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Term Twins With Discordant Birth Weights: Observations at Birth and One Year

Alistair G. S. Philip

The Departments of Pediatrics of the University of Hawaii, Honolulu and the University of Vermont, Burlington

Sixteen pairs of term discordant twins (weight discrepancy of more than 20% when the lighter twin was compared to the heavier) were evaluated at birth. Weight, length, head circumference, anterior fontanel area, and combined ossification of the knee epiphyses were measured, and ponderal index (weight/length ratio) calculated. The most severely growth retarded infants had markedly decreased ossification and larger anterior fontanels.

Eleven pairs had physical measurements at one year of age. With individual exceptions, the lighter twins at birth remained smaller in all dimensions. Despite these persistent differences between twin pairs, the values for length at one year of age were within normal limits for both the heavier *and* lighter twins. Infants without ossification at birth had a greater incremental linear growth by one year than those infants with ossification.

Key words: Birth weight, Growth retardation, Fontanel size, Ossification, Follow-up study, Twins

INTRODUCTION

Despite the general impression that the smaller of twins of greatly dissimilar birth weight (discordant twins) remains small, this notion is based upon relatively few studies, and some notable exceptions exist.

Babson et al [1] retrospectively studied sixteen twin pairs when the birth weight of the smaller twin was less than 2000 gm and at least 25% less than the larger. The smaller twin was at a disadvantage in both physique and intellect at follow-up examination. The difference persisted in eight pairs followed into adult life [2].

Falkner (using data from the U.S. collaborative study) has shown that although the smaller of twins stays small, the discrepancy between twin pairs decreases by one year [9]. He also described considerable "catch-up-" in the growth of the smaller of a male twin pair with markedly discordant birth weights [9].

Buckler and Robinson have described a female twin pair who had marked disparity in birth weights (2.99 and 1.35 kg). The smaller had very rapid "catch-up" growth after birth, so that by a year of age there was essentially no difference in physical measurements. When evaluated at ten years of age there was no difference in intelligence quotients [4].

Wilson has recently provided six-year follow-up on ten monozygotic twin pairs with large birth weight differences, showing a sustained effect on weight, but not on height [24].

In the present study, 16 pairs of twins born at term were carefully evaluated at birht to determine what factors might predict subsequent growth. It was anticipated that anterior fontanel size, epiphyseal ossification at the knee, or ponderal index (weight/length ratio) might provide predictive information. Lack of ossification has been related to subsequent linear "catch-up" growth in rats [23]. Lack of ossification was also associated with increased anterior fontanel size in twins discordant by birth weight [19]. Thus, it was considered that fontanel size might provide a simple predictor of linear growth.

MATERIALS AND METHODS

Sixteen pairs of term "discordant" twins were examined by the author in the neonatal period and eleven pairs were available for evaluation at one year of age. The first 13 pairs (born in Honolulu) have been briefly reported earlier [19]. The other three pairs were evaluated in Burlington, Vermont in 1975. All discordant twins who were born between 38 and 42 weeks gestation in 1972–75 (and seen by the author) were included in the study. Follow-up information was not available for five twin pairs seen in Honolulu, because the author moved to Vermont.

Discordance was based on a weight discrepancy of greater than 20% when the lighter twin was compared to the heavier [15]. Gestational age was confirmed with the scoring system of Dubowitz et al [8]. Although variations in external criteria often resulted in differences of a week or more between members of a twin pair [25], none was less than 38 weeks gestation.

Weight was determined on arrival in the nursery and other measurements carried out on the second or third day (with the exception of twin pair 15), using techniques described previously [18]. Birth weights were sometimes measured in pounds and ounces and then converted to grams. Length and head circumference were measured to the nearest quarter of a centimeter. Anterior fontanel size was assessed by tracing the outline of the fontanel, and epiphyseal ossification at the knee was measured on radiographs of the knee. Using a standard projection (100 cm), antero-posterior and lateral films of the knee were evaluated. The greatest diameters of the distal femoral and proximal tibial epiphyses were added together.

Ponderal index (weight/length ratio) was calculated from the formula:

$$\text{Ponderal index} = \frac{\text{weight (grams)} \times 100}{\text{length (cm)}^3}$$

Babies with birth weights less than 2 kg were always placed in incubators or under radiant warmers and were usually started immediately on 10% dextrose in water intravenously. Larger babies were placed in incubators if it was necessary to control their temperatures. All babies were followed with Dextrostix in the first two days, and oral feeding was usually started at four to six hours of age. All babies had essentially unremarkable courses during the first year of life.

