers and also of tonsillar and middle-ear infections. This is probably due to the increased risk of acquiring infections from siblings, and the earlier age at which these children are allowed out to play. It is noteworthy that throughout the first two years, respiratory infections account for more than half of all illness necessitating medical attention.

FIG. 1.—Total medical illness in the first two years of life by birth-weight and age.

FIG. 2.—Relative morbidity by diagnostic category.

Black = premature
White = mature

Respiratory Infections. The incidence of respiratory disease and infections of the throat and middle ear has been analysed in more detail, an endeavour being made to group the illness according to the severity of the condition. The following scoring has been adopted for each six-monthly period:

(1) Frequent head colds, one or two chesty colds, influenza (defined as a febrile attack of uncertain origin), whooping cough described as being mild, laryngitis and pharyngitis.

(2) Frequent chesty colds, tonsillitis, whooping cough described as being severe.

FIG. 3.—Standard of maternal care by parity of mother.

(3) Bronchitis, croup, otitis media with discharge, measles or whooping cough complicated by bronchitis.

(4) Pneumonia, laryngo-tracheo-bronchitis, measles or whooping cough complicated by pneumonia.

It might be expected that the amount of respiratory illness would be affected by the number of older siblings, the efficiency of the mother and the standard of housing, as well as by birth weight. The child with several siblings was found to have a higher incidence of respiratory infection than the only child, as well as of all other infective conditions, but it does not necessarily follow that the presence of older children in the family is of major importance. It was found that the standard of maternal care was highly correlated with parity, as seen in Fig. 3. In families with five or more children, 70% were considered to be receiving poor or only fair maternal care, whereas when the survey child was first born, care was satisfactory in 83% of cases. It is difficult to differentiate the relative effect on the morbidity rate of maternal care and number of older siblings, as in only 10% of the cases receiving the best care were there more than two older children, and in only 3% of firstborn children was maternal efficiency considered poor. In the subsequent analysis the incidence and severity of respiratory infection is related to maternal efficiency only, but it should be remembered that in those cases where efficiency is fair or poor there will be the added risk to the child of infection carried by other members of the family.

Fig. 4 shows the amount of respiratory infection in the first two years, according to the scoring given above, by birth weight and maternal efficiency. A very striking difference is seen between children

FIG. 4.—Amount of respiratory illness in first two years by maternal care and birthweight.

Care: 1 = very good. 2 = good. 3 = fair. 4 = poor.

receiving the best and worst care, this difference being most marked in the prematurely born, in spite of the fact that more of these children are first born. A smaller group of children who were 3 lb. or less at birth is also being studied, and the figure gives the comparative amount of respiratory illness in this group for two grades of maternal care, efficiency grades one and two, and three and four being combined to give larger numbers. Here the amount of illness in the best maternal efficiency group is only slightly higher than that for the larger birthweight groups, but children of this low birthweight receiving the poorest care show a very much higher infection rate than children from similar backgrounds who were bigger at birth.

In estimating the effect of housing on the amount of respiratory illness, the difficulty again arises that poor housing and low maternal care commonly go together. Fig. 5 demonstrates the amount of respiratory illness by birthweight in the best and worst housing accommodation in those cases where maternal care was satisfactory. In the prematurely born, there is a definite excess of respiratory illness associated with poor accommodation, though there is very little difference in those who were mature at birth. The other half of the figure shows the amount of respiratory illness by birthweight where maternal care was poor, for those accommodated in municipal housing compared with children in poorer housing. In the smallest born, and also those who were mature at birth, there was considerably more illness in those who might be considered adequately housed, these findings probably being due to the apparent increased susceptibility to respiratory infections in children of low birthweight, and to the fact that nearly all the maturely born children were members of large families. Adequate housing by itself does not diminish the amount of illness. There is no doubt that money available for food and clothing decreases considerably when a family with one wage earner moves into a municipal house at three or four times the previous rent, and with extra overhead expenses. During the age period studied, 32 children were removed from poor overcrowded accommodation into municipal houses. In only one case did the mother consider that the child's health had improved. It was striking how little illness was encountered in really poor accommodation, if maternal care was good, but most of these mothers restricted their families to one or two children until re-housing was possible. On the other hand, when a poor type family was re-housed, the pattern of living usually continued along the same lines, shared beds being the rule. Between the ages of 2 and 4 years the number of families

