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ORIGINAL ARTICLE

Growth until 24 months in preterm of very low birth weight, with or without intrauterine or postnatal growth restriction

Crecimiento a 24 meses de prematuros menores de 32 semanas, con o sin restricción de crecimiento intrauterino o postnatal

Patricia Mena Nannig[a], Patricia Vernal Silva[b], Alexis Díaz Gonzalez[c], María Teresa Henríquez Höfter[d], Enrica Pittaluga Pierdiluca[a], Ivonne D'Apremont Ormeño[a], Mónica Morgues Nudman[b], Jane Standen Herliz[e], Valeria de Toro Navarrete[f]

[a]Servicio de Neonatología, Hospital Sotero del Río. Santiago, Chile
[b]Servicio de Neonatología, Hospital San José. Santiago, Chile
[c]Servicio de Neonatología, Hospital Regional Libertador Bernardo O'Higgins. Rancagua, Chile
[d]Servicio de Neonatología Hospital San Juan de Dios. Santiago, Chile
[e]Servicio de Neonatología, Hospital Dr. Gustavo Fricke. Viña del Mar, Chile
[f]Pontificia Universidad Católica de Chile. Santiago, Chile

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What do we know about the subject matter of this study?

The growth of preterm infants may be slowed intrauterine, postnatally, or post-discharge. Characterizing later growth according to these alterations has been described with intrauterine growth retardation, postnatal growth retardation, or both.

What does this study contribute to what is already known?

It describes the growth of preterm infants without growth disturbance, preterm infants with postnatal growth disturbance but rapid recovery at discharge that continue with good subsequent growth, preterm infants with postnatal restriction with recovery in the first 6 months, and preterm infants with intrauterine and postnatal restriction that recover very slowly up to 2 years of age.

Abstract

The growth of preterm newborns can be affected during the fetal period, hospitalization, and post-discharge. **Objective:** to describe the anthropometric development of preterm newborns with or without intrauterine and postnatal growth restriction, and with or without recovery at 40 weeks from birth to 24 months of age. **Patients and Method:** Retrospective, descriptive study with Z-scores (Fenton and WHO) of weight, length, head circumference, and weight/length of preterm infants of less than 32 weeks of gestational age at birth up to 24 months of corrected age. 4 groups were defined according to prenatal, postnatal, post-discharge growth as follows: Group AAA: newborns born AGA, with no postnatal growth restriction; Group APA: newborns born AGA, with postnatal growth res-

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Correspondence:
Patricia Mena Nannig
mena.n.patricia@gmail.com

Edited by:
Carolina Heresi Venegas

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triction, weight < p10 at discharge, and weight > p10 at 40 weeks; Group APP: newborns born AGA, with postnatal growth restriction, weight < p10 at discharge and at 40w; and Group PPP: newborns born with intrauterine growth restriction and who maintained postnatal growth restriction (< p10 at birth, at discharge, and at 40w). We used descriptive statistics with ANOVA, Chi-squared, and linear mixed model analysis. **Results**: 710 preterm newborns were included, birth weight 1272 grams (SD 360) and gestational age 29 weeks (SD 1.9). Group AAA had weight, length, and head circumference Z-scores close to the median until 2 years of age. AGA preterm newborns and with postnatal growth restriction can evolve in two ways: one group presents recovery at 40 weeks (Group APA) while the other group presents weight Z-score < -1 up to 6 months (Group APP). Group PPP (with intrauterine and postnatal growth restriction) presents slow weight and length Z-score recovery, weight Z-score -2.3 at discharge, and slow improvement to < -1 at 2 years of age. All groups had weight/height Z-scores above the median in the first 2 months of corrected age. **Conclusion**: Preterm newborns with good fetal growth but restricted postnatal growth, may recover at 40 weeks, with subsequent normal development or recover at 6 months.

Introduction

In the last decades, neonatal mortality in preterm infants has been reduced achieving survival of infants with lower birth weight[1]. One of the relevant and still pending problems is to achieve optimal growth in preterm infants of lower gestational age (GA). Some of them are born with intrauterine growth restriction (IUGR)[2], and the possibility of recovering or maintaining restricted growth depends on the causes and magnitude of IUGR, morbidity, and subsequent nutritional management[2].

Despite advances in nutrition and improvements in macro and micronutrient intake, it is frequently observed that newborns present insufficient postnatal growth during hospitalization[3,4]. A weight below the 10th percentile at discharge has been denominated extrauterine growth restriction (EUGR)/postnatal growth failure (PGF) and may be observed in children with good prenatal growth or IUGR[3].