In all but two cases the placenta was examined by a pathologist grossly and microscopically, and assigned to dichorionic or monochorionic groups [3]. The assignment of zygosity is not entirely reliable, but the monochorionic pairs can be assumed to be monozygotic. No cases of "twin-twin" transfusion were apparent on placental examination (although injection studies were not performed), or by examining the hemoglobin and hematocrit in each twin pair (maximum difference in hemoglobin was 5 gm/dl).

Between-pair differences were analyzed using the Student t test. Correlations of "one year" with "birth" measurements were sought with Pearson correlation coefficients (r) and multiple regression analysis.

RESULTS

Birth data on 13 pairs of discordant twins have been reported previously showing a negative (inverse) correlation between fontanel size and epiphyseal ossifica-

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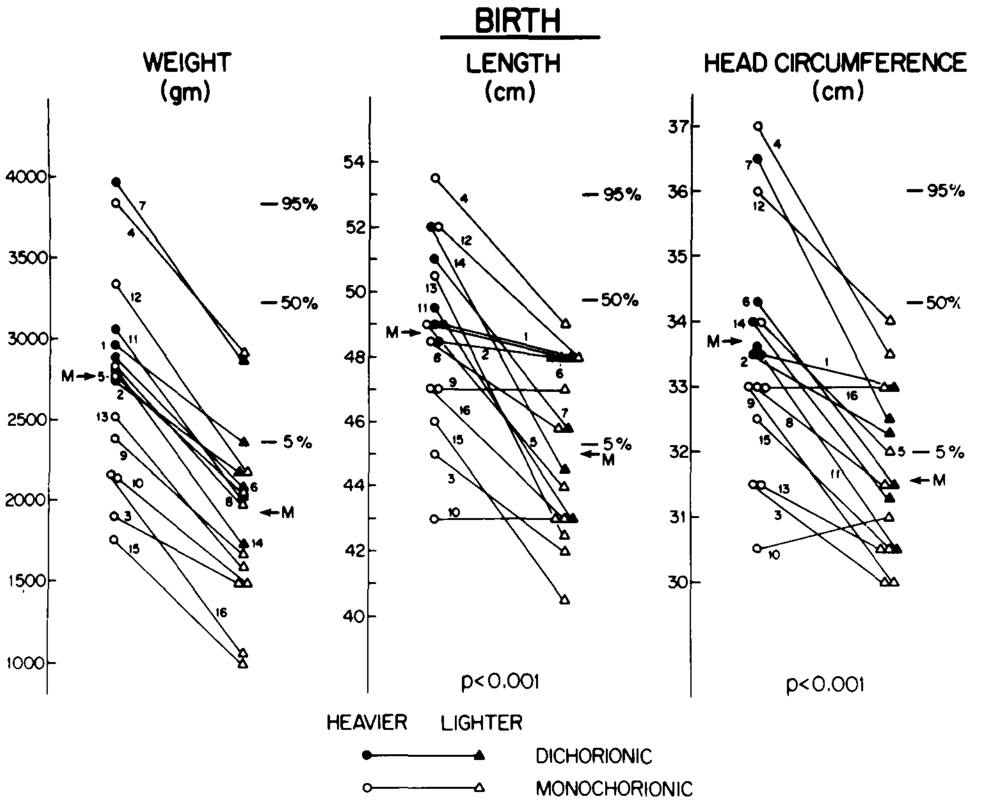

Fig. 1. Measurements at birth in 16 term twin pairs with discordant birth weights (difference > 20%). The 5th, 50th, and 95th percentiles for girls are shown, from the National Center for Health Statistics Growth Charts, 1976. M = mean. Individual twin pairs are linked.

tion [19]. Figure 1 shows the weight, length, and head circumference of individual twin pairs at birth according to their placentation. Differences between the means for length and head circumference of heavier and lighter twins were significant at $p < 0.001$ (weights were also significantly different, but this was the basis for selection). Table 1 provides the other measurements obtained on these twin pairs. The two twin pairs where the lighter twin had more advanced ossification were both dichorionic. The mean birth weight for lighter twins *with* ossification was 2257 gm (n = 8), compared to 1572 gm for twins *without* ossification (n = 8). Comparable birth weights in heavier twins were 2881 gm (n = 13) and 2230 gm (n = 3). The majority of babies were female. Ponderal index was below the tenth percentile (2.25) in 12 of the lighter twins, but only 5 of the heavier twins [15, 16]. For all measurements except anterior fontanel area, the monochorionic twin pairs had lower mean values than the others. However, no conclusions can be drawn, because of the small sample size.

