Impact of perinatal factors on growth deficits in preterm infants

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Summary

Objective: To review perinatal factors associated with a growth deficit in preterm infants at a corrected age of one year. **Methods:** Cohort study of preterm infants with a birth weight < 2,000 g. Percentiles and Z scores of body weight (W/A), length (L/A) and head circumference (HC/A) at one year of corrected age were calculated by using the Centers for Disease Control and Prevention curves. **Results:** Among 303 preterm infants, the frequencies of measures below the 10th percentile (P10) and Z scores -2 were 43.2% and 24.4% for W/A, 22.1% and 8.6% for L/A and 15.8% and 4.6% for HC/A, respectively. Logistic regression analyses showed factors associated with higher odds for W/A < P10 were resuscitation at birth (1.8 times) and small for gestational age infants (3.0 times). In infants rated as small at full-term postconceptual age, the odds for W/A < P10 were 4.0 times as high in those with a birth weight between 1,000 and 1,499 g and 3.5 times as high in those ≥ 1,500 g. As birth length was reduced, the odds for L/A < P10 increased, but this was not associated with birth weight. The odds for HC/A < P10 were 2.5 times as high in small for gestational age infants. In infants with a body weight < 1,000 g, the odds for HC/A < P10 were 4.4 times higher, compared with those between 1,000 g and 1,499 g and 5.3 times higher if compared with those ≥ 1,500 g. **Conclusion:** At a corrected age of one year, preterm infants with a birth weight < 2,000 g were found with high growth deficits frequencies, and associated factors were variable, depending on the analyzed deficit, with intrauterine and postnatal growth restriction being outstanding predictors.

Keywords: Preterm infant; low birth weight neonate; very low birth weight neonate; extremely low birth weight neonate; growth.

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Introduction

The progress of maternal-fetal and neonatal medicine has afforded a higher survival for preterm infants with increasingly lower gestational ages, with an increasing number of children and adolescents having a risk for morbidities resulting from prematurity, such as growth disorders[1]. Despite the progress in neonatal care, particularly for those with very low birth weight, preterm infants have a course with a growth deficit as inpatients, and an elevated number has a body weight below the 10th percentile for age at hospital discharge[2-5].

In preterm infants, perinatal growth deficits of body weight, length and head circumference can persist throughout childhood[6,-8], adolescence[9,10], and adulthood[11,12]; in addition, early body weight and head circumference deficits can be associated with neurodevelopment changes in childhood[13-15] and adulthood[16].

In Brazil, there are few studies evaluating the preterm infant growth after the hospital discharge[17,18]. Thus, this study aims to evaluate the frequency of body weight, length and head circumference growth deficits, according to the birth weight, and to assess for the perinatal factors associated with a growth deficit at the corrected age of one year in preterm infants born in a tertiary care hospital in the Southeastern region of Brazil.

Methods

In this study, a preterm infant cohort with a birth weight < 2,000 g, born in a public university hospital and followed in an outpatient facility specialized in preterm infant care was evaluated. All the preterm infants with a birth weight < 2,000 g and born at Hospital São Paulo between January 1997 and December 2003 having an outpatient evaluation when they were at a corrected age of one year were eligible. Diseases or procedures others that could interfere with growth regardless prematurity, such as congenital malformations with a functional repercussion, genetic syndrome, symptomatic congenital infection, inborn error of metabolism, malabsorption syndrome, oxygen therapy for longer than 90 days, hospitalization for more than 60 days after the corrected age of 40 weeks and death after hospital discharge were considered as exclusion criteria.

Preterm infants born in Hospital São Paulo with a birth weight < 2,000 g are followed by a multiprofissional team in a Premature Outpatient Clinic, *Universidade Federal de São Paulo* (Unifesp) from the neonatal unit up to the end of adolescence. The pediatric visits are provided by a third-year resident of the Neonatal Pediatrics Discipline at Unifesp, being always overseen by an assisting physician.

The study was approved by the Unifesp Research Ethics Committee, which considered the informed consent signature unnecessary, since it was a retrospective study in a preterm infant cohort.