Several studies show the importance of a good nutritional evolution in neurodevelopment from the first weeks of life[5-9]. Achieving growth close to fetal growth is one of the important tasks in neonatology. Weight recovery up to 3 to 4 months of corrected age (CA) is associated with significant effects on neurodevelopment but, after this age, the risk of obesity increases[10]. Skull development up to 8 months has been clearly associated with better development[11].

IUGR is a prenatal process, of obstetric follow-up, which can be managed with the termination of pregnancy by determining prematurity. According to weight and gestational age at birth, intrauterine growth curves classify newborns below the 10th percentile as Small for Gestational Age (SGA) and above the 10th percentile and below the 90th percentile as Adequate for Gestational Age (AGA)[2]. The nutritional follow-up with Z-score is the difference in the standard deviation of the mean for age and sex, that is, if the population distribution curve is normal, the 10th percentile of a curve corresponds to -1.3 deviations or -1.3 Z-score[12].

In Chile, the National Complementary Feeding Program (NCFP) for preterm newborns provides special formulas during the first year of life to all preterm infants less than 1500 g or less than 32 weeks at birth up to 12 months of CA[13]. Evaluating and intervening post-discharge growth is one of the activities of the Follow-up Programs for preterm or very low birth weight infants[14].

The objective of this study is to describe the anthropometric evolution of preterm infants younger than 32 weeks, from birth to 24 months of CA.

Patients and Method

Observational, multicenter, descriptive, and retrospective study on the growth of preterm newborns monitored in 5 Preterm Follow-up Clinics of the Public Health System in the central region of Chile, discharged from their neonatal hospitalization during 2011 and 2012.

This study included 721 infants born at less than 32 weeks of GA, who had complete information at birth, at discharge, at 40 weeks, and between 18 and 24 months of CA. Patients with genopathies or congenital diagnoses affecting growth were excluded.

The patients were assessed at the clinics of each center. The Follow-up Program had a common protocol and criteria for an evaluation in each check-up. Each infant was classified according to nutritional status at birth, at discharge, and 40 weeks with the Fenton growth chart for girls and boys respectively and exact gestational age (weeks and days) and subsequently according to WHO growth curves with the Anthro software[15,16].

Preterm infants were classified into 4 groups:

1. Group AAA: infants born AGA, without postnatal restriction (at birth, at discharge, and 40 weeks with weight higher than the 10th percentile).
2. Group APA: infants born AGA with postnatal restriction, with weight at discharge less than the 10th percentile and at 40 weeks greater than the 10th percentile.
3. Group APP: infants born AGA, with postnatal restriction, with weight at discharge less than the 10th percentile, remaining below the 10th percentile at 40 weeks.
4. PPP group: infants born with IUGR and who maintained postnatal restriction (at birth, at discharge, and 40 weeks with weight below the 10th percentile).

Data on weight, length, and head circumference at birth, at discharge, at 40 weeks, and 1, 3, 6, 9, 12, 18, and 24 months of CA, sex, gestational age at birth, and hospitalization length were collected from the records of each follow-up center. The post-discharge anthropometric data were recorded at each follow-up clinic in their clinical check-up, weight was measured with a calibrated scale, the length in supine decubitus position between 2 persons with a length meter/infant measuring board, and the head circumference considering the largest occipitofrontal diameter with a non-extensible measuring tape.

Data at birth and discharge were evaluated with exact age. The 1-month check-up is considered with a variation of approximately 15 days and in the following check-ups, variations of + 1.5 months were considered since most of the check-ups did not take place on the exact date they were due. The Z-score calculation was performed with the exact age on the day of the check-up.

The evolution of weight, length, and head circumference for each age was recorded and then compared between the groups AAA, APA, APP, PPP with Z-score considering underweight a Z-score lower than -1.3. The Z-score of the weight/length ratio was described from 40 weeks.

Statistical Analysis

Z-scores for the different anthropometric indices were calculated using the Fenton charts up to 40 weeks and the Anthro software for subsequent check-ups[13,15]. Growth trends were assessed using Z-score values for weight, length, head circumference, and weight/length ratio from birth to 2 years of corrected CA. Analyses were performed between groups according to growth patterns (AAA, APA, APP, and PPP).

