

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

PART I. INTRODUCTION

BY

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Over the past 40 years many studies of the later growth and development of premature infants have been reported in the literature with widely varying conclusions (for example: Ylppö, 1920; Capper, 1928; Hess, Mohr and Bartelme, 1934; Blegen, 1952; Alm, 1953). In a comprehensive review of the early literature Benton (1940) puts forward four reasons for its contradictory nature. These are: the substitution of 'clinical impression' for standardized tests; the lack of attention paid to socio-economic factors; inadequate numbers and unsatisfactory controls; and the biased nature of the samples.

The longitudinal developmental study which is described in this paper has been designed to take into account these important points.

The chief difficulty in planning a long-term study of this type is to obtain the co-operation of parents representing a cross section of the general population, and having gained co-operation to maintain it over a period of years. This is well illustrated by reference to some current long-term studies. For the longitudinal research in child development being carried out from the Child Study Centre, London (Moore, Hindley and Falkner, 1954), the parents of 18.4% of the 272 children originally selected, declined to participate in the study at the beginning. In a similar study from the Centre International de l'Enfance, Paris, 16% of the 515 children were never seen. In addition it was reported (Pernot, 1955) that not more than 15% attended all seven of the examinations arranged during the first two years.

Present Study

During the period 1953 to 1955, over 1,000 mothers delivered in two large Edinburgh maternity hospitals took part in an investigation into the social

factors affecting premature birth (Drillien, 1957). Every surviving premature infant and every pair of twins was selected for the developmental study, the only stipulation being that the family be resident in Edinburgh and likely to be so for the next six months. Illegitimate infants were only excluded if adoption was proposed. The sample so obtained was heavily weighted by the larger premature babies between 4½ and 5½ lb. at birth. It was therefore decided to include all babies of 4 lb. or less, who were resident in the surrounding counties.

The control group of infants who were mature at birth, on a weight basis, was selected by taking the next mature birth from the hospital record list occurring after every alternate premature birth. This method of obtaining a control sample has been chosen in preference to the commonly used matching technique (e.g., Douglas and Mogford, 1953) which is based on the assumption that social and economic differences between two groups will be removed by matching for certain broad categories such as social class, sex, age of parents, place in family and locality. This method has not been employed in the present study as it was felt that many more diverse influences affect the later growth and development of the child than can be covered by taking into account a few broad groupings. It has, in fact, been noticed on many occasions that two neighbouring families matched closely by such factors may show widely differing standards of child care and household management.

The mothers were not asked initially to co-operate in a long-term survey, but were asked to allow a visit and examination when their baby was 6 months old. At this time every mother agreed to co-operate, although later two withdrew their consent. Table 1

gives the total numbers of children originally recruited, by sex and birth weight. Tables 2 and 3 give the numbers of twin pairs and the birth weight distribution of individual twins by sex. It was hoped that after the first visit at 6 months of age, the mothers would be sufficiently interested to continue co-operation and this has, in fact, been the case. Losses from the sample have been minimal and have been due mainly to emigration, or removal to a considerable distance (i.e., more than 30 or 40 miles). Children who were grossly mentally defective were removed from the sample after one year if the diagnosis had been established. Two children were lost from the sample in the first two years for this reason. Table 4 gives the number

TABLE 1
TOTAL NUMBER OF SINGLETONS ORIGINALLY RECRUITED BY BIRTH WEIGHT AND SEX

Birth Weight (lb. oz.)	M.	F.	Total
3·0 and under ..	10	4	14
3·1-3·8 ..	13	15	28
3·9-4·0 ..	14	12	26
4·1-4·8 ..	18	20	38
4·9-5·0 ..	30	25	55
5·1-5·8 ..	37	53	90
5·9-6·8 ..	6	14	20
6·9-7·8 ..	22	27	49
7·9-8·8 ..	21	14	35
8·9 and over ..	9	6	15
Total ..	180	190	370

TABLE 2
TOTAL TWIN PAIRS ORIGINALLY RECRUITED

Twin Pairs of Unlike Sex:			
Both over 5½ lb. ..	..	..	14
Both under 5½ lb. ..	..	..	22
Male over 5½ lb., female under 5½ lb. ..	..	..	7
Female over 5½ lb., male under 5½ lb. ..	..	..	6
Total ..	..	..	49
Twin Pairs of Like Sex, Identical:		F.	M.
Both over 5½ lb. ..	..	1	2
Both under 5½ lb. ..	..	11	7
One over 5½ lb., one under 5½ lb. ..	..	1	5
Total ..	..	13	14
Twin Pairs of Like Sex, not Identical:		F.	M.
Both over 5½ lb. ..	..	7	7
Both under 5½ lb. ..	..	3	5
One over 5½ lb., one under 5½ lb. ..	..	7	—
Total ..	..	17	17
Surviving Twin of Like Sex, Other Twin Stillborn or Died Before Discharge		F.	M.
Over 5½ lb. ..	..	1	1
Under 5½ lb. ..	..	2	1
Total ..	..	3	2
Total no. of twin pairs ..	..	..	110
Total no. of twin pairs one only surviving ..	..	..	5
Total no. of infants ..	..	..	225

