

**GROWTH AND SEXUAL
MATURATION OF LOW
BIRTH WEIGHT CHILDREN:
A 14 YEAR FOLLOW UP**

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ABSTRACT

Objective: To evaluate the physical growth and sexual maturation of children born with low birth weight (<2000g). (LBW).

Design: Longitudinal follow up.

Setting: Hospital born urban cohort.

Methods: Weight, height, head circumference and pubertal changes were recorded till 14 years at specified intervals in 252 LBW and 176 control (term neonates with birth weights \geq 2500 g) children. Effect of prematurity and fetal growth retardation (SFD) was studied in 79 preterm appropriate for gestation and 45 term SFD children.

Results: LBW boys significantly lagged behind their controls for all physical growth parameters till 14 years, while the LBW girls had a physical growth comparable to controls after 11 years. Preterms had comparable weight, height and head circumference with their controls after 11 years. The SFDs, however, remained significantly

Low birth weight (LBW) babies constitute 24-39% of all births in India. Those weighing 2000g or less make up 3-14% of the births(1), with about half of them being term growth retarded infants. Studies on the subsequent physical growth of LBW children are mostly from developed countries and restricted to the preadolescent years. Further, these have remained controversial and inconclusive as to the ultimate outcome of LBW infants. Only a few reports have attempted to study the independent effects of prematurity or fetal growth retardation on the ultimate outcome(2-4). Data on the influence of LBW, particu-

handicapped in their overall physical growth even at 14 years. In comparison to controls, menarche occurred 6 months earlier in preterms and 12 months earlier in SFD girls. However, there was no change in the sequence of pubertal changes in either preterms or SFDs.

Conclusions: Fetal growth retardation has a lasting adverse effect on later physical growth, while most preterms catch up with their peers by adolescence.

Keywords: Low birth weight, Growth, Adolescence, Menarche, Preterm, Small for gestation.

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larly prematurity and fetal growth retardation, on pubertal changes are meager and the published studies have invariably not determined the sequelae of prematurity and fetal growth retardation on pubertal changes. The present communication attempts to fill the existing lacunae on some of these issues which are of great relevance to developing countries, particularly India.

Subjects and Methods

The cohort was made up of 428 children born at Safdarjung Hospital, New Delhi between 1968-1971. Children with morbidities in the perinatal period (such as birth asphyxia, malformations, hyperbilirubinemia) or in later life (chronic infections such as tuberculosis, recurrent urinary tract infection) which were likely to interfere with subsequent growth, were excluded from the study. Information on family background, socio-economic status, maternal nutrition, parental heights, perinatal history, gestation, birthweight, length and head circumference was available for the entire cohort. The intrauterine growth curves of Ghosh *et al.*(5) were used to assess the intrauterine growth status of the newborns at birth.

The children were longitudinally evaluated either at the hospital follow-up clinic or by home visits. The follow-up schedule included 3 monthly (± 2 weeks) visits during the first year and 6 monthly (± 4 weekly) visits thereafter till the age of 14 years. At each visit the weight, length/height and head circumference were recorded. During infancy, weight was recorded on a beam balance with a single balance arm and subsequently on a beam scale with two balance arms to the nearest 20 g. During the

first two years, length was recorded on an infantometer and later standing height by an anthropometer to the nearest 0.1 cm. Head circumference was recorded to the nearest 0.2 cm. Sexual growth data for boys and girls was recorded and graded as described by Tanner(6).

There were 252 LBW children with a birth weight of <2000 g (136 boys and 116 girls). The controls were made up of 176 children (76 boys and 100 girls) who were born between 37-41 weeks of gestation with birth weights ≥ 2500 g. The groups were matched for parental height and education and also for their socioeconomic status. Amongst the LBW, 79 preterms (appropriate for dates) and 45 term small for dates (SFD) were further analyzed separately to study the independent effect of prematurity and growth retardation on physical growth and sexual maturation.