Maternal data evaluated was: age, education, marital status, habits during pregnancy, pregnancy history, prenatal follow-up, multiple pregnancy, medical diseases (pregnancy-induced hypertension, chronic high blood pressure, urinary tract infection, *diabetes mellitus*), premature rupture of membranes, corticosteroid use to induce fetal maturity and type of delivery. Maternal diseases were diagnosed by the obstetrician assisting the pregnant woman over the antenatal period or at the delivery and the information was obtained from the mother's record.

The information about the neonates included: gender, gestational age, birth weight, length and head circumference (HC), adequacy of weight to gestational age, first- and fifth-minute Apgar score and delivery room resuscitation requirement, characterized by positive-pressure ventilation, followed or not by chest compressions and drug administration. The gestational age was calculated from the last menstruation date and when this was not available, by the New Ballard's[19], Capurro's[20] or obstetric ultrasound methods. Neonates with a body weight lower than the 10th percentile (P10) in Alexander's chart[21] were considered small for gestational age.

Over the hospital stay, respiratory distress syndrome, chronic pulmonary disease characterized as supplemental oxygen requirement by the corrected age of 36 weeks, sepsis, necrotizing enterocolitis, patent *ductus arteriosus*, peri- and/or intraventricular hemorrhage[22], periventricular leucomalacia and retinopathy of prematurity were assessed. Data about parenteral nutrition administration, ventilation length, packed red blood cell transfusion, and systemic corticosteroid use were collected. The length of hospital stay and the weight to full-term postconceptual age (between 37 weeks and 41 weeks and 6 days) adequacy was also analyzed, with those infants having a body weight lower than P10 in Alexander's chart[21] being considered small.

Weight, length, and head circumference were obtained at birth, at full-term postconceptual age, and at 12 months of corrected age, with a range of ± 2 months and these were used to evaluate growth, i.e., the measures obtained between 10 and 14 months of corrected age were accepted.

The body weight was measured by having the infant totally naked, with an electronic balance with 15 kg maximum capacity and a 5 g accuracy level being used. The length was measured by a wooden stadiometer graded in tenths of a centimeter, with the infant being positioned supine with both lower limbs extended, the fixed portion of the stadiometer positioned on the head and the mobile part under the feet. The head circumference was measured by a flexible nondistensible tape, graded in tenths of a centimeter, positioned around the widest occipitofrontal circumference. Measurements were made by the residents or assisting physicians, who received routine training to carry out the recommended techniques of the measurements. All information was obtained from the infants' records.

The Z scores and weight, length and HC percentiles for a corrected age of one year were calculated through the software Epi-info version 3.3.2 (2005), having the 2000 Centers for Disease Control and Prevention curves as a reference[23].

The software SPSS 12.0 was used in the statistical analysis. Depending on the variable distribution, the Student's *t* test or the Mann-Whitney test was used to compare two groups; the analysis of variance, complemented by the Tukey's test or the Kruskal-Wallis's test with Bonferroni correction, was used to compare three groups. Upon comparing categorical variables, the chi-square test or the exact Fisher's exact test was used.

To assess deficit-associated factors (< P10) of weight, length and HC by 12 months corrected age, multivariate analysis was performed, when the strength of the association between the odds ratio (OR) variables and their confidence interval was quantified. A logistic regression model including p < 0.15 variables in bivariate analysis for which was possible to obtain the OR estimate was used. For all statistical tests, the 5% significance level was adopted (p < 0.05).

Results

Over the study period, 813 preterm live infants with a weight < 2,000 g were born at Hospital São Paulo, with 215 having a course to death as inpatients; 86 were excluded, as they met any of the following exclusion criteria: 32 had cerebral palsy and swallowing change, 37 had a congenital defect or a genetic syndrome, 11 had an extended oxygen therapy and/or prolonged hospitalization, 2 had an inborn error of metabolism, 1 had a bowel resection, 1 had a meconium ileus and ileostomy, 1 had a symptomatic congenital toxoplasmosis at birth, and 1 died after hospital discharge. Among the 512 eligible infants for the study, 70 did not join the Premature Outpatient Clinic, of whom 69 had a birth weight ≥ 1,500 g and only one had a birth weight between 1,000 g and 1,499 g. Of the 412 infants joining the outpatient clinic, 139 discontinued the follow-up before the age proposed and thus the study group consisted of 303 infants. The study group was divided into three subgroups according to the birth weight: Group 1: < 1,000 g, n = 37; Group 2: 1,000 g to 1,499 g, n = 96; Group 3: ≥ 1,500 g, n = 170.