For the description of continuous variables, measures of central tendency (mean and median) and measures of absolute dispersion (standard deviation and interquartile range) were used according to their distribution. Categorical variables were described using absolute and relative frequencies. Differences between groups were analyzed by ANOVA and Kruskal Wallis for independent samples and the chi-square tests were used for categorical variables. Linear Mixed Models were applied for the repeated measures analysis, using each anthropometric index (Z score) as the dependent variable and the group according to growth pattern as the explanatory variable. In addition, sub-analyses were performed by time interval to see the differences between the groups in the first six months of CA and then from six to two years of corrected age. Significance was set at 0.05. EpiInfo, Excel, and STATA 13.0 SE for MAC (Lakeway Drive College Station, TX, USA) were used for the analyses.

The study was approved by the Research Ethics Committee of the South-East Metropolitan Health Service, in Santiago, on March 9, 2021. The data were treated anonymously.

Results

721 preterm infants who were monitored from 40 weeks of CA were included, of which 321 (44.5%) were female. Of note, 213 (29.5%) were discharged from the neonatal hospitalization with weight less than -1.3 Z-score and 508 (70.5%) with weight greater than or equal to -1.3 Z-score. The majority (537) attended check-ups at 24 months. Figure N°1 shows the distribution of the groups according to nutritional status at birth, at discharge, and 40 weeks.

Table 1 shows the anthropometry at birth, at discharge, at 40 weeks, and at 24 months of the groups studied. There were significant differences in all variables except sex. Between the two groups with Z-score weight above -1.3 at 40 weeks (AAA and APA), there were differences in anthropometry and gestational age at discharge. The two groups with Z-score weight below -1.3 (PPP and APP) were significantly different in anthropometry at birth, weight, and length at 40 weeks, with similar gestational age at birth and hospital discharge (Table 1).

Figure 2 shows the evolution of the average Z-score weight (ZW) from birth to 2 years of CA. The AAA group, without EUGR/PGF, had an evolution of ZW at 40 weeks of gestational age close to Z + 0.5, and at 3 months it reached the median and remained so until 24 months of CA. The APA group presented a marked EUGR/PGF but recovered rapidly and followed a similar pattern to the AAA group. The differences between these two groups in ZW were not significant from 6 months. We analyzed the evolution between discharge and 40 weeks in the APA group, in order to interpret the data of 4 cases that were discharged after 40 weeks and some cases that were discharged early and referred to a second center where they had a recovery growth, resulting in an average increase between discharge and 40 weeks of 39 g per day.

The other two groups with EUGR/PGF had a similar evolution, but the APP group showed a higher level (0.5 to 0.8 SD). At 40 weeks, the PPP group had a mean ZW of -2.3 and the APP group -1.8, which is statistically significant.

Figure N° 3 shows a Z-score for length (ZL) with an evolution curve similar to weight, but further away from the median, showing the greater compromise of length during evolution. The two groups with adequate growth at birth and 40 weeks (AAA and APA) had a different evolution from birth to 3 months of CA, with no significant differences thereafter. The group with IUGR and EUGR/PGF (PPP) presented a lower mean ZL (-2.8) at one month of CA, later presented growth recovery in length, and at 24 months had a ZL of -1.16. On the other hand, the APP group recovered length to that level at 9 months of CA, and at 24 months had a ZL over -1.

Figure N° 4 shows the Z-score of head circumference (ZHC) which had a curve similar to that of weight, but much narrower. There are ZHC differences between birth and 40 weeks only in the groups with good nutritional status at 40 weeks. The AAA group at discharge and 40 weeks is within the channel where it remains for the first two years. The APA group is located between 40 weeks and one month on the curve that continues until 24 months of CA. The PPP group presented the lowest level at birth (ZHC -1.37) and recovered at 18 months (ZHC -0.5). The APP group stabilized its ZHC at 6 months of CA. The three charts have the same units on the Y-axis, to clearly observe the differences in the evolution of the three anthropometric parameters.

Figure N° 5 shows the evolution of the W/L Z-score, with a common pattern in the first 3 months for the 4 groups and then a marked drop for the PPP group that, despite gradually recovering weight and length, remains with a very low W/L.

Tables 2 and 3 show the analysis of each anthropometric measure by linear mixed models between the periods from 0 to 6 months and 6 to 24 months. In the 0 to 6 months model, all groups are different from AAA, except in W/L where APA is not different from AAA. In the 6 to 24 months model, there is no difference between AAA and APA, but both are different from APP and PPP.

