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LOW INTELLIGENCE

ITS RELATION TO LENGTH OF GESTATION AND RATE OF FOETAL GROWTH*

BY

D. J. P. BARKER

Department of Social Medicine, University of Birmingham

More information is required about three aspects of the relation of low intelligence to birthweight and length of gestation:

(1) Low birthweight is known to be associated with mental subnormality, but the significance of this remains unknown.

(2) High birthweight has been reported to occur more frequently in association with subnormality, but the evidence is inconclusive.

(3) Prolonged gestation has been suggested as a cause of cerebral damage and consequent intellectual impairment, but no data bearing on this issue appear to have been published.

In this paper some observations which are relevant to these problems will be described.

METHODS

The observations were made on a group of 606 subnormal children for whose low intelligence there is no known cause. These children were drawn from a population of 73,687 single births for whom obstetric data were recorded at the time of birth.

POPULATION DATA

The population did not include children from multiple births but it otherwise comprised all children who were born in Birmingham during the years 1950–54 and who remained in the city until the age of 5 years. Obstetric data have been recorded for all births in Birmingham since 1950 (Charles, 1951) and recently these data have been transferred to magnetic tape to enable their analysis by computer. Birthweight was recorded, to the nearest quarter pound, for all but 68 of the births, and for 61,998 (84 per cent.) of the children the gestation period was known, calculated to the nearest week from the first day of the last menstrual period. No adjustments were made when birthweight appeared to be unusually low or high for the duration of gestation.

CHILDREN OF LOW INTELLIGENCE

At the time of the survey the children were aged between 9 and 14 years. Subnormal intelligence was defined as an Intelligence Quotient (IQ) of less than 75 (using the Terman-Merrill revision of the Stanford-Binet Intelligence Scale Forms L and LM). A search of records in the Birmingham Public Health Department and in the Special Schools Section of the Education Department enabled identification of 753 children with subnormal intelligence, who comprised 1 per cent. of the population being studied. Medical histories of these children were compiled from hospital records and from the records of local authority medical officers. 146 of the subnormal children had recognized conditions such as mongolism or microcephaly, or had had diseases such as meningitis to which subnormality can be attributed; these 146 children were removed from the subnormal group. The 607 children who remained were regarded as having "non-specific subnormality". Full details of the method of ascertainment and the medical histories have been given in a previous publication (Barker, 1966); and it seems probable that below an approximate IQ level of 65 ascertainment of subnormal children has been fairly complete, while above this level it has been incomplete since many children with IQs between 65 and 74 are not referred for special schooling. Children with IQs above 65 who have been ascertained are probably not representative of all such children.

NORMAL SIBS

The names, dates of birth, and school histories of all the sibs of the subnormal children were obtained, and birth records were located for all those who were born in Birmingham and could be shown to have normal intelligence. No birth records were

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available for sibs born before 1950, and those born after 1957 were less than 7 years old, and therefore too young for assessment of their intelligence to be made by the methods used.

At the time of the inquiry, sibs born before the last quarter of 1954 had become eligible to take the 11+ examination. These sibs were regarded as showing "normal intelligence" if they had achieved a mean score of 75 or more on the two verbal reasoning tests. Such a score corresponds to one of about 80 or more obtained on an individual intelligence test.

Sibs born between September 1, 1954, and December 31, 1957, were assessed from answers to a questionnaire which was sent to Head Teachers of Birmingham primary schools. The Head Teachers gave details of the children's performances on any standard reading tests, group intelligence tests, and individual intelligence tests which had been taken; and they said whether they thought that the children would continue to be suitable for education in ordinary schools. The Senior Educational Psychologist in the Birmingham Child Guidance Clinic assessed the questionnaires. Sibs were regarded as having normal intelligence only if their achievements were clearly above those of children on the borderline of subnormality. Their reading ages had to exceed eight tenths of their chronological ages; their intelligence test scores had to be above 75; and the Head Teachers had to affirm that their general performance was such that referral to a special school was not considered. Whenever there was doubt the sib was not accepted as having normal intelligence.

Subnormal children who have normal sibs are not typical of subnormal children as a whole (they differ, for example, in the fertility of their parents), and conclusions made from comparison of normal and subnormal sibs must take account of this.