To compare the maternal characteristics between the two groups in cases of twin pregnancies, the data was entered only once. Thus, the numbers of mothers considered for analysis in Groups 1, 2, and 3 were 36, 92, and 156, respectively. When the study group was compared with the group with an incomplete follow-up, almost all variables were found with no significant differences. In the study group, a higher mean maternal age (28.3 ± 7,4 and 26,6 ± 7.2 years; p = 0.030), a lower ratio of mothers with an educational level lower than 8 years (47.0% and 61.0%; p = 0.015), a higher prenatal follow-up frequency (95.4% and 88.4%; p = 0.008), a higher retinopathy of prematurity frequency (15.2% and 6.5%; p = 0.010) and a higher mean term postconceptual age weight (2,646.5 ± 618.6 g and 2,525.3 ± 540.2 g; p = 0.044) were observed.

In the study group, the gestational age was set through the last menstruation date in 281 (92.7%) neonates, obstetric ultrasound in 5 (1.6%), New Ballard's method in 15 (4.9%) and Capurro's method in 2 (0.7%). See Table 1 for some of the maternal variables reviewed. Smoking status was not different among the 3 groups (Group 1 – 22.2%; Group 2 – 27.2% and Group 3 – 19.2%). The frequency of pregnancy-induced hypertension was higher (p < 0.001) in Groups 1 (47.2%) and 2 (38.0%) than in Group 3 (19.9%). However, the frequencies of chronic high blood pressure (Group 1 – 11.1%; Group 2 – 16.3% and Group 3 – 14.1%), urinary tract infection (Group 1 – 13.9%; Group 2 – 17.4% and Group 3 – 23,7%) and *diabetes mellitus* (Group 1 – 8.3%; Group 2 – 9.8% and Group 3 – 7.1%) were not different among the groups.

The analysis of the newborn characteristics showed the lowest the gestational age, the lowest the birth weight group (p < 0.001), with a mean of 29.1 ± 2.3 weeks in Group 1, 30.8 ± 2.3 weeks in Group 2, and 33.5 ± 1.9 weeks in Group 3. The mean weight, length and HC values at birth differed among the three groups (p < 0.001), being 865.3 ± 108.4 g, 33.9 ± 1.9 cm and 24.9 ± 1.5 cm in Group 1; 1,246 ± 131.5 g, 37.9 ± 1.9 cm, and 27.4 ± 1.4 cm in Group 2; and 1,756.8 ± 143.0 g, 41,6 ± 1.7 cm, and 30.1 ± 1.4 cm in Group 3. As for the therapeutics instituted during the hospitalization, the frequencies of parenteral nutrition use (Group 1, 97.3%; Group 2, 84.4%; Group 3, 26.5%; p < 0.001), mechanical ventilation for over 24 hours (Group 1, 78.4%; Group 2, 51.0%; Group 3, 14.7%; p < 0.001), oxygen therapy more than 28 days (Grupo 1 - 40,5%; Grupo 2 - 16,7%; Grupo 3 - 2,4%; p<0,001) and blood transfusion (Group 1, 83.8%; Group 2, 57.3%; Group 3, 10.0%; p < 0.001) were higher for the lowest birth weights. Postnatal corticosteroid use was higher (p < 0.001) in Groups 1 (8.1%) and 2 (15.6%), compared to Group 3 (2.4%). See Table 1 for further variables related to birth and the period as inpatients.