This being a mixed longitudinal data, the means and increments for physical growth were obtained by the methods of Tanner(7) and Rao(8). The means between any two groups at any age were compared by Students 't' test. The sample size has an 80% power to detect a difference of 3 Kg weight and 3 cm height till 10 years; and a difference of 4 Kg weight and 4 cm height thereafter at a 5% probability. For the comparison of more than two groups, ANOVA was applied and pair wise comparison was done by LSD (least significant difference). The sexual maturation data was evaluated by probit analyses(9).

Results Physical

Growth

Weight: LBW boys significantly

lagged behind the controls all through 14 years. There was an attempt at catch up as the percentage weight deficit between the groups decreased from 40% at birth to 13% at 14 years (*Table I*). In the case of girls, the difference between the LBW and controls became insignificant at 12 years. Preterms and SFDs remained lighter than controls throughout till 14 years. However, in the case of preterms the observed difference became insignificant ($p > 0.05$) after 10 years, but not so in the case of SFDs (*Fig. 1*).

Height: LBW boys remained significantly shorter than controls till 14 years. However, the reduction in the height

difference from 8.7% at birth to 3.7% at 14 years was evidence of tendency to catch up. LBW girls remained significantly shorter than their controls only till 13 years (*Table II*). LBW girls had a higher peak height velocity (PHV) (mean 7.1 cm) compared to the controls (mean 6.6 cm), thus enabling them to catch up by 13 years. SFDs remained significantly shorter than controls till 14 years. In the case of preterms, the differences became insignificant ($p > 0.05$) after 10 years (*Fig. 2*).

Head Circumference: LBW boys had a significantly smaller head size than controls till 14 years. In the case of LBW

TABLE I—Best Estimates of Mean Weight From 0-14 Years

Age (Yr)	Mean weight (SD) (kg)							
	Boys				Girls			
	n	LBW	n	Controls	n	LBW	n	Controls
Birth	137	1.8(0.2)***	119	3.0(0.4)	115	1.7(0.2)	57	2.9(0.3)***
1	89	7.4(0.9)***	48	9.1(1.0)	72	6.7(0.7)	16	7.9(1.0)***
2	89	9.4(1.0)***	61	10.8(1.2)	68	8.6(1.2)	31	10.1(1.3)***
3	85	11.2(1.2)***	71	12.6(1.5)	73	10.4(1.3)	29	11.7(1.1)***
4	118	12.5(1.4)***	92	13.9(1.3)	88	11.8(1.4)	47	13.3(1.3)***
5	117	13.9(1.5)***	93	15.4(1.7)	88	13.2(1.5)	39	14.6(1.3)***
6	93	15.3(1.5)***	89	16.9(1.9)	74	14.5(1.6)	41	15.9(1.7)***
7	113	15.8(1.9)***	97	18.8(2.5)	90	15.9(1.8)	42	17.7(1.8)***
8	114	18.4(2.2)***	88	20.9(3.2)	94	17.6(2.3)	37	19.8(2.3)***
9	115	20.4(2.5)***	92	23.4(3.8)	90	19.7(2.9)	41	22.2(3.3)***
10	104	22.5(2.9)***	82	25.9(4.8)	76	22.2(3.3)	42	25.1(3.6)***
11	68	25.0(3.9)***	66	28.7(5.7)	53	25.4(4.2)	28	28.2(4.0)***
12	43	27.2(3.5)	19	31.1(7.3)	38	29.6(4.8)	9	31.9(5.2)
13	51	30.3(3.5)**	34	33.9(6.3)	36	33.1(5.5)	14	35.4(6.8)
14	20	34.9(6.3)*	14	40.2(6.9)	26	35.9(5.2)	7	39.5(5.2)