Results

The 607 subnormal children have been divided into three groups according to their IQs: below 50, 50 to 64, and 65 to 74. A division has been made at 65 because ascertainment of children above this level is known to have been incomplete. The division at 50 corresponds with the traditional demarcation between imbecility and feeblemindedness.

In Table I the mean birthweight of the subnormal children is compared with that of the entire population. Since birthweight is related to sex and birth rank (McKeown and Gibson, 1951; Gibson and McKeown, 1952) the mean weight of subnormal children is compared with an expected mean weight which allows for the sex and birth rank distribution in each IQ group. At all levels of intelligence the mean birthweight of subnormal children is low.

A low mean birthweight can result from reduction in either the rate or the duration of intra-uterine growth.

TABLE I

MEAN BIRTHWEIGHT OF SUBNORMAL CHILDREN

IQ Group	No. of Children	Mean Birthweight (lb.)	
		Observed	Expected*
Below 50 ..	123	6·81 (±0·10)	7·35
50 to 64 ..	198	6·92 (±0·08)	7·36
65 to 74 ..	285	6·93 (±0·07)	7·39

* Expected mean birthweight allows for sex and birth rank.
The birthweight of one child in IQ group 65 to 74 is unknown, and this child has been excluded from all analyses.

Rate of Intra-Uterine Growth

71 per cent. of the population were born during the 39th, 40th, and 41st weeks of gestation, and these weeks will be referred to as "term". Table II shows the mean birthweight of subnormal children born at term. As in Table I, comparison is made with expected mean birthweights which allow for sex and birth rank. In each IQ group the mean birthweight of term children is low, and it can therefore be inferred that their average rate of intra-uterine growth was slow.

TABLE II

MEAN BIRTHWEIGHT OF CHILDREN BORN AT TERM
(39 to 41 weeks gestation)

IQ Group	No. of Children	Mean Birth Weight (lb.)	
		Observed	Expected*
Below 50 ..	67	7·17 (±0·12)	7·41
50 to 64 ..	100	7·18 (±0·10)	7·46
65 to 74 ..	128	7·08 (±0·09)	7·46

* The expected mean birthweight allows for sex and birth rank.

In Table III the birthweights of subnormal children are compared with those of their normal sibs. In order to compare the birthweights of children born after differing periods of gestation, it was necessary to restrict attention to those born between the 36th and 44th weeks inclusive. In the population the distribution of birthweight in each of these weeks of gestation is approximately normal, and the standard deviation can therefore be used as a measure of the spread of observations around the mean. The birthweights which are shown in Table III have been standardized by calculation of the deviation of each weight from the mean weight of all children with the same sex, birth rank, and gestation period, and subsequent division of this deviation by the standard deviation. The standardized birthweights which are obtained can be interpreted as measures of the overall rate of intra-uterine growth. Table III includes only subnormal children whose standardized birthweights were negative (whose rate of foetal growth was therefore below average). The rate of growth of these children is compared with that of all their normal sibs who were born in Birmingham between 1950 and 1957 and whose gestation periods were recorded. Where a subnormal child has two or more normal sibs the average value of their standardized birthweights has been used, and the Table represents the results of a comparison between 118 subnormal children and 156 normal sibs.

TABLE III

CORRELATION BETWEEN BIRTHWEIGHTS OF SUBNORMAL CHILDREN AND THEIR NORMAL SIBS

Birthweights of Subnormal Children (expressed in standard deviations below the mean)*	Birthweights of Normal Sibs (expressed in standard deviations above and below the mean)*: −3 to −2	−2 to −1	−1 to 0	0 to +1	+1 to +2	+2 to +3	
0 to −1	0	5	6	6	2	0	IQ Below 50
−1 to −2	0	1	1	2	2	0	
−2 to −3	0	1	0	1	0	0	
0 to −1	0	2	12	5	0	0	IQ From 50 to 64
−1 to −2	1	3	3	4	0	0	
−2 to −3	2	1	2	0	0	0	
0 to −1	1	6	14	8	1	0	IQ From 65 to 74
−1 to −2	3	7	7	4	0	0	
−2 to −3	0	2	2	1	0	0	

* The mean takes account of length of gestation, sex, and birth rank.