The length of stay in hospital was longer when birth weight was the lowest, with 67.8 ± 18.0 days in Group 1, 47.5 ± 18.8 days in Group 2 and 21.3 ± 12.2 days in Group 3. The mean term postconceptual age when the weight analyzed did not differ among the three groups: 39.8 ± 1.1 weeks, 39.4 ± 1.2 weeks and 39.4 ± 1.3 weeks in Groups 1, 2 and 3, respectively. The term postconceptual weight in Group 1 (2,325 ± 413.2 g) was lower than in Group 2 (p = 0.003) and 3 (p < 0.001), whereas Group 2 (2,636.5 ± 597.1 g) and 3 (2,722.4 ± 647.3 g) weights were similar. The frequency of small newborns at the term postconceptual age was higher in Group 1 (86.5%) than in the other (p = 0.005), but it was

Table 1 – Maternal and newborn (NB) characteristics according to the birth weight group

	Group 1	Group 2	Group 3	p
Maternal variables[§]	n = 36	n = 92	n = 156	
Age in years (mean ± SD)[a]	30.1 ± 7.9	29.5 ± 6.9	27.1 ± 7.3	0.011
Education < 8 years[#] (n, %)	15 (41.7)	43 (47.3)	73 (48.0)	0.620
Absence of a partner[##] (n, %)	6 (17.6)	27 (29.3)	32 (21.2)	0.241
Primigravidas (n, %)	11 (30.6)	35 (38.0)	62 (39.7)	0.844
Prenatal follow-up (n, %)	35 (97.2)	86 (93.5)	150 (96.2)	0.602
Twin pregnancy (n, %)	4 (11.1)	12 (13.0)	25 (16.0)	0.675
Premature rupture of membranes (n, %)	4 (11.1)	12 (13.0)	26 (16.7)	0.593
Antenatal corticosteroid (n, %) [b]	21 (58.3)	35 (38.0)	56 (35.9)	0.043
C-section delivery (n, %)	27 (75.0)	62 (67.4)	90 (57.7)	0.088
NB variables	n = 37	n = 96	n = 170	
Female (n, %) [b]	28 (75.7)	43 (44.8)	80 (47.1)	0.003
Resuscitation (n, %) [c]	29 (78.4)	50 (52.1)	46 (27.1)	< 0.001
SGA (n, %)	16 (43.2)	37 (38.5)	87 (51.2)	0.129
RDS (n, %) [d]	19 (51.4)	32 (33.3)	15 (8.8)	< 0.001
CPD (n, %) [e]	8 (21.6)	5 (5.2)	2 (1.2)	< 0.001
Sepsis (n, %) [d]	27 (73.0)	44 (45.8)	31 (18.2)	< 0.001
NEC (n, %)	2 (5.4)	4 (4.2)	6 (3.5)	0.697
PCA (n, %) [d]	13 (35.1)	19 (19.8)	3 (1.8)	< 0.001
PIVH (n, %) [f]	18 (48.6)	34 (35.4)	26 (15.3)	< 0.001
PVL (n, %) [g]	2 (5.4)	2 (2.1)	0 (0.0)	0.015
ROP (n, %) [c]	22 (59.5)	22 (22.9)	2 (1.2)	< 0.001

Group 1 – birth weight < 1,000 g; Group 2 – birth weight 1,000 g to 1,500 g; Group 3 - birth weight ≥ 1,500 g
[§]Maternal information is included only once in twin pregnancies
[#]5 with no information (1 in Group 2 and 4 in Group 3);
[##]7 with no information (2 in Group 1 and 5 in Group 3)
SGA, small for gestational age; RDS, respiratory distress syndrome; CPD, chronic pulmonary disease; NEC, necrotizing enterocolitis; PCA, patent *ductus arteriosus*; PIVH, peri- and intraventricular hemorrhage; PVL, periventricular leukomalacia; ROP, retinopathy of prematurity
Tukey Test: [a]Group 2 > Group 3
Chi-squared Test Partition: [b]Group 1 > Group 2 and Group 3; [c]Group 1 > Group 2 > Group 3; [d]Group 1 and Group 2 > Group 3
Fisher's Exact Test: [e]Group 1 > Group 2 and Group 3; [f]Group 1 and Group 2 > Group 3; [g]Group 1 > Group 3

no different between Groups 2 (69.8%) and 3 (59.8%). See Table 2 for mean values at the corrected age in the moment of evaluation, Z scores and weight, length, and HC percentiles for the age, in addition to index frequencies below -2 scores and lower than P10 at one year of corrected age.