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

TABLE II—Best Estimates of Mean Height From 0-14 Years

Age (Yr)	Mean Height (SD) (cm)							
	Boys				Girls			
	n	LBW	n	Controls	n	LBW	n	Controls
Birth	131	45.0(2.5)***	85	49.3(1.9)	114	44.8(3.1)***	41	48.6(1.6)
1	98	69.8(3.2)***	33	74.4(2.3)	73	68.5(2.6)	12	70.5(3.8)
2	97	79.6(3.3)***	55	83.7(2.8)	75	77.7(3.5)***	32	81.5(3.6)
3	97	87.4(4.0)***	63	91.7(3.6)	80	85.6(3.9)***	29	89.4(3.5)
4	131	93.8(4.2)***	83	97.3(3.4)	95	91.9(3.9)***	45	95.4(4.0)
5	133	99.6(4.3)***	87	103.1(4.1)	103	97.9(3.9)***	40	101.2(4.0)
6	108	105.1(4.6)***	89	108.7(4.3)	84	103.6(4.6)***	42	106.6(4.4)
7	121	110.8(4.9)***	89	114.8(4.8)	93	109.0(4.6)***	44	112.3(4.4)
8	122	115.6(8.5)***	81	120.7(5.3)	95	114.6(5.1)***	40	118.1(4.4)
9	122	121.1(5.7)***	86	126.0(5.6)	93	119.7(5.5)***	42	123.8(5.1)
10	111	126.2(5.9)***	75	131.3(6.6)	79	125.5(6.1)***	43	129.2(5.2)
11	77	131.3(6.7)***	57	136.2(5.7)	55	131.8(7.2)**	27	135.5(6.3)
12	46	136.4(6.5)***	16	142.5(5.1)	40	138.9(6.3)	9	142.1(4.6)
13	51	141.9(7.3)*	34	147.3(7.2)	37	144.8(9.5)*	15	148.5(4.8)
14	20	150.0(9.9)	17	155.8(8.2)	26	146.6(6.4)	8	149.3(4.2)

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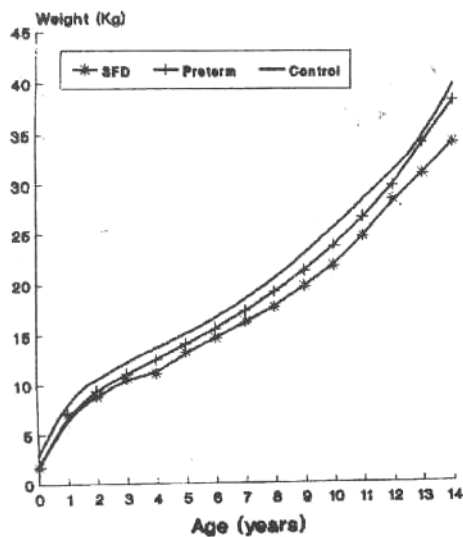


Fig. 1. Mean weights in preterms, SFDs and controls from 0-14 years.

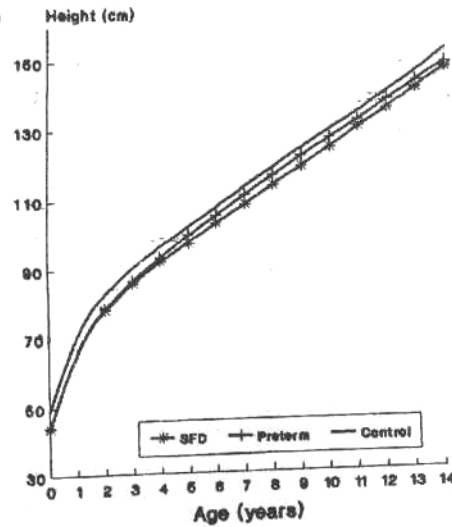


Fig. 2. Mean heights in preterms, SFDs and controls from 0-14 years.

girls the differences in head circumference became insignificant after 11 years (Table III). Preterms and SFDs had a significantly smaller head circumference compared to controls till 11 years and 14 years, respectively.

