CHAPTER 6

Assessment of Physical Growth

A more direct way of testing our hypothesis that different abnormalities of intra-uterine growth may produce different types of disturbance of later growth is provided by our measurements of height and weight at the ages of five, six and seven years, and of skull circumference at the age of six years. The results of the assessments reported in the previous three chapters all provide indirect evidence in support of the disturbance of later growth in that the impairment of a wide variety of functions in both extreme abnormal groups, but more in the very light-for-dates than the short-gestation group, may reflect corresponding abnormalities of the structure of the specialised tissues upon which these functions depend. But, again, such an inference must be very tentative in view of the many ways in which the children's performance may have been modified by a variety of biological and environmental 'confusing' factors acting between the time of birth and the time of testing. The inferences from physical measurements are clearly more direct: but again it is possible that any long-term effects of our specific abnormalities of intra-uterine growth which may be revealed by such measurements may themselves be at least partly due to such 'confusing' factors.

Procedure

Each child's height and weight were measured at the time of each attendance at our Unit for other types of assessment, at mean ages of 5 years 8 months, 6 years 6 months and 7 years 6 months. The occipito-frontal skull circumference was measured only once, at the age of 6 years 6 months. The methods used are described in the Appendix (obtainable from the Editors).

We have expressed the results in three different ways:—

(1) The absolute values in centimetres and kilograms are summarised in tabular form, the mean values for the groups being given without any correction for age, since the mean ages of the children in the various groups were virtually identical (see note to Table 3.1, p. 19).

(2) The distributions of heights and weights in the two extreme abnormal groups, expressed in terms of centiles, are illustrated in the form of histograms (Figs. 9, 10) to facilitate comparison with each other and with the control group. The norms used for converting the absolute values into centile groupings were the British standards of Tanner (1958).

(3) The increments of mean height and weight of the various groups, during the mean period of 22 months which elapsed between the first and last measurements, have been summarised in tabular form to facilitate comparison between the growth rates of the children in the various groups at this stage of their development. The total weight increments between birth and 7½ years are also shown.

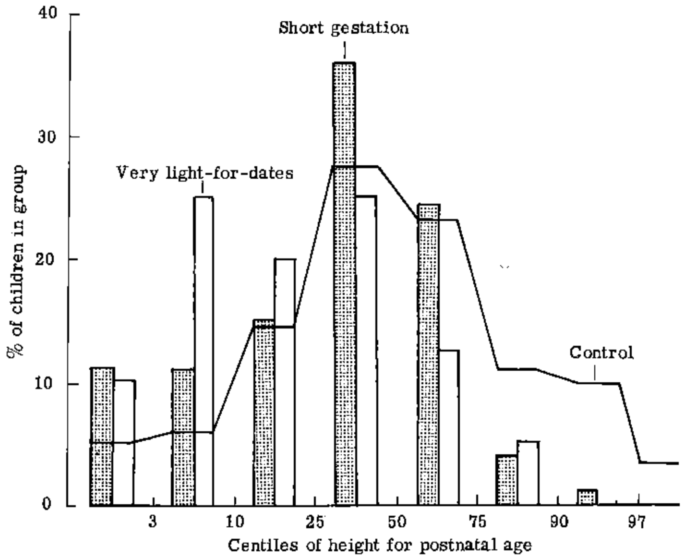

Fig. 9. Height distribution at age seven years in short-gestation and very light-for-dates groups compared with control group.

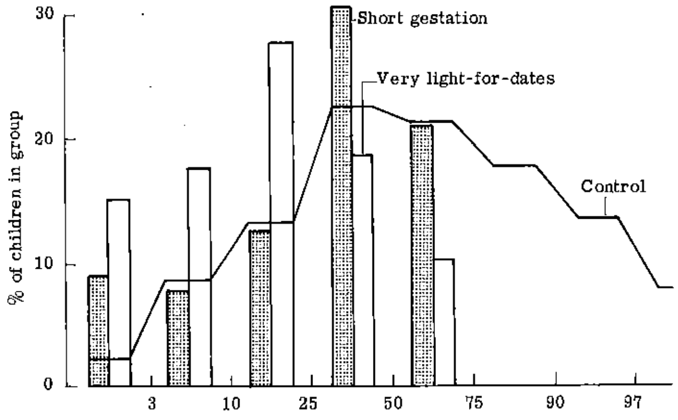

Fig. 10. Weight distribution at age seven years in short-gestation and very light-for-dates groups compared with control group.

Results

(1) The absolute measurements (Table 6.1) all show similar trends to those which we have observed in the majority of the assessments reported in the previous chapters. At all three ages the children in the abnormal groups are very significantly shorter and lighter than the controls; the differences are greater in the very light-for-dates than in the short-gestation group; and where there are significant differences between these

two extreme abnormal groups (in weight at all three ages), the very light-for-dates children have lower values than those of short gestation. Although the trend is the same for skull circumferences, none of the differences between the groups is large enough to be statistically significant. In all three types of measurement the values for the rather light-for-dates group are intermediate between the very light-for-dates and the control group.