FIG. 5.—Amount of respiratory illness in certain types of housing by maternal care and birthweight.

rehoused has increased, and it may be possible at a later date to estimate more accurately the effect of re-housing on health. The incidence of respiratory illness was found to be considerably higher in prematurely born boys than in girls, but it also happens that in this sample there was an excess of poor maternal care in the male group. When the sexes were compared according to whether care was satisfactory or unsatisfactory it was found that prematurely born boys had between 20 and 30% more respiratory illness than girls for all grades of maternal care, but no difference was found between maturely born boys and girls from similar homes. The apparent increased susceptibility of boys to lower respiratory infections is confirmed by local and national figures. In the Report of the Department of Health for Scotland (1957) for 1956 the notifications for all forms of pneumonia in the under-5-year-old group are 35% higher for boys than girls. Deaths attributed to pneumonia and bronchitis in Edinburgh for the same year and age group were 19 per 1,000 for boys and two per 1,000 for girls.

Gastro-intestinal Infections. The incidence of gastro-intestinal infections reached a peak during the second half of the first year, when the child was being introduced to solid foods. No marked difference was found in incidence in different birthweight groups, although, as would be expected, the incidence increased with increasing size in family. Fig. 6 shows the relative amount of gastro-intestinal infection according to the standard of maternal care.

FIG. 6.—Gastro-intestinal infections by maternal care.

Mild digestive disorders with little constitutional disturbance, and parenteral diarrhoea and vomiting associated with another infection have not been included. Gastro-enteritis and dysentery of moderate severity have been scored 1, and more serious conditions necessitating admission to hospital have been scored 2. The risk of gastro-intestinal infection increases markedly as maternal care deteriorates. It is noteworthy that of a total of 327 children receiving the best care only two were admitted to hospital with gastro-intestinal infections during the first two years of life. In the worst maternal efficiency group there were 14 admissions for a total of 63 children.

Specific Fevers. Table 1 gives the numbers of children in the sample who contracted various specific fevers during the first 2 years of life, and also the incidence for firstborn children, and those with older siblings.

Measles and whooping cough were the commonest infectious diseases during this period, and these two conditions have been analysed in more detail. It was found that the incidence of measles and whooping cough was correlated both with size of family and maternal efficiency. There was no significant difference in susceptibility to infection between the prematurely and maturely born. The level of care in the premature group was lower, but the larger number of firstborn children cancelled out this effect.

TABLE 1
INCIDENCE OF CERTAIN SPECIFIC FEVERS

Specific Fever	Firstborn		Later Born		Total	
	No.	Per cent.	No.	Per cent.	No.	Per cent.
Measles ..	35	12.2	58	19.1	93	15.7
Whooping cough ..	21	7.3	30	9.9	51	8.6
Chicken pox ..	5	1.7	24	7.9	29	4.9
Rubella ..	6	2.1	3	1.0	9	1.5
Mumps ..	1	0.3	7	2.3	8	1.4
Others ..	2	0.7	—	—	2	0.3
	70		122		192	

TABLE 2
INCIDENCE OF MEASLES AND WHOOPING COUGH BY MATERNAL EFFICIENCY

Maternal Efficiency	Children Affected			Severe Cases (%)
	First born (%)	Later born (%)	Total (%)	
	Measles			
1 and 2 ..	10.7	16.4	13.4	9.7
3 and 4 ..	23.3	25.0	24.4	29.0
	Whooping Cough			
1 and 2 ..	6.6	7.3	6.9	9.4
3 and 4 ..	11.6	16.7	15.0	52.6

Table 2 gives the incidence of measles and whooping cough by maternal efficiency for firstborn children and those with older siblings, and also the percentage of total cases which were considered to be severe. The illness was called severe when there was considerable constitutional disturbance and a prolonged convalescence, and when there was a complicating bronchitis or pneumonia. The incidence of measles and whooping cough was twice as high for those children who were receiving poor or only fair maternal care, both for firstborn children and those with older siblings. In addition, the proportion of cases classified as being severe was three times as high for measles, and more than five times as high for whooping cough.