TABLE 3
BIRTH WEIGHT DISTRIBUTION OF TWINS RECORDED SEPARATELY BY SEX

Birth Weight (lb. oz.)	M.	F.	Total
3·0 and under ..	2	6	8
3·1-3·8 ..	1	3	4
3·9-4·0 ..	12	7	19
4·1-4·8 ..	15	13	28
4·9-5·0 ..	11	17	28
5·1-5·8 ..	22	21	43
5·9-6·8 ..	30	22	52
6·9-7·8 ..	15	18	33
7·9-8·8 ..	5	5	10
Total ..	113	112	225

TABLE 4
LOSSES FROM SAMPLE

Age (months)	Total	Examination Completed	Examination not Completed	Lost from Sample*
6	595	572	13	10
12	585	564	3	18
18	567	548	5	14
24	553	538	6	9

*Total 51: death (9); refused to co-operate (7); moved or emigrated (33); removed from sample because of gross mental defect (2).

of examinations completed at 6, 12, 18 and 24 months of age, the number of examinations missed and losses from the sample. Out of the original 595 children recruited, 544 (91·4%) remained in the survey at 2 years.

Although at the time these children were born about 75% of all Edinburgh births took place in hospital, it seemed possible that a sample of children selected from hospital deliveries only might be biased, particularly as regards social background and parity of the mother. All births in Edinburgh are notified to the Public Health Department of the Corporation as being under or over 5½ lb. at birth, and access to these records was allowed. It was therefore decided to obtain some comparative information about all births in Edinburgh during the 12-month period October, 1953, to October, 1954 (Drillien and Richmond, 1956). Every premature birth together with one in 10 of all mature births was investigated and the following information recorded about each: birth weight, legitimacy, age of mother, parity and occupation of the father.

The survey sample can therefore be compared with the general infant population to see how far the two are alike and in drawing any general conclusions from the sample cognisance can be taken of the differences observed.

Tables 5 and 6 give the parity and social class distribution of the survey sample as compared with the general population, for premature infants of

TABLE 5

PARITY DISTRIBUTION, EXPRESSED AS PERCENTAGE, OF SURVEY SAMPLE COMPARED WITH ALL INFANTS BORN IN EDINBURGH, 1953 TO 1954

Birth Weight (lb. oz.)	Parity											
	0		1		2		3		4		5 and over	
	Survey	Edin.	Survey	Edin.	Survey	Edin.	Survey	Edin.	Survey	Edin.	Survey	Edin.
>5·8	58·9	36·6	21·0	27·9	15·1	15·5	3·4	8·0	0·8	8·0	0·8	6·0
4·1 to 5·8	56·8	48·9	20·8	22·6	10·4	14·7	6·6	5·1	6·6	5·1	2·7	4·6
<4·1	47·1	51·0	19·1	14·9	19·2	12·8	11·8	12·8	11·8	12·8	—	8·5

TABLE 6

SOCIAL CLASS DISTRIBUTION, EXPRESSED AS PERCENTAGE, OF SURVEY SAMPLE COMPARED WITH ALL INFANTS BORN IN EDINBURGH, 1953 TO 1954

Birth Weight (lb. oz.)	Social Class					
	1 and 2		3		4 and 5	
	Survey	Edin.	Survey	Edin.	Survey	Edin.
>5·8	21·8	26·9	55·5	53·6	22·7	19·5
4·1 to 5·8	15·3	12·5	51·4	57·1	33·3	30·4
<4·1	14·7	19·1	66·2	55·4	19·1	25·5

4 lb. or less at birth, those between 4 lb. 1 oz. and 5 lb. 8 oz., and those mature at birth.

The social class distribution of the survey sample and the Edinburgh infants is very close and appropriate statistical tests show that there is no reason to suppose that the survey sample is biased in any way with respect to social class distribution.

Parity distribution in the premature groups is also sufficiently close to be free from bias, but in the mature control group there is an excess of first births in the survey sample, which must be taken into account in drawing general conclusions about the effect on the child of place in family.

As nearly all twin pregnancies are delivered in hospital, it has been assumed that the sample of twins will be representative of twins in the general population.

Procedure and Methods

Hospital Interview. All mothers were interviewed in the maternity hospital and consent to the initial visit obtained. At the same time particulars were noted of the mother's social background both before marriage and since, and any complication of the pregnancy or delivery.

First Home Visit at Six Months. At the initial home visit a special effort was made to establish a good relationship with the mother and to secure her continuing interest in the survey.