These results show that, if the IQ is above 50, the slow intra-uterine growth of subnormal children is associated with slow intra-uterine growth of their normal sibs; and in general the slower the rate of growth of subnormal children the slower is that of their normal sibs. But, if the IQ is below 50, the rates of growth of the subnormal children and their normal sibs seem unrelated.

LENGTH OF GESTATION

The relative incidence of subnormality according to the period of gestation was obtained by comparing the distribution of the gestation periods of the subnormal children with that of the whole population (Table IV). In each IQ group, relative incidence is increased among children born before term. In the highest IQ group there is also an increased incidence among children born during or after the 42nd week of gestation; but the number of subnormal children seems too small to justify the conclusion that mild subnormality and prolonged gestation are associated.

TABLE IV

RELATIVE INCIDENCE* OF SUBNORMALITY ACCORDING TO LENGTH OF GESTATION

IQ Group	Length of Gestation (wks): 35 or Less	36, 37, 38	39, 40, 41	42 or More
Below 50	3·4 (8)	1·4 (19)	0·9 (67)	0·6 (9)
50 to 64	2·5 (9)	1·4 (28)	0·9 (100)	0·9 (19)
65 to 74	2·8 (15)	1·7 (50)	0·8 (128)	1·3 (41)

Numbers of subnormal children given in brackets.
* Relative incidences were obtained from comparison of the percentage distribution of subnormal children with that of the population.

7·6 per cent. of births in the population occurred before 38 weeks of gestation, but among subnormal children the percentage is much higher, being 15·5 when the IQ is below 50, 16·7 in IQ group 50 to 64, and 18·4 in IQ group 65 to 74. However an excess of subnormal children come from Social Classes 4 and 5 (Table V) and in these classes there is a higher incidence of birth before 38 weeks of gestation (Baird, 1962). In the survey population, 5·9 per cent. of children in Social Classes 1 and 2 were born

TABLE V

PERCENTAGE DISTRIBUTION OF SOCIAL CLASS

IQ Group	Social Class: I and II	III	IV and V	No. with Known Social Class*
Below 50	9·0	68·0	23·0	100
50 to 64	5·2	66·0	28·8	153
65 to 74	1·5	71·7	26·8	198
Whole Population of Single Births . .	11·3	73·9	14·8	57,129

* During 1950 details of the father's occupation were not included in the obstetric records.

before 38 weeks compared with 8·4 per cent. in Social Classes 4 and 5. But these differences in incidence cannot explain the findings in subnormal children, where the incidence of birth before 38 weeks exceeds 15 per cent. in all IQ groups.

Onset of labour before term may either be spontaneous or it may be induced on account of obstetric complications. Previous analyses of these data have provided no evidence of a relationship between subnormal intelligence and those obstetric complications such as toxaemia which commonly lead to induction of premature labour. And, when allowance is made for the small numbers of children, the proportion of births before 38 weeks of gestation in which the onset of labour was induced is approximately the same in subnormal children as it is in the population as a whole (Table VI).

TABLE VI

PROPORTION OF BIRTHS BEFORE 38 WEEKS GESTATION IN WHICH THE ONSET OF LABOUR WAS INDUCED

IQ Group	Total No. of Births before 38 wks Gestation	Births in which Onset of Labour was Induced	
		No.	Per cent.
Below 50	16	3	19
50 to 64	26	5	19
65 to 74	43	4	9
Whole Population of Single Births	4,743	500	11

Table VII shows the frequency of birth before 38 weeks of gestation in sib pairs, composed of one normal and one subnormal sib. The normal sibs were born during the same 5 years as the subnormal ones. Where the IQs of the subnormal sibs are below 50, numbers are too small to permit any conclusions, but where the IQs of the subnormal children are above 50 there is an excess of subnormal over normal sibs who were born before 38 weeks.

TABLE VII

NUMBERS OF NORMAL AND SUBNORMAL SIBS BORN BEFORE 38 WEEKS GESTATION

IQ of Subnormal Sibs	No. of Sib Pairs	No. Born before 38 wks Gestation	
Below 50	32	Subnormal	3
		Normal	4
50 to 64	54	Subnormal	7
		Normal	4
65 to 74	94	Subnormal	13
		Normal	6

Although the numbers of sib pairs are not large, these results, together with the high incidences of short gestation periods shown in Table IV, indicate a relationship between subnormality and birth before term. However 98 per cent. of children in the population who were born before 38 weeks are not subnormal and the relationship must therefore depend on additional influences.