However, these absolute differences in the physical measurements of the different groups of children of school age do not truly refect differences in rates of postnatal growth, since the different groups presumably had different starting points. The only measurement for which we have data at the time of birth is the weight, the mean weight in the abnormal groups having been significantly lower than in the control group (see Table 2.1, p. 10), so this is the only measurement for which we can make an appropriate correction. We have done so by comparing the increments between birth and the age of seven years.

(2) The distributions of the heights and weights of the two extreme abnormal groups at the age of seven years are obviously very different from those of the control group (Figs. 9 and 10). Once again it is apparent that the difference is greater in the case of the very light-for-dates group (the obvious excess of children being in the centile bands below the 25th) than in the short-gestation group (where the excess is below the 50th centile). This difference between the two extreme abnormal groups becomes all the more interesting when we look back at the way in which the short-gestation group was selected (see Fig. 1, p. 5, which shows how the babies with a birthweight above the 90th centile were excluded), whereas the three whose birthweight fell below the 10th centile were treated as members of the short-gestation group for purposes of analysis. These features of the initial selection procedure would be expected to produce some downward distortion of the measurements at later ages in the short-gestation group. The fact that the 22 children in the random sample whose gestational age or birthweight characteristics overlapped with those of the abnormal groups were excluded from the random control group would be expected to produce some upward distortion of these later measurements in the latter group. In fact, a look at Figures 9 and 10 suggests that there is a slight distortion of the weight distribution in the expected direction, but not of the height distribution.

(3) The increments shown in Table 6.2, representing the difference between the group mean values (*a*) at 5 years 8 months and at 7 years 6 months (an interval of 22 months) and (*b*) at birth and at 7 years 6 months (an interval of 7 years 6 months) are intended to facilitate comparison of the rates at which the children in the different groups grew over two different time-intervals. During the mean period of 22 months over which they were measured in this study there is no suggestion of any real differences in the rates at which the different groups grew in length (as reflected in their height increments): and although there is an obviously smaller weight increment in the very light-for-dates group than in any of the others, the difference is not statistically significant.

The increments in weight over the whole period from birth to the age of 7 years 6 months are intended to give a true picture of the relative postnatal growth rates of the children in the various groups, making allowance for the fact that they did not start from the same point because they had different mean birthweights. After this allowance has been made, it is clear that the children in the short-gestation group had gained weight at the same rate as the controls, whereas those in the very light-for-dates group had gained very significantly more slowly, and those in the rather light-for-dates group had gained at an intermediate rate.

Discussion

The results reported in this chapter give direct support to the idea that restriction of growth during the intra-uterine phase may lead to subsequent impairment of growth at least up to the age of seven years. The children in the short-gestation group, who were growing at a normal rate up to the time of birth, continued to do so afterwards; in contrast, the children in the light-for-dates groups, whose nett rate of growth was less than that of the controls up to the time of birth, continued to grow more slowly afterwards. We regret that these conclusions can be based firmly only upon weight measurements. It would have been valuable to have comparable data on height or skull circumference at birth, since these two variables are better and more stable indicators of the quality of growth. However, the data which we do have concerning these two variables, summarised in Table 6.1, suggest comparable trends to those for weight. The data illustrated in Figures 9 and 10 show that there is both a downward shift and a skewing of the whole distribution of both height and weight in the two extreme abnormal groups, and to a greater extent in the very light-for-dates than in the short-gestation group.

The effects of sex upon physical growth are well known and it is clearly important to study and compare these effects in our three groups. The results summarised in Table 6.3 show that the effects of the child's sex upon both height and weight at the age of seven years are much less than the effects of the two abnormalities of intra-uterine growth. The greater vulnerability of boys than girls is again evident, and in the short-gestation group this has resulted in a reversal of the normal sex gradient for both height and weight. Although there are no statistically significant differences between the two abnormal groups themselves, in the girls the advantage in favour of the short-gestation over the very light-for-dates group for both height and weight very nearly reaches the conventional level of significance (p only just <0.05).

The effects of social class (Table 6.4) are also clearly less than the effects of our abnormalities of intra-uterine growth. This finding is in marked contrast to that discussed in Chapter 3, where it was noted that the social-class gradient of scores in both the WPPSI and the ITPA was much steeper than the gradient between our different intra-uterine growth groups. There were too few children in social classes I and II in the short-gestation group for valid comparisons to be made, but it is still obvious that, within social class groupings, the adverse effects of being born too small are more marked than those of being born too soon. The light-for-dates children were shorter or lighter than the controls in five of the six possible comparisons: the comparable figure for the short-gestation group is one out of four, and in social class III the short-gestation children weighed significantly more than the light-for-dates.