Full particulars were taken of housing and certain information was obtained about other children in the family. Details of feeding, vitamin supplements, and protective immunization were noted. At this and every subsequent interview a record was made of any illness necessitating medical attention or hospital admission.

A brief clinical examination was carried out and the children graded as to general nutrition and health, and a note made of any minor abnormalities which had not received medical attention. The children were weighed in light, indoor clothing, an appropriate deduction being made for the clothes worn, and, from the age of 2 years, crown-heel and crown-rump lengths were taken recumbent on a portable measuring board.

The developmental level was estimated on the response to the Gesell developmental tests.

Subsequent Examinations. The children are seen every six months (± 7 days) up to the age of 18 months and at 2 years old (± 14 days) and thereafter they are seen once yearly (± 14 days). It was originally anticipated that after the initial visit a proportion of the mothers would be willing to bring their babies for examination to a central clinic, thus saving much time and providing standard conditions for examination and testing. In practice it has been found that the number of mothers who are willing to do this is very small. Even the best-intentioned find it difficult to attend regularly at a set time especially if there are other children in the family. Mothers from the two extremes of the social scale are the most reluctant to attend a clinic, and insistence on such attendance inevitably introduces bias in the social composition of the sample. In many cases the mother has become pregnant again during the course of the survey, and this is an added deterrent to further clinic attendance.

Mental testing may be difficult, especially after the first year, in the presence of other members of the family and absence of adequate table and floor space. Nevertheless as the children are seen at regular

intervals an incomplete testing at one visit can be confirmed and completed on the next occasion.

Some authorities hold strongly to the view that developmental testing can not be considered valid unless carried out under standard conditions. This would be more convincing if the subjects for testing came from a standard environment. It may be argued that the child's own house approximates more nearly to a standard setting than an impersonal clinic room to which children from different types of homes react in a different way. In practice it has been found that the children who have been tested both at home and in the clinic are more responsive in their own homes.

Table 7 gives the proportion of children seen within the pre-arranged period. Up to 18 months quite a large percentage were examined more than seven days after the set age. In some cases, this was due to illness of mother or child, or absence on holiday, but in the majority it was due to a change of address and the inevitable lapse of time before the family could be traced and a fresh appointment made. One hundred and ninety-five changes of address have been recorded. This is 35% of total families and does not include those who have been lost to the survey by removal. Nearly all were seen within 14 days, and it will be noticed that at 2 years old (± 14 days) only a small percentage were not seen within this period. A suitable adjustment has been made for measurements and estimated developmental levels if the child was seen within four weeks of the pre-arranged date. Measurements for children seen later than four weeks have not been included in the subsequent analyses.

Although much of the information collected is

TABLE 7
PERCENTAGE OF CHILDREN SEEN LATER THAN
PRE-ARRANGED DATE

Age (mths.)	%
6 \pm 7 days	14
12 7 days	10
18 7 days	11
24 \pm 14 days	5

necessarily subjective in character, an attempt has been made to adhere to certain standards throughout. Some of these are now described.

Housing

The following criteria were employed in grading housing accommodation:

- (1) A separate living room not used for sleeping.
- (2) Sufficient bedrooms for the child in question to sleep apart from the parents after the age of 1 year and with not more than two other children of the

same sex, or one adult. (3) Adequate furnishings, in particular that the child should be able to occupy a separate cot or bed. (4) Modern cooking facilities (gas or electric cooker), and a kitchen sink. (5) A supply of hot water. (6) A bathroom. (7) An inside W.C. (8) Easy access to a garden or green. (9) A reasonable standard of cleanliness and structural repair.

The following classification was adopted according to the number of points satisfied:

1=Very good	9
2=Good	7 to 8
3=Fairly good	5 to 6
4=Fair	3 to 4
5=Poor	1 to 2
6=Very poor	0

The majority of municipally owned houses were classified as very good, although some come in the next category as they failed to satisfy points 3 and 9. The majority of privately owned houses belonging to parents in social classes 1 and 2, also were graded as being very good. Privately owned houses belonging to families in social class 3, were usually graded as good, or fairly good, overcrowding being the commonest problem here.

Many rented houses occupied by families in social classes 3, 4 and 5 were graded as fair or poor, these most often being of the room and kitchen type, without a bathroom or hot water, and often with a shared toilet on the landing.

Houses graded as very poor possessed none of the facilities mentioned above and in addition were kept in a state of squalor and filth.

A house which might have been considered good or fairly good when the child was under 1 year old, and the only child in the family, might drop to a lower category at a later age and when other children were born.

Fig. 1 gives the percentage of singletons in the survey living in these grades of accommodation at 6 months by social class.