Discussion

In this study we analyzed the anthropometric evo-

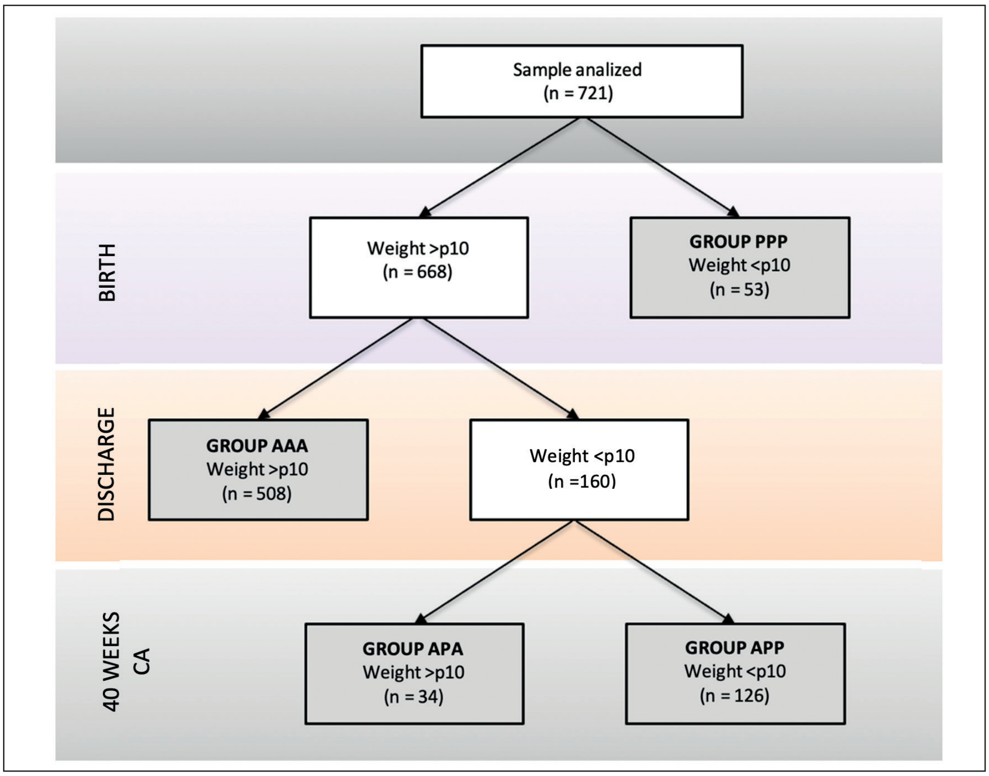

Figure 1. Sample analized distribution AAA: birth, discharge, 40 weeks weight over 10 percentile; APA birth and 40 weeks over 10 percentile, discharge weight lower 10 percentile; APP birth weight over 10 percentile, discharge and 40 weeks weight under 10 percentile; PPP birth, discharge, 40 weeks weight under 10 percentile. CA corrected age.

Table 1. Anthropometric characteristics at birth, discharge, 40 weeks gestational age and two years corrected age of four groups studied

	AAA(a)	APA(b)	APP(c)	PPP(d)	p
n / %	508 / 70.5%	34 / 5.4%	126 / 17.5%	53 / 7.4%	Diferences p < 0.05
Birth weight g	1376 (332)	1317 (305)	1030 (260)	817 (188)	a,b > c,d c > d
Birth length cm	38.7 (3.1)	37.9 (3.4)	35.4 (3.3)	33.3 (3)	a,b > c,d c > d
Cranial perimeter cm	27.7 (2.2)	27.5 (1.8)	24.4 (2.3)	24.8 (1.9)	a,b > c,d
Gestational age, weeks	29.1 (1.8)	29.6 (1.4)	28.2 (2.1)	28.8 (1.9)	a,b > c,d
% Female	44.7	32.1	50	38.2	Ns
Discharge					
Length of hospitalization*	7.3 (5.4-10.9)	8.3 (5.9- 10.7)	11 (8.1-15.4)	11.6 (8.4-14.3)	a,b < c,d
Weight g	2855 (726)	2447 (488)	2640 (529)	2574 (572)	a > b,c,d
Length cm	47.2 (3.1)	45.5 (2.7)	46.5 (2.8)	45.5 (3.1)	a > b,c,d
Cranial perimeter cm	33.8 (2.2)	32.5 (2.2)	33.5 (1.8)	33.4 (1.8)	b < a,c,d
Gestational age, weeks	37.6 (3)	38.7 (3.1)	40 (3.1)	40.5 (2.9)	a,b < c,d
40 weeks					
Weight g	3521 (474)	3475 (397)	2771 (237)	2601 (363)	a,b > c,d
Length cm	49.7 (4.3)	49.6 (1.9)	46.6 (1.6)	45.3 (2.3)	a,b > c,d
Cranial perimeter cm	35.9 (1.4)	35.9 (1.1)	34.4 (1.8)	34 (1.3)	a,b > c,d
Weight/length	0.70 (1.03)	0.63 (0.89)	0.02 (0.96)	0.09 (0.73)	a,b > c,d
24 months CA					
Weight k	12.22 (1.59)	12.50 (2.24	10.84 (1.32)	10.53 (1.27)	a,b > c,d
Length cm	86.6 (3.4)	87.8 (3.7)	83.9 (3.4)	83.4 (3.6)	a,b > c,d
Cranial perimeter cm	48.7 (1.9)	48.8 (1.9)	47.2 (1.9)	47.1 (1.8)	a,b > c,d
Weight/length	0.24 (1.04)	0.13 (1.33)	-0.49 (1.04)	-0.81 (0.96)	a,b > c,d