In order to evaluate factors associated with weight, length and HC deficits at 12 months of corrected age characterized as measures below P10 for the age, maternal data were included into the logistic regression model: age, education, marital status, smoking and alcohol intake during the pregnancy, gestational history, prenatal follow-up, multiple pregnancy, medical diseases (pregnancy-induced hypertension, chronic hypertension, urinary tract infection, *diabetes mellitus*), premature rupture of membranes, antenatal corticosteroid and type of delivery. The following newborn variables were also considered: gender, gestational age, weight, length, HC, weight to gestational age adequacy, 1- and 5-minute Apgar score and resuscitation in the delivery room. The hospitalization period variables included were the medical (respiratory distress syndrome, chronic pulmonary disease, sepsis, necrotizing enterocolitis, patent *ductus arteriosus*, peri- intraventricular hemorrhage, periventricular leukomalacia and retinopathy of prematurity) and therapeutic (parenteral nutrition, mechanical ventilation, oxygen therapy, packed red blood cell transfusion and systemic corticosteroid) events, length of stay in the hospital and weight to term postconceptual age adequacy. In each one of the multivariate analysis modeling steps, the option to exclude the variable with the highest p value was chosen. The association between birth weight range and term postconceptual age weight adequacy was also considered and thus both variables were maintained in the model regardless their extent of association with the endpoint.

For logistic regression analysis results, see Table 3. Infants who required resuscitation in the delivery room had odds 1.8 times higher and those rated as small for the gestational age had odds 3.2 times higher for weight deficit for the age. In order to interpret the birth weight and the weight adequacy at term postconceptual age, the interaction term was considered, i.e., one of the two variables was fixed while the other variable odds were evaluated in

Table 2 – Z-scores and measurement percentiles at 1 year of corrected age according to the birth weight group

	Group 1 (n = 37)	Group 2 (n = 96)	Group 3 (n = 170)	P
Corrected age (mean, SD)	12.4 ± 0.5 mon	12.1 ± 0.9 mon	12.1 ± 1.0 mon	p > 0.05
Z-scores				
W/A (mean, SD) [a]	-2.2 ± 1.4	-1.3 ± 1.1	-0.9 ± 1.2	< 0.001
W/A < -2 Z-scores [b]	21 (56.8%)	21 (21.9%)	32 (18.8%)	< 0.001
L/A (mean, SD) [c]	-1.0 ± 1.1	-0.8 ± 1.1	-0.2 ± 1.1	< 0.001
L/A < -2 Z-scores [d]	6 (16.2%)	13 (13.5%)	7 (4.1%)	0.006
HC/A (mean, SD) [e]	-0.8 ± 1.2	-0.1 ± 1.3	0.2 ± 1.1	< 0.001
HC/A < -2 Z-scores	3 (8.1%)	6 (6.3%)	5 (2.9%)	0.272
Percentiles				
W/A (mean, DP) [c]	11.0 ± 19.5	19.4 ± 22.0	28.5 ± 27.4	< 0.001
W/A < P10[f]	28 (75.7%)	46 (47.9%)	57 (33.5%)	< 0.001
L/A (média, DP) [c]	24.5 ± 25.9	31.5 ± 27.2	44.5± 28.7	< 0.001
L/A < P10[d]	15 (40.5%)	26 (27.1%)	26 (15.3%)	0.001
HC/A (média, DP) [e]	30.7 ± 31.1	48.8 ± 32.6	54.9 ± 30.2	< 0.001
HC/A < P10[b]	15 (40.5%)	13 (13.5%)	20 (11.8%)	< 0.001

Group 1 – birth weight < 1,000 g; Group 2 – birth weight 1,000 g to 1,500 g; Group 3 - birth weight ≥ 1,500 g
SD, standard deviation; mon, months; W/A,weight for age; L/A, length for age; HC/A, head circumference for age
Tukey Test: aGroup 1 < Group 2 < Group 3; c Group 1 and Group 2 < Group 3; e Group 1 < Group 2 and Group 3
Chi-squared Test Partition: b Group 1 > Group 2 and Group 3; d Group 1 and Group 2 > Group 3; fGroup 1 > Group 2 > Group