Figure 2 shows that at one year of age there were still significant differences between the mean measurements for the heavier and lighter twins at birth. However, all the lengths were within the normal range. Individual twin pairs are linked and there are two exceptions to the general trend. In twin pair 6 (dichorionic), the

TABLE 1. Measurements at Birth on 16 Pairs of Discordant Twins

Twin pair no.	Weight difference (g)	Placenta	Weight (g)		Sex		Ponderal index		Anterior fontanel area (sq cm)		Combined ossification at knee (mm)	
			H	L	H	L	H	L	H	L	H	L
1	610 (21%)	DC	2977	2367	F	F	2.5	2.1	2.0	1.1	8	14
2	581 (21%)	?	2764	2183	F	F	2.4	2.0	0.7	0.7	7	5
3	426 (22%)	MC	1913	1487	F	F	2.1	2.0	1.8	5.1	6	2
4	949 (25%)	MC	3841	2892	F	F	2.5	2.5	3.1	2.2	8	6
5	737 (27%)	MC	2778	2041	F	F	2.4	2.4	3.1	3.5	0	0
6	808 (28%)	DC	2892	2084	F	F	2.5	1.9	0.8	1.8	6	3
7	1092 (28%)	DC	3969	2877	M	F	2.9	3.0	1.0	1.2	1	10
8	847 (30%)	MC	2832	1985	F	F	2.5	2.1	1.2	4.2	7	2
9	708 (30%)	MC	2381	1673	F	F	2.3	2.0	2.2	2.5	3	0
10	680 (32%)	MC	2140	1460	F	F	2.7	1.8	1.9	5.3	2	0
11	1035 (34%)	?	3062	2027	F	F	2.5	2.5	2.2	3.4	3	0
12	1162 (35%)	MC	3345	2183	M	M	2.4	2.0	2.7	1.6	14	8
13	930 (37%)	MC	2520	1590	M	M	2.0	2.1	1.8	1.8	6	0
14	1092 (39%)	DC	2814	1722	M	F	2.0	2.0	1.9	7.4	14	0
15x	758 (43%)	MC	1758	1000	F	F	1.8	1.5	1.5	3.5	0	0
16	1092 (51%)	MC	2155	1063	M	M	2.1	1.3	4.2	8.6	0	0
Mean values			2759	1915			2.4	2.1*	2.0	3.4†	5.3	3.1

*$p < 0.01$.
†$p < 0.02$.
H = heavier twin; L = lighter twin; x = measurements done at 1 month (born at 36 weeks gestation); MC = monochorionic; DC = dichorionic.