TABLE 6.1

Assessment of growth*

	Random control (*a*)	Short gestation (*b*)	Rather light-for-dates (*c*)	Very light-for-dates (*d*)	Significant differences $p<0.05$	$p<0.01$
Height (cm)						
5 years 8 months	111.5	108.2	108.7	107.4	—	a/b, a/c, a/d
6 years 6 months	116.1	113.3	113.3	112.3	—	a/b, a/c, a/d
7 years 6 months	122.2	119.9	120.1	118.4	—	a/b, a/c, a/d
Weight (kg)						
5 years 8 months	20.2	19.1	18.6	18.1	b/d	a/b, a/c, a/d
6 years 6 months	21.4	20.1	20.1	19.1	b/d	a/b, a/c, a/d
7 years 6 months	23.9	22.9	22.3	21.5	a/b	a/c, a/d, b/d
Skull circumference (cm)						
6 years 6 months	51.3	50.3	50.3	50.0	—	—

*Mean height (cm) and weight (kg) at five, six and seven years; mean skull circumference (cm) at age six years.

TABLE 6.2

Assessment of growth

	Random control (*a*)	Short gestation (*b*)	Rather light-for-dates (*c*)	Very light-for-dates (*d*)	Significant differences $p<0.05$	$p<0.01$
Increment						
(a) *from 5 years 8 months to 7 years 6 months						
Height (cm)	10.7	11.4	11.4	10.9	—	—
Weight (kg)	3.7	3.8	3.7	3.4	—	—
(b) †from birth to 7 years 6 months						
Weight (kg)	20.4	20.5	19.6	19.1	a/c	a/d

*(a) Increments of mean height (cm) and weight (kg) from 5 years 8 months to 7 years 6 months.
†(b) Increments of mean weight (kg) from birth to 7 years 6 months.

TABLE 6.3

Assessment of growth by sex*

		Random control (*a*)	Short gestation (*b*)	Light-for-dates (*c*)	Significant differences *p*<0.05	*p*<0.01	*p*<0.001
Boys							
Mean height (cm)	(1)	122.3	118.6	119.4	—	a/b, a/c	—
Mean weight (kg)	(2)	24.2	22.6	22.0	—	a/b	a/c
Girls							
Mean height (cm)	(3)	121.7	120.2	118.2	—	—	a/c
Mean weight (kg)	(4)	23.6	23.2	21.6	—	—	a/c
Significant differences p<0.05		—	—	—			

*Height and weight at age seven years.

TABLE 6.4

Assessment of growth by social class*

		Random control (*a*)	Short gestation (*b*)	Light-for-dates (*c*)	Significant differences *p*<0.05	*p*<0.01	*p*<0.001
Mean height (cm)							
Classes I and II	(1)	124.2	(120.6)†	120.5	a/c	—	—
III	(2)	122.4	119.9	118.6	a/b	—	a/c
IV and V	(3)	120.5	118.6	118.5	—	—	—
Mean weight (kg)							
Classes I and II	(4)	25.1	(23.4)	22.7	a/c	—	a/c
III	(5)	23.9	23.1	21.7	—	b/c	a/c
IV and V	(6)	23.5	22.6	21.5	—	a/c	—
Significant differences p<0.05		1/3	—	—			

*Height and weight at age seven years.
†The bracketed figures are derived from the measurement of only two children. The numbers of children in the other cells range from 14 in social classes I and II in group (c) to 111 in social class III in group (a).

Our over-all findings agree closely with those of Babson (1970), who found that among babies with a birthweight of less than 2.0kg, those who were at term showed little or no sign of catch-up growth in height, weight and skull circumference, whereas those who were born before 33 weeks and so being of appropriate weight for age did show signs of catching up or actually caught up to normal values by the age of one year. The findings in our very light-for-dates group, as summarised in Figures 9 and 10, correspond with those reported by Fitzhardinge and Stevens (1972*a, b*) for height, weight and head circumference up to the age of eight years. Their 96 babies were probably below the third centile of birthweight for gestational age (*i.e.* even more deviant than our very light-for-dates group). They showed their results separately for boys and girls and did not note any special vulnerability of the former. Davies and Davis (1970) compared the rates of head growth during childhood of two groups of babies weighing 1500g or less at birth. Those who were below the 10th centile of birthweight for gestational age had a slower rate than those who were above the 10th centile, but the rate in the latter was slowed down if they did not receive adequate food and warmth during the neonatal period (that is to say, if they underwent a period of sub-optimal nutrition postnatally, at a post-conceptional stage of development corresponding to the last trimester of a full-term pregnancy). At the time when our study children were born (1961-62), the evidence in favour of early feeding of such babies—either by stomach (Smallpeice and Davies 1964) or by vein (Cornblath *et al.* 1966)—had not been published, and it is likely that they underwent some degree of sub-optimal nutrition postnatally. We do not have systematic information concerning their calorie intake, but we have noted all cases in which they took more than 14 days to regain their birthweight. There were four such cases among the 59 short-gestation babies (one of whom was later found to be suffering from spastic cerebral palsy) and only one among the 74 very light-for-dates babies. This difference is not statistically significant ($p>0.05$), but it is indicative of a tendency and gives some support to the possibility that such impairment of later function as does occur in babies of short gestation may be due to their having undergone a period of postnatal malnutrition which is similar to, but less severe than, the intra-uterine malnutrition of the very light-for-dates babies.