Short Labour and Unsupervised Delivery.—In compiling the birth data, a simple classification was used to denote the duration of labour. The time recorded was that from the beginning of the first stage until the completion of the second. The incidence of short labours, those completed in 2 hours or less, is shown in Table VIII. In the population the incidence of short labour rose from 2·4 per cent. in nulliparous mothers to 12·2 per cent. in mothers of parity 6 or more, and in Table VIII the percentage of short labours in each IQ group is compared with an expected percentage which allows for the birth rank distribution of the children. There is a considerable excess of children in IQ groups 50 to 64, and 65 to 74, who were born after short labours; and subnormal sibs with IQs between 65 and 74 were more frequently affected than were their normal sibs (Table IX).

TABLE VIII

PERCENTAGE OF SHORT LABOURS (COMPLETED IN 2 HOURS OR LESS)

IQ Group	Per cent. of Short Labours	Expected Per cent. of Short Labours*	No. with Length of Labour Recorded
Below 50 ..	6·3	6·8	111
50 to 64 ..	10·7	7·3	169
65 to 74 ..	13·2	8·2	258

* Expected percentage of short labours allows for birth rank.

TABLE IX

FREQUENCY OF SHORT LABOURS PRECEDING BIRTHS OF SIB PAIRS

IQ of Subnormal Sibs	No. of Sib Pairs	No. Born after Short Labours	
Below 50 ..	32	Subnormal	3
		Normal	4
50 to 64 ..	54	Subnormal	6
		Normal	6
65 to 74 ..	94	Subnormal	14
		Normal	6

In a previous publication (Barker, 1966), it was shown that delivery before arrival of a qualified attendant occurred more frequently during the births of subnormal children than in the population as a whole; and it was more frequent among subnormal children than their normal sibs. But, as with short labours, this was found only among subnormal children in the two highest IQ groups.

One of the causes of the delivery of a child occurring before the arrival of an attendant is an unusually short labour; and in the population 36 per cent. of unsupervised deliveries occurred after labours lasting 2 hours or less. Table X shows the occurrence of (1) short labours which did not terminate in unsupervised deliveries and (2) unsupervised deliveries which were not preceded by short labours. Short labour and unsupervised delivery each seem to have a separate association with subnormal intelligence above the level of IQ 50.

TABLE X

INDEPENDENT INCIDENCE OF SHORT LABOURS AND UNSUPERVISED DELIVERIES

IQ Group	Per cent. of Short Labours not terminating in Unsupervised Deliveries	Per cent. of Unsupervised Deliveries not preceded by Short Labours	No. with Length of Labour and Birth Attendant Recorded
50 to 64 ..	9·5	4·7	169
65 to 74 ..	10·5	4·7	258
Whole Population of Single Births	6·1	1·5	66,007

Table XI compares the occurrence of short labour and unsupervised birth in children who were born either before, or during and after the 38th week of gestation. Subnormal children in the two highest IQ groups have been combined to form a single group with IQs between 50 and 74. In the population the incidence of both factors is, not unexpectedly, higher when children are born before 38 weeks of gestation. But comparison of the percentages of affected children in the subnormal group with those in the population shows that the excess of subnormal children is much greater when gestation is short; and the increased incidence of short labour and unsupervised delivery in subnormal children therefore seems especially characteristic of those born after short gestation periods. It has already been shown that among the sib pairs in which the IQ of the subnormal sib is above 50 there are twenty subnormal sibs who were born before 38 weeks of gestation compared with ten normal sibs (Table VII). Of the twenty subnormal sibs, six were born after short labours and a further two were born in the absence of a qualified attendant. But only two of the normal sibs were born after short labours and none were born in the absence of a qualified attendant. It therefore seems that, of the excess of ten subnormal sibs born before 38 weeks, six could be children who were also affected by one of these two factors.