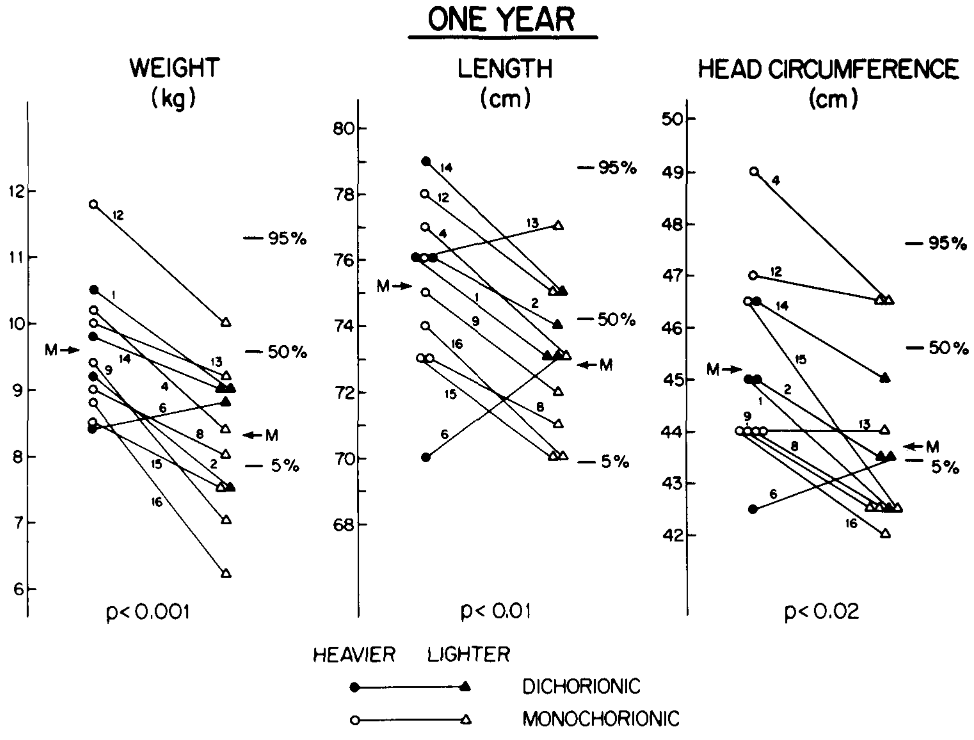

Fig. 2. Differences in measurements at 1 year of age in 11 term twin pairs discordant by birth weight. The 5th, 50th, and 95th percentiles for girls are shown, from the National Center for Health Statistics Growth Charts, 1976. M = mean. Individual twin pairs are linked.

TABLE 2. Mean Differences Between Heavier and Lighter Twin as a Percentage of the Heavier Twin at Birth and at 1 Year

	Mean difference at birth			Mean difference at 1 year		
	Weight	Length	Head circumference	Weight	Length	Head circumference
All twins (n = 11)	33%	7%	5%	14%	3%	3%
Monochorionic (n = 7)	36%	8%	5%	17%	3%	4%
Other (n = 4)	27%	5%	5%	9%	2%	2%

lighter twin at birth was heavier, longer, and had a larger head circumference at one year of age. In twin pair 13 (monochorionic), the lighter twin at birth remained somewhat lighter at one year, but was longer and had the same head circumference. Individual pairs can be matched with Figure 1 and Table 1 for clues to prediction of subsequent outcome.

The mean differences between heavier and lighter twins at birth and at one year are shown in Table 2. All twins showed a marked decrease in weight discrepancy, with monochorionic twins showing a similar decrease to the others. Incremental

TABLE 3. Incremental Growth of Weight, Length, and Head Circumference From Birth to 1 Year in Discordant Twins

	Birth to 1 year differences					
	Weight (kg)		Length (cm)		Head circumference (cm)	
	mean	(range)	mean	(range)	mean	(range)
Heavier twin						
Monochorionic (n = 7)	6.98	(6.17–8.45)	25.9	(23.5–28.0)	11.8	(11.0–14.0)
Other (n = 4)	6.62	(5.51–7.52)	25.6	(21.0–27.5)	10.9	(8.2–12.5)
	6.85		25.8		11.5	
Lighter twin						
Monochorionic (n = 7)	6.27	(5.14–7.82)	27.5	(24.0–34.5)	11.9	(9.0–13.5)
Other (n = 4)	6.49	(5.32–7.28)	26.6	(25.0–30.5)	11.6	(9.5–13.7)
	6.35		27.2		11.8	

TABLE 4. Pearson Correlation Coefficients Between Birth and 1 Year Measurements

	1 year measurements			
Birth measurements	Weight	Length	Head circumference	Ponderal index
Weight	0.713 **	0.547 ††	0.631 **	0.498 *
Length	0.641 **	0.565 †	0.605 **	0.338 N.S.
Head circumference	0.569 ††	0.401 †	0.672 **	0.406 †
Ponderal index	0.590 ††	0.397 †	0.419 †	0.531 ††
Anterior fontanel area	−0.342 N.S.	−0.248 N.S.	−0.157 N.S.	−0.389 †
Ossification at knee	0.647 **	0.517 *	0.415 †	0.430 †

* < 0.01.
† < 0.05.
** < 0.001.
†† < 0.005.

growth from birth to one year is shown in Table 3, by twin size and placentation. In infants without ossification at birth, incremental increase in length was 28.6 cm (n = 7) compared to 25.5 cm (n = 15) in those infants with ossification at birth. This was statistically significant ($p < 0.01$).