Sexual Maturation

Boys: Genitalia development (G2) was the first sign of puberty in both LBW and controls. The median age for genitalia Stage 2 were similar in the LBW (10.2 years) and controls (10.02 years). Pubic hair appeared at a median age of 12.1 years (range 9.5-15.5 years) in LBWs compared to 11.7 years (range 9.5-14.5 years) in controls. The age at ap-

pearance of facial and axillary hair was not influenced by birth weight or gestation. The sequence of pubertal changes was almost similar in all groups of boys.

Girls: Breast development (B2) was the earliest sign of puberty in LBW and controls. Almost half the LBW were in Stage B2 at 9.5 years compared to 28% amongst the controls. The median age for stage B2 in SFDs was 10.7 years compared to 11.1 years in the controls.

Menarche occurred at a median age of 13.6 years in the controls. It occurred 6 months earlier in preterms and 12 months earlier in SFD girls. However, the sequence of pubertal changes were

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***P<0.001; ** p <0.01; * P <0.05

alike in all groups of girls. The puberty onset to menarche interval was similar in all groups. The pubertal onset to PHV was shorter in controls (median 0.9 years) than amongst preterms (median 1.9 years) or SFDs (median 1.8 years).

Discussion

In the present study, it was observed that the lag in weight and height between LBW and control girls became insignificant after 11 years. The catch up growth in the LBW was contributed by the earlier adolescent growth spurt and a longer puberty onset—PHV interval. However, the catch-up in height appears to be partly offset by an earlier onset of menarche, thus resulting in their ultimate shorter stature. This is especially important since the parental heights were comparable in both the groups. Some workers(10) observed that LBW (<2000 g) children did not differ from controls at 6 years. However, others have reported significantly lower physical growth parameters with non catch up in LBWs(11-13) even at 18 years age(2).

LBW boys significantly lagged behind controls in all physical growth parameters even at 14 years. Unlike the girls, the boys had not yet completed their adolescent growth spurt, and therefore it would be premature to comment on their ultimate physical growth. The observation(2) that LBW boys have a greater adolescent growth spurt than LBW girls, could suggest that the LBW boys in the present cohort may also catch up in the subsequent years.

The perterms caught up with the controls at 10 years for weight and height, and at 12 years for head circumference. Some workers have demon-

strated catch up between preterm AGAs and controls during the preschool years(14,15). However, others have reported preterms as being lighter and shorter during the same period(16-19) and even after full growth(2,17). Babson(19) reported that when corrected for gestational age, growth curves of perterms paralleled but remained below standard curves. Some studies have observed that head circumference growth was not influenced by gestation(10,19), while others have noted lower head circumference values in preterms compared to controls(2). In this study too, the head circumference was lower, particularly in boys.

SFDs were observed to be significantly handicapped in weight, height and head circumference compared to controls even at 14 years. These observations are consistent with other studies(2,16,20,21). Animal models suggest that malnutrition at a critical period of fetal growth could cause a small size throughout life(22). These could be due to resetting of the hypothalamic growth programme at a lower activity level.

The first sign of adolescence was similar in both LBW and control girls and boys. Menarche occurred about 6 months earlier in preterm girls and almost one year ahead in SFD girls compared to the controls. Westwood(3) too had made similar observations. This observation is, however, in contrast to others studies(2,23), which have observed delayed menarche in LBW girls. It may be postulated that growth retardation during the second half of pregnancy may reset the hypothalamic gonadostat, resulting in decreased sensitivity to negative feedback and an earlier onset of

puberty. The PHV to menarche interval was shorter in LBW (median age 1 year) than control girls (median age 1.6 years), which may be an important factor underlying the ultimate shorter stature observed in LBW girls.

It is concluded that LBW children take almost 14 years to catch up with controls. Fetal growth retardation appears to result in greater handicap in physical growth than prematurity in LBW children. These observations may have important implications for the second generation offspring of SFD girls, who may be at a greater risk of begetting LBW infants.

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