AAA: birth, discharge, 40 weeks weight over 10 percentile (a); APA birth and 40 weeks over 10 percentile, discharge weight lower 10 percentile (b); APP birth weight over 10 percentile, , discharge and 40 weeks weight under 10 percentile (c); PPP birth, discharge, 40 weeks weight under 10 percentile (d). CA corrected age. Data as mean and standard deviation. *median and interquartile range.

lution from birth to 2 years of corrected age of 4 groups of preterm infants of less than 32 weeks at birth, observing that the group with good prenatal and in-hospital growth maintained a similar evolution to the WHO reference median after 40 weeks, with ZW calculated by Anthro, with CA up to 24 months.

The infants who presented with EUGR/PGF were distributed into 3 groups where 2 groups were born with weight above the 10th percentile of the Fenton curve. One group (APA) showed growth recovery and presented a ZW greater than -1.3 at 40 weeks, and the other group (APP) maintained insufficient growth, but began a gradual weight recovery from discharge, reaching ZW -1 at 6 months of CA and ZW -0.8 at 12 months, which was maintained for the second year.

Median head circumference was not compromised in either group, being greater than Z -1.3 (equivalent to the 10th percentile) at 40 weeks post-conception, demonstrating the priority of brain growth.

Previous studies have considered preterm infants

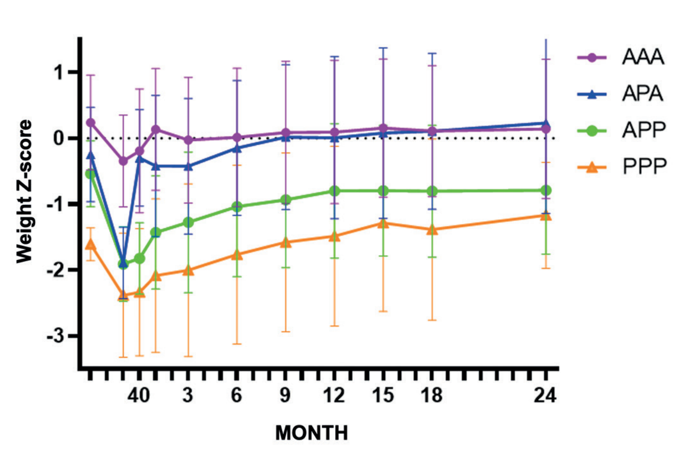

Figure 2. Weight /age Z score from birth to 24 months corrected age by group; mean ± standard deviation. AAA: birth, discharge, 40 weeks weight over 10 percentile; APA birth and 40 weeks over 10 percentile, discharge weight lower 10 percentile; APP birth weight over 10 percentile, discharge and 40 weeks weight under 10 percentile; PPP birth, discharge, 40 weeks weight under 10 percentile.

with IUGR as the group at the highest risk of growth deficit[19]. This study also shows that preterm infants with good prenatal growth but with postnatal growth restriction may also have a recovery growth at 40 weeks of CA or may maintain a slow recovery curve similar to that of preterm infants with IUGR, but less compromised.

The incidence of EUGR/PGF in this population was 19.3% with 7.4% already presenting IUGR (Table 1). Reviewing the literature, these figures are comparable[20]. The definitions of what is considered to be IUGR are varied; initially, they were less than p10, but with the use of Z- scores, cut-offs of -1, -1.5, and -2 have been proposed[21-24]. The difference between the Z- score at birth and discharge has also been used, proposing a decrease in the score of 0.8 or 1[21,22]. There is no consensus on a definition based on physiopathology[21].