TABLE XI

INCIDENCE OF SHORT LABOURS AND UNSUPERVISED DELIVERIES ACCORDING TO LENGTH OF GESTATION

Length of Gestation (wks)	IQ Group	Per cent. of Short Labours	No. with Length of Labour Recorded	Per cent. of Unsupervised Deliveries	No. with Birth Attendant Recorded
Less than 38	50 to 74	18·3	60	10·1	69
	Whole Population of Single Births	9·4	4,352	3·3	4,738
38 or More	50 to 74	10·0	300	3·7	321
	Whole Population of Single Births	6·3	53,861	1·8	57,176

Non-haemolytic Jaundice.—This known concomitant of birth before term, occurred in 2·2 per cent. of the population; but the data did not include measurements of serum bilirubin levels. It does not occur more frequently among subnormal children (Table XII) and does not affect more subnormal than normal sibs (Table XIII).

TABLE XII

INCIDENCE OF NON-HAEMOLYTIC JAUNDICE

IQ Group	Per cent. with Non-haemolytic Jaundice	No. with Condition at Birth Recorded
Below 50	2·6	117
50 to 64	3·1	191
65 to 74	1·4	282
Whole Population of Single Births ..	2·2	69,841

TABLE XIII

NON-HAEMOLYTIC JAUNDICE IN SIB PAIRS

IQ of Subnormal Sibs	No. of Sib Pairs	No. with Non-haemolytic Jaundice	
Below 50 ..	32	Subnormal	1
		Normal	1
50 to 64 ..	54	Subnormal	2
		Normal	3
65 to 74 ..	94	Subnormal	1
		Normal	2

INCIDENCE OF HIGH BIRTHWEIGHT

Table XIV shows the relative incidence of subnormality according to birthweight (as in Table IV relative incidences were obtained by comparison of the birthweight distribution in each IQ group with that in the whole population). The small numbers of children weighing more than 9 lb. make interpretation difficult, but it seems unlikely that high birthweight is associated with a marked increase in the risk of subnormality.

TABLE XIV

RELATIVE INCIDENCE* OF SUBNORMALITY ACCORDING TO BIRTHWEIGHT

IQ Group	Birthweight (lb.)				
	6 or Less	7	8	9	10 or More
Below 50	1·4 (56)	1·0 (44)	0·6 (17)	0·6 (5)	0·6 (1)
50 to 64	1·5 (99)	0·8 (57)	0·6 (25)	0·9 (12)	1·8 (5)
65 to 74	1·4 (134)	0·8 (88)	0·8 (48)	0·7 (13)	0·5 (2)

Numbers of subnormal children given in brackets.

* Relative incidences were obtained from comparison of the percentage distribution of subnormal children with that of the population.

DISCUSSION

In this survey the association between low birthweight and severe intellectual impairment has again been confirmed. Wallich and Fruhinsholz (1911), Benton (1940), and Alm (1953) have reviewed the numerous investigations which have been made into the development of children with low birthweight. In the majority of these investigations, the mental and physical attributes of groups of children with birthweights below some fixed limit, usually 2,500 g., were observed some years after their birth. Few studies were designed to show the frequency of low birthweight in groups of subnormal children. Although much of the work is open to methodological criticism, many authors found a raised incidence of subnormality in children of low birthweight. Wiener (1962) has reviewed recent work, and although the overall prognosis for low birthweight children remains in doubt their increased liability to subnormality is not disputed.

Although the subject has been so frequently studied, few people seem to have distinguished shortened gestation from slow intra-uterine growth or to have commented on the aetiological significance of these factors. Little (1861) described how premature labour could lead to cerebral injury and consequent subnormality. Dollinger (1921) found that there was an excess of subnormal children who were born before term and weighed less than 2,500 g. Rosanoff and Inman-Kane (1934) distinguished "premature birth" from "underweight condition at birth" and concluded that they were aetiological factors in subnormality. Duyzings (1935) found an increased incidence of subnormality among children born during or before the 38th week of gestation, but he attributed their low intelligence to genetic factors and not to the effects of a shortened gestation period.

The results of the present study show that subnormality has associations with both slow intra-uterine growth and a shortened gestation period, and they permit some conclusions about the significance of these associations. It is well known that "non-specific" subnormality does not have a single aetiology; but sub-division of the subnormal children according to such characteristics as additional neurological lesions or family histories has not clarified any of the conclusions.