Correlations between the measurements at birth and those at one year are provided for the total sample in Table 4. As expected, weight, length, and head circumference at birth correlated closely with the respective measurements at one year. In addition, both ponderal index and ossification at birth showed a positive correlation with weight, length, head circumference, and ponderal index at one year. Anterior fontanel area showed poor correlations.

Contrary to expectation, intra-pair differences (heavier minus lighter, divided by heavier) at birth did not correlate with intra-pair differences at one year for

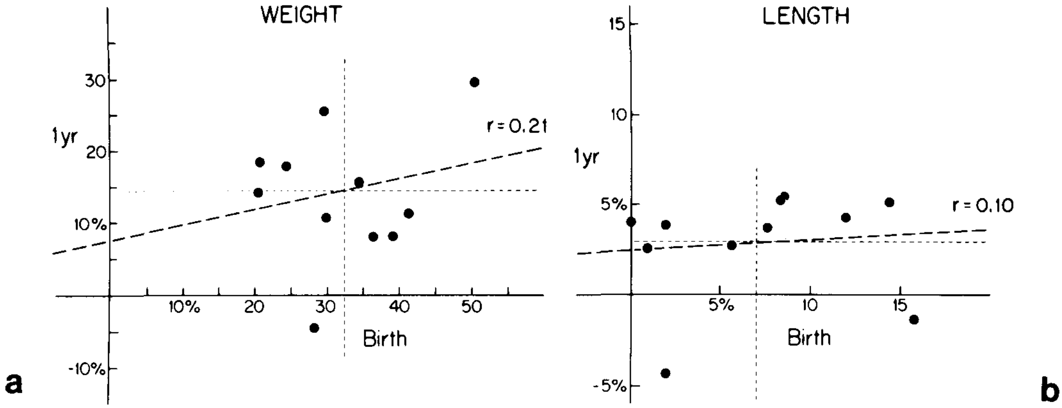

Fig. 3. Percentage differences between individual twin pairs at birth and at 1 year (heavier minus lighter, divided by heavier), for (a) weight and (b) length, show no correlation. This indicates that intra-pair differences at 1 year cannot be predicted on the basis of intra-pair differences at birth.

TABLE 5. Birth and 1 Year Measurements in Discordant Term Twins, Showing the Tendency for the Lighter Twin to Catch Up. Data on Term Singletons [13] Is Provided for Comparison

	Term twins		Term singletons	
	Heavier (n = 11)	Lighter (n = 11)	AGA (n = 100)	SGA (n = 47)
Weight				
Birth	2.76 ± 0.51	1.89 ± 0.56	3.40 ± 0.51	2.10 ± 0.37
1 year	9.60 ± 1.0	8.24 ± 1.11	10.08 ± 1.10	8.01 ± 1.51
Length				
Birth	49.4 ± 2.4	45.8 ± 2.8	52.1 ± 2.3	45.4 ± 2.6
1 year	75.2 ± 2.6	73.0 ± 2.2	74.4 ± 2.9	68.8 ± 5.6
Ponderal index				
Birth	2.27 ± 0.26	1.91 ± 0.31	2.40 ± 0.28	2.23 ± 0.16
1 year	2.26 ± 0.15	2.11 ± 0.19	2.45 ± 0.23	2.45 ± 0.23

AGA, Appropriate for gestational age; SGA, small for gestational age [cf 6].

weight, length, or head circumference. This is exemplified in Figure 3 showing the differences for weight and length. By definition, the weight discrepancy at birth was at least 20% (mean = 33%), but varied from −5% to 28% at one year (r = 0.21). Length discrepancy varied from 0 to 16% (mean = 7%) at birth, but in all instances was within 5% (mean = 3%) at one year (r = 0.10).

When heavier twins were evaluated alone, the best predictor of weight and length at one year was ossification at birth, whereas in lighter twins ponderal index at birth was the best predictor of weight, length, and head circumference at one year (using multiple regression analysis).

Decreasing discordance can be deduced from the tendency of ponderal index in the heavier and lighter twins to come closer together (Table 5). The values are contrasted with recent data on term singletons who were either appropriate or small for gestational age at birth and were evaluated at one year [6].

DISCUSSION

Although it seems to be a comparatively uncommon situation for monozygotic twins to have grossly differing birth weights [9], discordant twins provide a useful model of intrauterine (fetal) growth retardation, because the heavier twin acts in many cases as a normally grown control for the lighter twin. However, the heavier twin may also suffer some degree of fetal growth retardation [11, 13].