Another variable that influences is the reference curve used. We used Fenton and Anthro pragmatically because an appropriate software is available, but if we used the current curves in use in Chile, the percentage of IUGR and EUGR/PGF would be higher[25]. Figures of IUGR between 26 and 59% are reported with different curves[26]. In the future, the Intergrowth curves could solve the heterogeneity of curves and allow different populations to be compared more adequately[26].

The real EUGR/PGF has also been distinguished as those newborns who do not present IUGR and whose nutritional deterioration occurs during hospitalization[27]. This group accounts for 22.9 % of our data (Table 1). In addition to prenatal growth, early nutritional support has an influence during hospitalization, especially a good supply of amino acids from the first day[5-7].

Among the morbidities reported that affect growth are bronchopulmonary dysplasia, late-onset sepsis, and necrotizing enterocolitis, especially the surgical type[28,29]. Regarding the evolution of length, the drop in Z-score continues post-discharge, with the PPP group presenting a mean of -2.75 after one month of CA, and then there was a slow growth in length until 24 months of age.

The head circumference recovers rapidly in all cases. Adequate growth from the intrauterine period and postnatal follow-up is a support base to enable brain development close to normal, and a favorable neurocognitive evolution[30].

The evolution of the weight/length ratio Z-score shows a very interesting curve which, at one month of CA, presented a difference between the 4 groups that was not significant, with the greatest difference of 0.24 Z-units (SD). At 3 months, there was a significant difference between the AAA and the PPP groups of 0.32 Z-units. At 6 months, the W/L Z-score decreases below the median in the APP and PPP groups, while groups AAA and APA remain above the median. The PPP group present a decrease at 6 months of -0.57 and continues to decrease slightly until 18 months to -0.94.

Clinically, these figures appear with respect to the overweight that these preterm infants have between 1 and 3 months, with W/L ratios above the median, however, they do not gain equal weight subsequently. The W/L ratio in the AAA and APA groups remains normal, but infants with history of IUGR or EUGR/PGF without rapid recovery have less weight gain, with a slow increase in length, and especially those with IUGR tend to be thinner. In body composition studies,

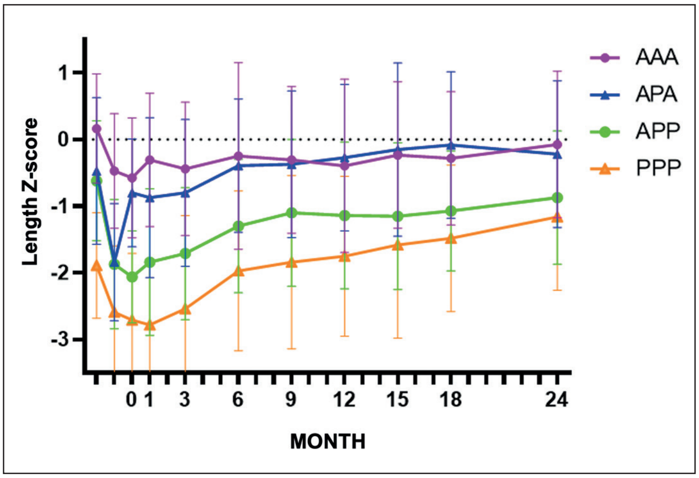

Figure 3. Length/age Z score from birth to 24 months corrected age by group; mean ± standard deviation. AAA: birth, discharge, 40 weeks weight over 10 percentile; APA birth and 40 weeks over 10 percentile, discharge weight lower 10 percentile; APP birth weight over 10 percentile, discharge and 40 weeks weight under 10 percentile; PPP birth, discharge, 40 weeks weight under 10 percentile.