The observations on the intra-uterine growth of subnormal and normal sibs are based on rather small numbers, and subnormal children who have normal sibs are not representative of subnormal children as a whole. Nevertheless, a cautious conclusion seems justified. The significance of slow intra-uterine growth preceding the birth of subnormal children differs according to whether their IQs are above or below an approximate level of 50. If they are below this level, sibs of normal intelligence have a normal rate of intra-uterine growth. Therefore, the slow growth of the subnormal children may be closely related to their low intelligence, and both could be direct consequences of the same influences. But if the intelligence of the subnormal children is above 50 the average growth rate of both subnormal and normal sibs is slow. Therefore, the slow growth of the subnormal children does not seem to be directly related to their low intelligence but reflects influences which affect the intra-uterine lives of all children in their families.

It is only possible to speculate about influences which could cause the combination of slow foetal growth and subnormality in children with IQs below 50. Various genetic, chromosomal, and environmental abnormalities are known to cause slow foetal growth (Warkany, Monroe, and Sutherland, 1961), and mongolism provides an example of such abnormalities causing both slow growth and subnormality (Smith and McKeown, 1955). It seems probable that environmental agencies can interfere with foetal growth and impair cerebral development, not only by action during the early months of pregnancy (when most malformations are determined) but also during the later stages through processes such as placental insufficiency (Gruenwald, 1964) or dysmaturity (Sjöstedt, Engleson, and Rooth, 1958).

It seems that in most cases the influences which cause the slow intra-uterine growth of subnormal children with IQs above 50, while they may affect cerebral development, do not impair intelligence to the point of subnormality. An excess of these children come from families in Social Classes 4 and 5, and poor maternal diet might be put forward as an explanation of slow intra-uterine growth. However, there is little evidence to support this hypothesis (Smith, 1962; Thomson, 1963), and the mother's physique seems more important than her nutrition in determining foetal growth. The average height of mothers in Social Classes 4 and 5 is lower than that in other classes (Baird, 1962), and small maternal stature is associated with a reduced rate of foetal growth (Cawley, McKeown, and Record, 1954).

There is a marked association between subnormality and birth after a short gestation period. This association can be interpreted in three ways. Both factors may be determined by the same mechanism, as they can be in congenital toxoplasmosis. Or the presence of an abnormal foetus in the uterus may disturb the mechanisms which determine the onset of parturition; for it is well known that hydramnios, a cause of premature labour, may be associated with the presence of a malformed foetus—although in the survey only one of the 85 births which occurred before 38 weeks of gestation was associated with this condition—and for reasons which remain unknown mongols have a markedly reduced gestation period (Smith and McKeown, 1955). But it seems that at least a part of the association between subnormality and short gestation must depend on cerebral damage being a direct consequence of birth before term. There are many reasons why children born before term may be liable to cerebral damage either during birth or in the neonatal period, but only two factors, short labour and unsupervised delivery, are implicated by the results of this survey. It is not unreasonable to suppose that exposure of an immature foetus to the trauma of violent uterine contractions or a precipitate and unsupervised delivery could lead to brain injury, and it is interesting that Little (1861), in his case histories of children with "spastic rigidity", mentions both "sudden labour" and absence of a qualified birth attendant. However, there seems to be a limit to the intellectual impairment which can be caused by these factors. In the first place, their incidence is not increased among subnormal children with IQs below 50. And, secondly, Lewis (1933) has described how many mildly subnormal children are born into families where genetic endowment is below average and the environment is generally unfavourable for intellectual development. This survey has shown that an excess of these children were born into Social Classes 4 and 5, and in the 11 + examination the mean verbal reasoning score of their normal sibs was 88, almost one standard deviation below the mean. Therefore, while the combination of a premature and very short labour, or a premature labour and an unsupervised delivery, may reduce a potential Secondary Modern pupil to the level of a Special School, they do not seem able to change a potential Grammar School candidate into an imbecile.

No association has been found between non-haemolytic jaundice and subnormality (although it must be noted that the population comprised children who had survived for 5 years after birth). There seems to be conflicting evidence as to whether infants who are born before term, and develop high levels of serum bilirubin from causes other than haemolytic disease, are liable to sustain brain damage (Koch, 1964); and the consequences of hyperbilirubinaemia may partly depend upon collateral factors such as the coincident administration of sulphonamides. However, the findings of this survey are in accord with those of Shiller and Silverman (1961), and Vuchovich, Haimowitz, Bowers, Corsey, and Yi-Yung Hsia (1965). There is evidence that hyperoxia, another factor associated with birth before term, may have contributed to the subnormality of one child in the survey. This child was born at 29 weeks, weighed under 2 lb. 12 oz., and has retrolental fibroplasia, spastic diplegia, and an IQ below 50.