Table 3 – Final multivariate model adjusted for the presence of growth deficit (< 10th percentile) at 1 year of corrected age

	OR	95% CI	p
Weight for age			
Resuscitation	1.801	[1.034; 3.138]	0.038
Birth weight			0.061
1,000 g to 1,499 g *vs.* < 1000 g	0.062	[0.006; 0.675]	
≥ 1,500 g *vs.* < 1,000 g	0.130	[0.013; 1.270]	
Birth weight adequacy SGA *vs.* non-SGA	3.231	[1.721; 6.066]	< 0.001
Term weight adequacy SGA *vs.* non-SGA	0.451	[0.042; 4.795]	0.509
Birth weight interaction and Term adequacy			
< 1,000 g – SGA *vs.* non-SGA	0.451	[0.042; 4.796]	0.509
1,000 g to 1,499 g - SGA *vs.* non-SGA	4.007	[1.351; 11.885]	0.012
≥1,500 g - SGA *vs.* non-SGA	3.480	[1.234; 9.812]	0.018
Length for age			
Birth length	0.826	[0.757; 0.902]	< 0.001
Term weight adequacy SGA *vs.* non-SGA	1.963	[0.990; 3.894]	0.053
Head circumference for age			
C-section *vs.* vaginal delivery	2.183	[0.978; 4.871]	0.057
Birth weight			< 0.001
1,000 g to 1,499 g *vs.* < 1,000 g	0.228	[0.092; 0.568]	
≥ 1,500 g *vs.* < 1,000 g	0.187	[0.080; 0.438]	
Birth weight adequacy SGA *vs.* non-SGA	2.454	[1.235; 4.879]	0.010

SGA, small for gestational age at birth and at term postconceptual age

each category for that fixed variable. Thus, infants with a birth weight between 1,000 g and 1,499 g or ≥ 1,500 g who were rated as small at the term postconceptual age were observed to have odds 4.0 times and 3.5 times as high to be found with a weight deficit at one year of corrected age, respectively, than those not rated as small. For the group with birth weight < 1,000 g, a statistically significant difference in the odds for a weight deficit for the age among infants either rated as small or not at the term postconceptual age was not observed.

The birth length was independently associated with the length rate for the age below P10. A 1 cm reduction in the birth length increased the odds for length deficit at 12 months of corrected age by 21%. Although the variable term weight adequacy has been maintained in the logistic regression model, it did not reach statistical significance (p = 0.053), but would be representative that small infants at term postconceptual age would have odds 2 times as high for a length deficit for the age than those with no neonatal growth restriction. As for the birth weight, no relationship with a length deficit at 12 months of corrected age could be found.

Infants born from a C-section delivery had odds 2.2 times as high for a HC deficit than those born vaginally, but this result did not show statistical significance (p = 0.057). Small for gestational age infants had odds 2.5 times as high for HC deficit. Infants with a birth weight < 1,000 g showed odds 4.4 times as high for HC deficit than those between 1,000 g and 1,499 g and 5.3 times higher than those with a birth weight ≥ 1,500 g.

Discussion

As preterm infant survival increases, so does their follow-up importance. Only with follow-up studies of children and adolescents born preterm late repercussions of neonatal events and interventions on their growth and development can be detected[24]. Recent preterm infant cohort studies have shown antenatal and neonatal growth deficits impair growth and development in childhood[14,15] and point out how important the first year of life is as an opportunity to compensate for early malnutrition and promote somatic and brain growth even in late premature babies[25]. Our study is the first one in Brazil reviewing preterm infant growth after hospital discharge distributed into three birth weight ranges, including neonates with a weight ≥ 1,500 g.

The methods adopted in this study were similar to those in other cohort studies of preterm infants[12,14,15]. Although the optimum percentage of follow-up for cohort studies has not been achieved, the infants who were not given an outpatient follow-up had characteristics similar to those in the study group. This study design was feasible because the Preterm Outpatient Clinic at Unifesp was settled to provide care and conduct studies related to long-term prematurity outcomes. Thus, the medical records have detailed information about diagnoses and therapeutics in neonatal period, as well as about the outpatient follow-up, allowing for reliable data attainment.