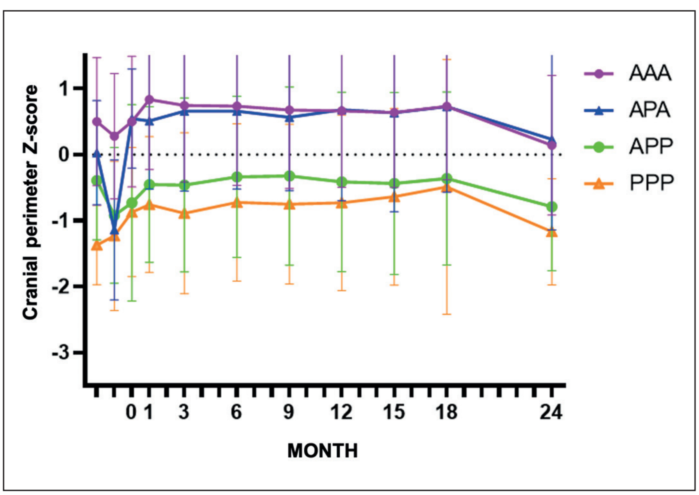

Figure 4. Cranial perimeter/age Z score from birth to 24 months corrected age by group; mean ± standard deviation. AAA: birth, discharge, 40 weeks weight over 10 percentile; APA birth and 40 weeks over 10 percentile, discharge weight lower 10 percentile; APP birth weight over 10 percentile, discharge and 40 weeks weight under 10 percentile; PPP birth, discharge, 40 weeks weight under 10 percentile.

Table 2. Weight, length cranial perimeter for age and weight for length Z score differences from 0 to 6 months corrected age

	Group	Coefficient	Confidence Interval 95%	p
Weiht/age Z	AAA ref			
	APA	-0.53	(-0.77 – -0.30)	0.000
	APP	-1.29	(-1.42 – -1.15)	0.000
	PPP	-2.00	(-2.19 – -1.80)	0.000
	cons	-0.032	(-0.09 – 0.03)	0.292
Length/age Z	AAA ref			
	APA	-0.48	(-0.74 – -0.23)	0.000
	APP	-1.16	(-1.30 – -1.01)	0.000
	PPP	-2.03	(-2.24 – -1.82)	0.000
	cons	-0.38	(-0.45 – -0.32)	0.000
CP/age Z	AAA ref			
	APA	-0.45	(- 0.71 – -0.18)	0.000
	APP	-1.13	(-1.28 – -0.98)	0.000
	PPP	-1.59	(-1.81 – -1.37)	0.001
	cons	0.57	(0.498 – 0.633)	0.000
Weight/length Z	AAA ref			
	APA	-0.48	(-0.74 – -0.23)	0.000
	APP	-1.16	(-1.30 – -1.01)	0.000
	PPP	-2.03	(-2.25 – -1.82)	0.000
	cons	-0.38	(-0.45 – -0.32)	0.000

ref: reference cons: constant CP cranial perimeterAAA: birth, discharge, 40 weeks weight over 10 percentile; APA birth and 40 weeks over 10 percentile, discharge weight lower 10 percentile; APP birth weight over 10 percentile, , discharge and 40 weeks weight under 10 percentile; PPP birth, discharge, 40 weeks weight under 10 percentile.

Table 3. Weight, length cranial perimeter for age and weight for length Z score differences from 6 to 24 months corrected age

	Group	Coefficient	Confidence Interval 95%	p
Weiht/age Z	AAA ref			
	APA	-0.10	(-0.46 – 0.26)	0.585
	APP	-0.93	(-1.13 – -0.72)	0.000
	PPP	-1.58	(-1.88 – -1.28)	0.000
	cons	0.06	(-0.03 – 0.15)	0.188
Length/age Z	AAA ref			
	APA	-0.25	(-0.53 – 0.02)	0.070
	APP	-1.0	(-1.15 – -0.84)	0.000
	PPP	-1.74	(-1.97 – -1.52)	0.000
	cons	-0.37	(-0.44 – -0.30)	0.000
CP/age Z	AAA ref			
	APA	0.0004	(-0.39 – 0.40)	0.998
	APP	-1.04	(-1.27 – -0.82)	0.000
	PPP	-1.35	(1.68 – -1.03)	0.000
	cons	0.67	(0.57 – 0.77)	0.000
Weight/length Z	AAA ref			
	APA	-0.16	(-0.51 – 0.18)	0.355
	APP	-0.69	(-0.88 – -0.49)	0.000
	PPP	-1.08	(-1.37 – -0.80)	0.000
	cons	0.34	(0.26 – 0.43)	0.000

ref: reference cons: constant CP cranial perimeter. AAA: birth, discharge, 40 weeks weight over 10 percentile; APA birth and 40 weeks over 10 percentile, discharge weight lower 10 percentile; APP birth weight over 10 percentile, discharge and 40 weeks weight under 10 percentile; PPP birth, discharge, 40 weeks weight under 10 percentile.