As would be expected there is a marked social gradient in the standard of accommodation. In social classes 1 and 2, 91% were occupying houses graded as good or very good, compared with 27% in social classes 4 and 5. Of the total population studied 54% were living in good or very good accommodation and 27% in poor or very poor houses. By the age of 2 years the situation had improved a little, 58% now living in good accommodation and 20% in poor. In 16% of the total, the housing had improved due mainly to rehousing by the municipal authority and in 4% the housing had deteriorated.

Social Class

The social class of the child's father has been

recorded, the classification used being based on that given by the Registrar General (1951) in the Classification of Occupations, 1950, with certain minor modifications (Drillien, 1957) principally the addition of a social class 6 to cover homes in which the mother was widowed, divorced or separated from her husband, or where the child was illegitimate.

In addition to the social class classification, working class mothers and fathers, if seen, have been graded as being superior working class, average or poor.

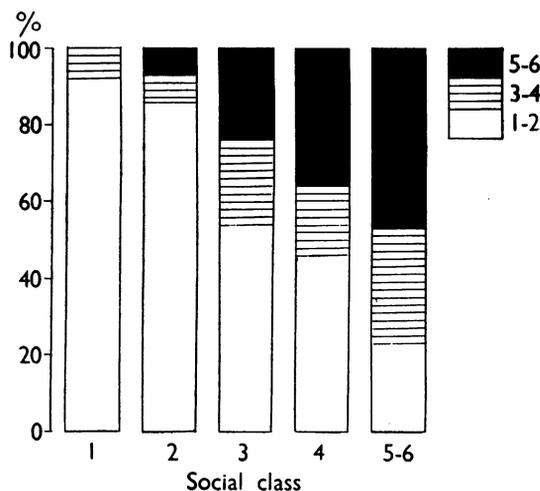


FIG. 1.—Standard of housing by social class.

Maternal Efficiency

The following points were noted when considering the efficiency of the mother: (1) Cleanliness of the house, the child and his clothes. (2) Feeding habits and diet. (3) Advantage taken of welfare facilities, such as vitamin supplements, protective immunization and infant clinics. (4) Management of training problems such as weaning, sleeping and toilet training. (5) The relationship of the mother with the child, other children in the family, and the father. (6) Maternal health.

Maternal efficiency was graded as being: very good, good, fair and poor. This grading was necessarily a purely subjective assessment, but is considered valid as all examinations were carried out by the same person and the same standards adopted throughout. In some cases the grading of efficiency changed as the child grew older. The mother who could deal adequately with a baby might prove less capable of coping with a toddler. The standards of others though satisfactory with the first child became

less satisfactory as succeeding pregnancies entailed more work and responsibility.

Some mothers, especially those in the higher social groups, with an only child, though giving every material care and much affection, yet were over-anxious and fussy in their handling. A separate note has been made of this and it appears to have some bearing on the genesis of behaviour problems, which will be dealt with in a separate paper.

Fig. 2 gives the grading of maternal efficiency by social class at the initial home visit. In the total sample, maternal care was graded as good, or very good, in 84% of homes. This comes very close to the findings in the Newcastle 1,000-family survey (Spence, Walton, Miller and Court, 1954) in which at least 85% of the families were regarded as receiving a good standard of child care.

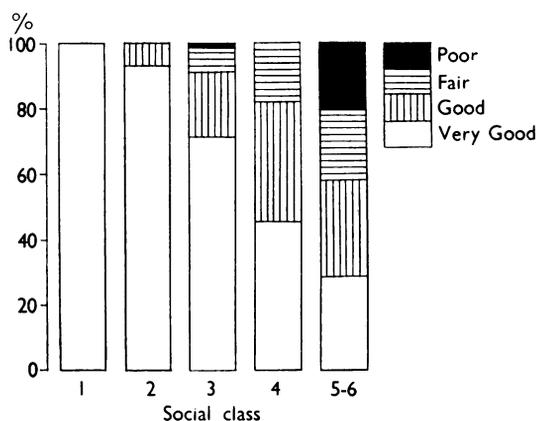


FIG. 2.—Efficiency of the mother by social class.

Again there is a marked social gradient. In social classes 1 and 2, maternal efficiency was considered good or very good in 100% of cases, compared with less than 60% in social class 5. In one-fifth of homes in this latter group, maternal efficiency was considered poor. The children were found to be dirty, inadequately clothed and fed, subject to a disproportionate amount of illness, and in many cases lacking in security and affection.

At 2 years of age the percentage of maternal efficiency graded as fair or poor had risen from 16% to 20%, mainly due to deterioration in standards with succeeding pregnancies in social class 5.

All children in the survey have now reached the age of 2 years and subsequent papers will present the data collected for this age period under the following headings: (1) Physical growth in relation to birth weight, height of parents, nutrition, early

illness and social class. (2) Mental development in relation to birth weight, gestation time and social class. (3) Morbidity in relation to nutrition, maternal efficiency, place in family, housing and social class. (4) Patterns of maternal care.

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