It seems likely that the efficient mother is more conscientious about protecting her child from infection, this being made easier by the better standard of housing, and that when infection does occur, the child who has been well nourished and whose general health has hitherto been good is less likely to suffer from a severe attack or lower respiratory complications. As would be expected, the proportion of children receiving protective immunization against whooping cough is higher for those receiving satisfactory care, 77.2% compared with 42.6% in those cases where care was unsatisfactory. No statistically significant differences were found in case incidence of protected and unprotected children

after maternal care and number of older siblings had been taken into account. However, numbers are small. It may be possible at a later date to estimate more accurately the protection afforded by immunization.

Skin Diseases. Table 3 gives the number of skin diseases requiring medical attention by two grades of maternal efficiency. As would be expected, there was a much higher incidence of septic skin infection

TABLE 3
INCIDENCE OF SKIN DISEASES BY MATERNAL EFFICIENCY

	Maternal Efficiency			
	1 and 2		3 and 4	
	No.	Per cent	No.	Per cent.
Impetigo and other septic skin conditions	13	2.8	22	17.3
Abscesses and recurrent boils	9	1.9	5	3.9
Infantile eczema	18	3.9	1	0.8
Other skin conditions	6	1.3	2	1.6

where maternal care was unsatisfactory. It is of interest that 18 out of a total of 19 cases of infantile eczema occurred in children receiving satisfactory care, whose mothers appeared to be rather above average in intelligence. The affected children also appeared to be above average intelligence. This, too, was the only skin condition which occurred predominantly in the prematurely born, only four of the 19 cases being seen in full term infants.

Other Infections. During the two-year period only eight cases of infectious illness were recorded other than those already considered. These were: meningococcal meningitis (3), pneumococcal meningitis (1), tuberculous meningitis (2), and pyelitis (2). All cases of meningitis occurred in the prematurely born.

Accidents. Thirty cases of accident or injury were treated in hospital during the two-year period. These are set out by cause in Table 4. There was no difference in incidence between children whose care was satisfactory (5% of total children at risk) and unsatisfactory (5.5%). As would be expected, the majority of accidents (83%) occurred in the second year of life. Twice as many accidents occurred in boys, and three times as many in the maturely born, due to the earlier age of walking. No accident was fatal.

TABLE 4
ACCIDENTS REQUIRING HOSPITAL TREATMENT

Burns and scalds	12
Fractures and dislocations	6
Cuts requiring stitches	6
Swallowed foreign bodies	3
Concussion	2
Poisoning	1
Total	30

Congenital Defects. Table 5 gives the number of congenital defects found in different birthweight groups, and also the incidence of minor and major defects, the latter involving risk to life or considerable handicap. Both minor and major handicaps increase strikingly with decreasing birthweight. This would be expected, as the child with a congenital abnormality is likely to be born before term. No social gradient could be demonstrated in the incidence of congenital defect.

TABLE 5
CONGENITAL ABNORMALITIES BY BIRTHWEIGHT

No. of children at risk	Birthweight (lb. oz.)		
	4.8 and under	4.9 to 5.8	5.9 and over
Microcephaly	2	—	—
Cerebral palsy	6	1	1
Mongolism	—	—	1
Congenital deafness	4	—	—
Congenital cataract	—	2	—
Other congenital eye abnormalities	1	—	1
Cleft palate	—	1	—
Congenital stridor	—	—	1
Congenital heart lesions	1	1	—
Pyloric stenosis	3	2	1
Other abnormalities of digestive tract	1	2	—
Inguinal hernia	9	1	2
Umbilical hernia	—	—	3
(requiring operative treatment)			
Congenital dislocation of hip	1	—	—
Talipes	—	1	—
Absence of limb	—	1	—
Asymmetry of limbs	—	1	—
Haemangiomas	6	3	2
Total	34	16	12
Percentage	20.6	7.5	5.6
Major abnormalities	16	8	3
Percentage	9.7	3.7	1.4
Minor abnormalities	18	8	9
Percentage	10.9	3.7	4.2