The small numbers of children at the upper end of the distributions of birthweight and gestation period make interpretation difficult, but it seems unlikely that either high birthweight or prolonged gestation are associated with a marked increase in the risk of subnormality. The association between high birthweight and low intelligence was described by Asher and Roberts (1949), using retrospective data on a rather small population of school children. They wrote that it was necessary "to await the collection of more ample data before accepting this finding without some reservation".

The results of this survey have implications both for the concept of children "at risk" of subnormality and for the results which may be expected from a reduction of the incidence of "prematurity"—defined as a birthweight of $5\frac{1}{2}$ lb. or less. It seems probable that few subnormal children with IQs below 65 were not ascertained; and since there are 321 children with "non-specific" subnormality of this degree the incidence is 4 per 1,000 of the population. However, there is considerable variation in incidence according to birthweight and duration of gestation, and this is summarized in Table XV.

TABLE XV

THE INCIDENCE PER 1,000 OF CHILDREN WITH IQs LESS THAN 65, ACCORDING TO BIRTHWEIGHT AND GESTATION PERIOD

Birth-weight (lb.)	Duration of Gestation (wks)			
	36 or Less	37, 38	39, 40, 41	42 or More
Less than 5	17 (587)	21 (239)	0 (274)	0 (29)
5–	13 (692)	4 (990)	12 (2,173)	12 (325)
6–	8 (630)	7 (2,435)	4 (10,410)	2 (1,579)
7 or Over	5 (745)	3 (3,101)	3 (31,072)	3 (6,717)

Numbers in the population (single-born children surviving to 5 years) given in brackets.

The highest incidences of subnormality occur among children with low birthweight born before term, and among children born at or after term with birthweights between 5 and 6 lb. There are no subnormal children among those who weighed less than 5 lb. and were born at or after term, a point of some interest since it has been suggested that there is a high incidence of subnormality among the smallest term children (Illingworth, 1964). The risks incurred by the action of factors known to be associated with subnormality, such as short labour and unsupervised delivery, are liable to exaggeration. There were 56 children in the population who were exposed to the triple hazard of a premature and short labour followed by an unsupervised delivery. Only three of them have been ascertained as subnormal.

The prevention of "prematurity" has recently been discussed by Clifford (1964), in a paper entitled "prevention of prematurity: the *sine qua non* for reduction in mental retardation and other neurologic disorders". If obstetricians could reduce the numbers of children born spontaneously before term, there would probably be some reduction in the incidence of subnormality. But in the present survey one half of the children whose birthweights were 5½ lb. or less were born after 37 weeks of gestation, and their low birthweight was therefore the result of slow intra-uterine growth. There is little reason to expect that an acceleration of intra-uterine growth, by itself, would result in much change in the incidence of subnormality. Among severely subnormal children, slow foetal growth seems to be just one of the effects produced by the pathological processes which determine low intelligence; and the slow growth of mildly subnormal children is one of many characteristics which reflect their origin from families where many genetic and environmental influences combine to prejudice the development of intelligence.

SUMMARY

An analysis has been made of the birthweights and gestation periods of 606 children with low intelligence of unknown cause. These children were ascertained from a population of 73,687 single births for whom obstetric data had been recorded.

Low intelligence is associated with both a slower rate of intra-uterine growth and a higher incidence of birth before 38 weeks of gestation than are found in the population. Below an approximate IQ level of 50, slow intra-uterine growth may be closely related to the factors causing subnormality; but above this level it seems to be one of many characteristics of families in which genetic endowment and the environment are generally unfavourable for intellectual development.

Although their association can be explained in several ways there is evidence that birth before 38 weeks of gestation is a cause of low intelligence when it is accompanied by a very short labour or delivery in the absence of a qualified birth attendant.

It seems unlikely that either high birthweight or prolonged gestation are associated with a marked increase in the risk of subnormality.

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