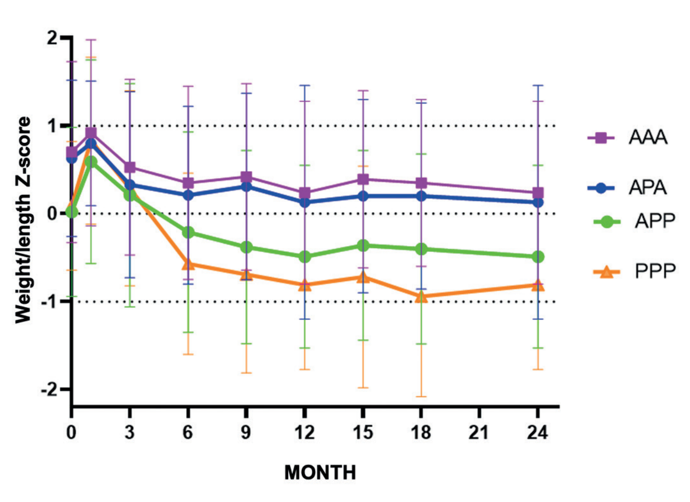

Figure 5. Weight /length Z score from birth to 24 months corrected age by group; mean ± standard deviation AAA: birth, discharge, 40 weeks weight over 10 percentile; APA birth and 40 weeks over 10 percentile, discharge weight lower 10 percentile; APP birth weight over 10 percentile, discharge and 40 weeks weight under 10 percentile; PPP birth, discharge, 40 weeks weight under 10 percentile.

these infants maintain both fat mass and fat-free mass much lower than controls of normal birth weight and age[31].

The evolution of weight after discharge has lost predictive value when is adjusted by length and HC[5]. Length and HC are more sensitive and specifically associated with better neurocognitive development, although it is also affected by morbidity and nutritional management[5,27-29]. However, weight remains a clinical reference since anthropometric evolution has interdependence.

In our data, we found no difference in anthropometric evolution by Z-score between boys and girls (data not shown). Girls usually have less response to nutritional supplements in anthropometry and cognitive development, but basally they are better than boys[32,33].

At discharge, these infants receive milk formula for premature infants as a complement to breastfeeding up to 6 months of CA, and an infant milk formula for the second semester according to the NCFP[13]. The availability of milk formulas makes it possible to assume that there is no important primary factor in the evolution. There is no consensus on post-discharge feeding of preterm infants. In the literature, a transitional formula for post-discharge has been tested, which has an intermediate composition between a preterm formula and a starter formula. Some studies maintain preterm formula until 40 weeks of CA and then continue with a starter formula[34]. Special formulas with higher protein and micronutrient intake have been proposed, considering that the infant regulates oral intake by energy concentration and that the recovery of lean mass should be greater than fat[35,36].

The term postnatal malnutrition or postnatal growth restriction allows comparing the evolution of different centers, however, it has been recently questioned due to the low specificity of weight alone in cognitive development when used as a predictor of an individual[19]. Length and especially head circumference have better sensitivity and specificity in this regard. Length is more difficult to measure appropriately so that a higher HC with normal neuroimaging is more useful and has a better prognosis[37].

Comparisons between preterm infants with IUGR and those without IUGR depend on whether they are made by weight, for example, less than 1500 g at birth, or by gestational age[38]. In this case, we have considered the comparison of early recovery or not in cases with IUGR, highlighting an important difference between them; as well as the similar evolution of the infants with history of IUGR and EUGR/PGF (PPP group), with those who have only had postnatal restriction.

The main strength of this study is the number of patients studied, coming from several follow-up centers, with a common, protocolized care plan and a complementary feeding program during the first year[14].

It would have been very interesting to have data on the evolution of growth and nutritional intake during hospitalization and the main morbidities presented in order to include them in the study of factors associated with subsequent development. On the other hand, having an estimate of neurocognitive development at 2 years of age for these 4 groups would allow us to see how associated these growth patterns are with later development. Another limitation is that attendance is not at the exact date, but the Z-score is assigned by exact age, which compensates for this situation.

Optimal, intensive, and timely nutrition is a critical factor and should be an important objective in the intrahospital period since it is a determining factor in subsequent growth[5-9]. Our study highlights that early growth is associated with subsequent anthropometric evolution.

Conclusions

The growth evolution of preterm infants born at less than 32 weeks of gestational age varies during hospitalization and after discharge. A weight greater than the 10th percentile at 40 weeks is associated with good growth in the first 2 years of life, therefore, is an important objective of neonatal nutrition when there has been a previous unfavorable nutritional evolution. Analyzing morbidity and management information during hospitalization would allow us to identify clinical factors associated with adequate weight at 40 weeks and to plan clinical interventions during hospitalization to minimize the risk of postnatal malnutrition in preterm infants younger than 32 weeks.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

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