All Other Conditions. Table 6 sets out all other conditions requiring medical treatment or hospital admission. Nearly all cases classified as 'failure to thrive' also had an obvious anaemia. As would be

TABLE 6

ALL OTHER CONDITIONS REQUIRING MEDICAL TREATMENT

	Premature	Mature
Failure to thrive and anaemia	26	2
Recurrent convulsions	4	—
Thrombocytopenic purpura	1	—
Pink disease	1	—
Recurrent acidosis	1	—
Squint	12	2
Flat foot, knock knees, bow legs ..	17	1
Sternomastoid tumour	3	—
Facial palsy	1	—
Rectal prolapse	1	—
Hydrocoele	1	1
Mesenteric adenitis	1	1
Venous thrombosis (foot)	1	—

expected, these cases occurred predominantly in the premature group, anaemia of prematurity being a well recognized condition. It is noteworthy, however, that three-quarters of these cases were receiving unsatisfactory maternal care. Of 18 cases of marked flat foot requiring treatment, 17 occurred in the premature group.

Hospital Admissions. Table 7 gives the number of children admitted to hospital for medical reasons in the first 2 years of life, and also the total number of admissions by birth weight. It will be seen that twice as many prematurely born children were admitted to hospital, and the total number of admissions was two and a half times as high as in the mature control group.

Table 8 gives total admissions for different diagnostic categories, and shows that nearly one-half of hospital admissions in the premature group were due to lower respiratory infections.

Deaths. Ten children out of the total of 595 died before reaching their second birthday. Details of their deaths are set out in Table 9. The numbers are too small to draw any general conclusions, but a few points seem to stand out. All deaths except one occurred in the premature group of 381 children (death rate, 23.6 per 1,000 children surviving for

TABLE 7

HOSPITAL ADMISSIONS BY BIRTHWEIGHT

Birthweight (lb. oz.)	No. of children admitted per 100 children at risk	No. of admissions per 100 children at risk
4.8 and under	18	25
4.9-5.8 ..	19	26
5.9 and over ..	9	10

TABLE 8

HOSPITAL ADMISSIONS FOR MEDICAL ILLNESS BY CAUSE AND BIRTHWEIGHT

	Premature	Mature
Lower respiratory infections	42	3
Convulsions (? cause)	5	1
Dysentery, gastro-enteritis	22	6
Tonsillitis, laryngitis, otitis media ..	6	3
Specific fevers	8	5
Skin infections	3	1
Other infections	6	1
All other causes	7	2
Total	99	22
No. of children at risk	381	214

longer than 28 days after birth). In another investigation of the later development of children who were 3 lb. or less at birth, six deaths occurred in the first two years out of a total of 65 children (death rate, 92.3 per 1,000 surviving children). Seven of the ten children were males, although numbers of males and females in the sample are about equal. Six of the 10 children were twins, although only 38% of the total sample were twin births. Maternal efficiency was considered to be unsatisfactory (efficiency grade three or four) in one-half of the cases. Of the total sample of children, 20% were considered to be receiving unsatisfactory care.

Discussion

In the report of the study of health and sickness experience in the first year of life in Newcastle (Spence, Walton, Miller and Court, 1954), the following sentence occurs: 'In the study of these

TABLE 9

DEATHS IN THE FIRST TWO YEARS OF LIFE IN 595 CHILDREN SURVIVING FOR LONGER THAN 28 DAYS

Birthweight (lb. oz.)	Sex	Twin or single birth	Age at death (months)	Cause of Death	Maternal Efficiency
2.7	F	T	6	? Found dead in cot	1
3.0	M	S	4	Pneumonia	4
3.12	M	S	5	Cerebral sinus thrombosis	1
3.13	M	T	24	T.B. meningitis	4
4.7	M	T	6	Whooping cough. Gastro-enteritis	1
4.13	F	S	3	Pneumonia	3
4.14	M	S	17	Pneumococcal meningitis	1
5.0	F	T	1	Pneumonia	4
5.6	M	S	15	T.B. meningitis	2
6.1	M	T	3	? Found dead in cot	4

families and in attempting to correlate their environments with the health of the children, there emerged one dominating factor, the capacity of the mother.' The current study of the health of prematurely and maturely born children in Edinburgh confirms this finding. For all birthweights, morbidity rates, and severity of infective disease were highly correlated with maternal efficiency, prematurely born children being affected to a greater extent by adverse environmental conditions than maturely born children from similar homes.