The follow-up studies on growth of discordant twins have largely been devoted to preterm infants. In a retrospective study, Babson et al drew attention to continuing growth retardation in the smaller of discordant twins [1]. Only 3 of the 16 pairs studied were born at 38 or more weeks gestation. A more recent study from Poland showed that the smaller of twins remained at a disadvantage, mainly with respect to body weight, but dealt only with premature twins [13]. A small sample of discordant twins from the Louisville twin study showed continued weight deficit (but not height or IQ deficit) at six years of age [24]. Six of the ten twin pairs were born at term.

Apart from this, there have been only a few sporadic reports concerning subsequent growth of individual pairs of discordant twins born at term [4, 9]. These indicate the potential for comparable growth patterns in twins of greatly dissimilar birth weight.

Subsequent development or intelligence (as opposed to growth) may be worse in the smaller twin when a significant birth weight difference is present [7, 12, 14]. It has also been suggested that there may be no significant difference in development between "discordant" twins [10].

The present study attempted to find predictive information about subsequent growth. Ossification and ponderal index at birth provided correlations with measurements at one year for the group, but there was little *individual* predictability, and no apparent difference between monochorionic and other twin pairs.

Ossification

The association of delayed ossification at the knee with fetal growth retardation was first described by Scott and Usher [22] and confirmed by the present author [20]. In the twins described by Buckler and Robinson (where marked discordancy rapidly disappeared), it was noted that the distal femoral epiphysis was ossified in the larger twin but absent in the smaller [4]. This was usually the case in the present study, and suggests that the severity of intrauterine growth retardation may be reflected in the degree to which epiphyseal ossification is decreased.

Since ossification is more advanced in females [18], this could affect subsequent growth. The great majority of babies with follow-up (8 of 11 twin pairs) were female, so that male–female differences could not be evaluated. More advanced ossification was noted in the lighter of two twin pairs, both of whom were dichorionic (with the heavier being male in twin pair 7). In two monochorionic twin pairs with "normal" ossification (some ossification of both distal femoral and proximal tibial epiphyses), length was within normal limits, even though the lighter twin was below the tenth percentile for weight.

Since lack of ossification has been related to subsequent linear "catch-up" growth in rats [23], it was hoped that this might prove a useful predictor in the human newborn. Although those infants *without* epiphyseal ossification at birth showed greater incremental linear growth as a group than those with ossification, this was not a reliable indicator in the individual baby.

Follow-up

The birth to one year differences in the smaller twin were similar to those seen in singletons with fetal growth retardation [5, 20]. Incremental growth in the heavier twin was similar to that seen in the term control group in Cruise's study [5]. Despite considerable scatter and a difference in mean length between heavier and lighter twins (Fig. 2), the length of all babies at one year of age was within normal limits.

Head circumference at birth seems to be less affected than weight and length in the smaller of discordant twins, both in this study and that of Lubchenco [19]. In most cases, at one year of age the difference in head circumference within a twin pair was not very great. Similar small differences (1 cm or less) were seen on follow-up in term twin pairs by Babson et al [1] and Falkner [9], despite marked differences at birth.

In a recent German study, it was suggested that there may be a critical birth weight difference of 650 grams between monozygotic twins of at least 36 weeks gestation, which results in decreased weight and head circumference on long-term follow-up [21]. This is only partially confirmed in this study (i.e., *some* remained small, but not all).

CONCLUSION

The "extraordinary diversity at both extremes of fetal growth rate" has been documented by the Ounsteds, who further commented that "postnatal growth cannot be predicted from birth weight" [17]. This study supports that contention, but shows that twins who are markedly discordant at birth have a tendency to become more concordant by one year. This finding has been noted previously for monochorionic twins [9, 24], but not dichorionic [24]. Despite measurements within normal limits, discrepancies between twin pairs usually persist. Prediction of postnatal growth using physical measurement at birth is not reliable.

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Correspondence: Alistair G. S. Philip, Department of Pediatrics, Evanston Hospital, 2650 Ridge Avenue, Evanston, IL 60201, USA.

Present address for A. G. S. Philip: Dept. of Pediatrics, Evanston Hospital, 2650 Ridge Avenue, Evanston, Illinois 60201, USA.