In the current study, preterm infants with a birth weight < 2,000 g were observed to have a significant growth deficit at 12 months of corrected age, whether it was characterized by measurements below P10 or -2 Z scores. The highest the frequency and severity of weight, length and HC deficits, the lower the birth weight was, an observation borne out by other studies[6,26,27].

Preterm infant's growth is influenced by several biological and environmental factors and can be different in groups from the same country and in similar time[6,26]. A study conducted in Botucatu, Brazil[17], evaluated a cohort with 70 extremely low birth weight preterm infants and, in Porto Alegre, Brazil[18], 100 very low birth weight preterm infants were studied. The mean Z-score values at 12 months of corrected age found in this study in extremely low birth weight preterm infants were close to those observed in Botucatu[17] (-2.0 for weight, -1.3 for length, and -0.7 for HC), whereas mean values for infants with very low birth weight were lower than those observed in Porto Alegre[18]: -1.5 *versus* -0.5 for weight and -0,8 and -0,4 for length, respectively. These results indicate it is relevant to know the progress in preterm infants with different perinatal and sociodemographic characteristics. Although the nutritional delivery after hospital discharge and the population socioeconomic level have not been evaluated, most families of preterm infants born at *Hospital São Paulo* belong to C, D and E classes and this may have contributed to the growth deficits observed[28].

The growth deficit frequency in infancy for preterm babies is different among the studies and depends on the anthropometric indicator analyzed, but studies on risk factors show a lower birth weight and neonatal and intrauterine growth restriction are commonly associated with a higher growth deficit frequency in infancy[6,14,17]. These findings are quite relevant, since intrauterine growth restriction is an important prematurity etiologic factor[29] and neonatal growth restriction frequency among very low birth weight preterm infants is very high, reaching 97%[3]. In the last years, the importance of preterm infant growth over the first weeks of life has been highlighted, since it corresponds to the period the conceptus should be intrauterine and malnutrition in this phase is supposed to have consequences similar to those found in intrauterine growth restriction. In the current study, the frequencies of intrauterine and extrauterine growth restriction were elevated, indicating this population has factors associated with a high risk for future growth deficits.

The number of patients included in this study enabled several antenatal and neonatal variables that could be associated with infancy growth deficits to be analyzed, but most of them showed no association. However, small for gestational age infants and those with a birth weight ≥ 1,000 g rated as small at term postconceptual age had higher odds for weight deficit, as observed in other studies[6]. In the extremely low birth weight group in this study, the frequency of small infants at term postconceptual age was over 80% for those with or without weight deficit at 12 months. This event precluded the detection of an association of neonatal growth restriction in extremely low birth weight preterm infants with weight below P10 in infancy, as other studies have found[14].

The influence of birth length on preterm infant growth in childhood has been under-analyzed, but a study found an association between low birth length Z-score and short stature at the age of 5[30]. In this study, the odds for growth deficit at 1 year of corrected age was observed to be inversely related to birth length, i.e., the higher the odds for length deficit, the lower the birth length; this relationship, in turn, may result from the prematurity grade or the presence of intrauterine growth restriction.

The infants considered small for the gestational age and those with a birth weight < 1,000 g had higher odds for HC deficit for the age, and these results are consistent with a study in preterm infants showing a positive association between gestational age, birth weight, as well as birth weight Z-score and HC at 2 years of corrected age[31]. These findings suggest stature and HC growth in childhood is also influenced by intrauterine growth.

Current investigations indicate low probability growth deficits in preterm infants can be overcome up to the hospital discharge and that specialized follow-up and nutritional intervention to improve growth must extend beyond the length of stay in the hospital[6].

Conclusion

At 1 year of corrected age, preterm infants with a birth weight < 2,000 g had a significant weight, length and HC growth deficit and the factors associated changed according to the deficit analyzed, with intrauterine and postnatal growth restriction being highlighted. These findings point out it is important to be aware of the preterm infants' progress and to provide an appropriate nutritional care implementation to promote growth.

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