In the Newcastle study, 85% of total recorded illness was infective in origin, which compares closely with the Edinburgh findings of 85% for prematurely born and 90% for the mature control group. Nearly one-half of the total morbidity was due to respiratory infections, as was also found in a recent survey reported by Grundy and Lewis-Faning (1957).

For all types of infection, the prevalence and severity of the condition varied inversely with the standard of maternal care. The excess morbidity of prematurely born children in the first year of life is largely accounted for by the lower standard of maternal care in this group, but there does appear to be a small but definite excess of lower respiratory infections in those smallest at birth. This susceptibility to bronchitis and pneumonia of prematurely born children was noted by Douglas and Mogford (1953). Douglas reported that the excess in lower respiratory infections was found even when the premature infant was reared in an apparently favourable environment, which is contrary to the findings in the present investigation. In the Edinburgh sample very little difference was found between the incidence and severity of respiratory infections in children receiving the best maternal care, but there was a marked difference between the smallest and larger born where maternal efficiency was poor. It seems probable that the failure to note a social morbidity gradient is accounted for by the fact that the better type mother is more likely to remember and record her child's illnesses accurately, especially as the children studied by Douglas were seen at infrequent intervals: 2 months, 2 years, and 4½ years. Similarly, in an investigation of morbidity in the first 5 years of life in Luton (Dykes, Grundy and Lewis-Faning, 1953), no social morbidity gradient could be demonstrated after the exclusion of bronchitis and pneumonia in the first year. In this study, sickness was defined as a condition requiring treatment in bed for 48 hours, a visit from the doctor, or a condition leaving a recognizable disability. The mother from the higher social grades is more likely to treat minor illness seriously than

the poor mother with a large family, as well as to remember her child's illnesses in retrospect.

Only small social group differences were found by Douglas and Blomfield (1958) in the incidence of measles and whooping cough, though children from poor families contracted these infections at an earlier age. The influence of housing and maternal care was considered to be negligible. Again, it is likely that there has been under-reporting on the part of the poorer mothers. In another paper, discussing the reliability of longitudinal surveys, Douglas and Blomfield (1956) report that of 1,296 mothers who stated at 2 years that their child had contracted whooping cough and/or measles, 96 failed to report this at 4½ years, failure to remember occurring predominantly amongst poor type mothers.

Summary

The health history has been studied of a group of nearly 600 prematurely and maturely born children in Edinburgh in the first two years of life.

The following conclusions were reached:

More than 85% of all illness requiring medical attention was infective in origin, nearly one-half of this being due to respiratory infections. Prematurely born children suffer from more medical illness in the first year of life, especially from respiratory infections.

The incidence and severity of respiratory infection is highly correlated with the standard of maternal care. Prematurely born children are affected to a greater extent by an adverse environment than maturely born children from similar homes. No great difference was found in the incidence of respiratory infections in different types of housing, for children receiving similar care. Prematurely born boys appeared to be more susceptible to respiratory infections than girls.

The incidence and severity of gastro-intestinal infections is highly correlated with the standard of maternal care.

The incidence and severity of measles and whooping cough is also highly correlated with standard of care both for firstborn and later born children. No statistically significant difference in case incidence was found between children who had or had not received protective immunization against whooping cough.

Infective skin conditions were associated with unsatisfactory care. Infantile eczema was found predominantly amongst intelligent children of good type mothers.

No social gradient was demonstrated in the incidence of accidents, most of which occurred in

the second year of life. The incidence was highest amongst maturely born boys.

The incidence of congenital defects, both major and minor, increased with decreasing birth weight. No social gradient could be demonstrated.

Hospital admissions for medical illness were considerably higher in the prematurely born, especially for lower respiratory infections. Details are given of deaths.

The health experience of the Edinburgh group is compared with that of similar surveys, and some reasons put forward for certain discrepancies observed.

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