Growth curves and dietary profile of preterm newborns with appropriate weight for gestational age during hospital stay

Curvas de crescimento e perfil dietético de recém-nascidos pré-termo com peso adequado para a idade gestacional durante a hospitalização

Curvas de crecimiento y perfil dietético de recién nacidos pretérmino con peso adecuado para la edad gestacional durante hospitalización

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ABSTRACT

Objective: To develop growth curves and to establish the dietary profile of preterm newborn infants with appropriate weight for gestational age (AGA) during hospital stay after birth.

Methods: This retrospective and descriptive study enrolled AGA preterm newborn infants born from January 2006 to December 2007, admitted to one NICU in Southeast Brazil. The following data were collected: anthropometric measures at birth (daily weight and length, weakly measures of head and chest circumference); as well as information on daily diet. Based on the collected anthropometric data, growth curves were built according to gestational age and they were compared to the main international and national intrauterine growth references. Third-degree polynomial functions were used for modeling growth curves.

Results: The study included 68 AGA preterm newborn infants, with a mean gestational age of 33.2±2.6 weeks. The median of the four anthropometric variables measured at birth were similar to the 50th percentile of the same measures in the intra-uterine growth reference curves. However, the 50th percentile of postnatal growth curves for the same variables were similar to the 10th percentile or -2 standard deviations of the intra-uterine reference growth curves. During hospital stay, 84.6% of the infants received breast milk; however, the median percentage of days of breast milk use in relation to the length of hospital stay was only 50% (variation: 2-100%).

Conclusions: The anthropometric gains during hospital stay do not reproduce intrauterine growth. There is a need to increase breast milk offer during the entire period of hospitalization.

Key-words: infant, premature; growth; child nutrition; anthropometry; milk, human; child health.

RESUMO

Objetivo: Elaborar curvas de crescimento e estabelecer o perfil dietético de recém-nascidos pré-termo com peso adequado para a idade gestacional (AIG) durante a internação após o nascimento.

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Métodos: Estudo coorte retrospectivo e descritivo de recém-nascidos pré-termo AIG, nascidos entre janeiro de 2006 e dezembro de 2007, internados em um hospital de Viçosa, Minas Gerais, Brasil. Foram coletadas informações sobre as medidas antropométricas ao nascer e sua evolução (peso diário e comprimento, perímetro cefálico e torácico semanal) e sobre a evolução diária da dieta. A partir dos dados coletados foram construídas curvas de crescimento referentes às medidas ao nascer e àquelas no pós-natal, em função da idade gestacional, as quais foram comparadas às referências nacionais e internacionais. Além da análise descritiva, foram feitos ajustes por funções polinomiais de terceiro grau para modelação das curvas de crescimento.

Resultados: Foram incluídos no estudo 68 recém-nascidos pré-termo AIG, com idade gestacional média de 33,2±2,6 semanas. Observou-se uma grande concordância entre as curvas do percentil 50 das quatro medidas antropométricas ao nascer em estudo e as curvas do percentil 50 de crescimento intrauterino. Entretanto, as curvas do percentil 50 das medidas antropométricas no período pós-natal foram similares às curvas do percentil 10 ou -2 desvios-padrão de crescimento intrauterino. Durante a internação, 84,6% das crianças receberam leite materno; entretanto, a mediana encontrada do percentual dos dias de uso do leite materno em função do tempo de internação foi de somente 50% (2 a 100%).

Conclusões: Os ganhos antropométricos durante o período de internação não reproduzem o ganho intrauterino. Observou-se a necessidade de maior oferta do leite materno durante o período de internação.

Palavras-chave: recém-nascido prematuro; crescimento; nutrição da criança; antropometria; leite materno; saúde da criança.

RESUMEN

Objetivo: Elaborar curvas de crecimiento y establecer el perfil dietético de recién nacidos pretérmino adecuados para la edad gestacional durante internación después del nacimiento.

Métodos: Estudio de cohorte retrospectivo y descriptivo de recién nacidos pretérmino adecuados para la edad gestacional, nacidos entre enero de 2006 y diciembre de 2007, internados en un hospital de Viçosa, Minas Gerais, Brasil. Fueron recogidas informaciones sobre las medidas antropométricas al nacer a lo largo del periodo de internación (peso diario, longitud, perímetro cefálico y torácico semanal) y sobre la evolución diaria de la dieta. A partir de los datos recogidos, fueron construidas curvas de crecimiento referentes a las medidas al nacer y a aquellas post-natales, en función de la edad gestacional, las que fueron comparadas a las referencias nacionales e internacionales. Además de los análisis descriptivos, se hicieron ajustes por funciones polinominales de tercer grado para modelación de las curvas de crecimiento.

Resultados: Fueron incluidos en el estudio a 68 recién nacidos pretérmino adecuados para la edad gestacional con edad gestacional mediana de 33,2±2,6 semanas. Se observó una gran concordancia entre las curvas del percentil 50 de las cuatro medidas antropométricas al nacer en estudio y las curvas del percentil 50 de crecimiento intrauterino. Sin embargo, las curvas del percentil 50 de las medidas antropométricas post-natales fueron similares a las curvas del percentil 10 o -2 de desviación estándar de crecimiento intrauterino. Durante la internación, 84,6% de los niños recibieron la leche materna; sin embargo, la mediana encontrada en el porcentaje de los días de uso de leche materna, en función del tiempo de internación, fue de solamente 50% (2,2 a 100%).

Conclusiones: Las ganancias antropométricas durante el periodo de internación no reproducen las intrauterinas. Se observó la necesidad de mayor oferta de la leche materna durante el periodo de internación.

Palabras clave: recién nacido prematuro; crecimiento; nutrición del niño; antropometría; leche materna; salud del niño.

Introduction

Infant growth is one of the best child health indicators[1]. Children born prematurely, i.e., with gestational age (GA) <37 weeks or 259 days[2], and with low birth weight (LBW), i.e., <2500g[3], have a higher risk of growth deficits during childhood compared to children born at term[4]. It is estimated that nearly 2/3 of children born with LBW are preterm[5] and have a 29 times greater chance of presenting a weight-for-age index below the 10th percentile at 12 months of age[6] and a nine times greater chance of presenting a deficit in their weight-for-age index at the end of the second year of life[7], when compared to children with normal birth weight. However, despite this evident risk for growth deficit, the outcome of preterm newborns (PTNs), compared to that of full-term newborns (FTNs), shows conflicting results in the literature[8-10]. According to Rugolo[11], several factors influence the growth of preterm children, one of them being nutritional pattern.

Although some problems caused by prematurity can be mitigated over time, others, when underdiagnosed at early ages, represent an important concern and may lead to the development of chronic diseases in adulthood[12-14]. Cross-sectional curves of intrauterine growth have become essential instruments in Pediatrics, because they allow, besides the cross-sectional evaluation of anthropometric measures at birth, to estimate whether PTNs grow during hospital stay as if they were still in the uterus[15]. The study of growth in infancy helps to foresee situations that can be preventable. In this context, it is necessary to understand the growth pattern of PTNs in hospital units, evaluate their dietary profile in this setting, and infer its possible health consequences.

Therefore, the present study aimed to develop growth curves for appropriate-for-GA (AGA) PTNs during hospitalization after birth through the study of the variables weight, length, head circumference, and chest circumference and the comparison of these variables with four cross-sectional curves of intrauterine growth from the international[16-18] and national[19] literature; and to establish the dietary profile of AGA-PTNs during hospitalization after birth at Hospital São Sebastião, in Viçosa, state of Minas Gerais, Southern Brazil.

Method

The present work is part of the case-control study *Influence of gestational age on clinical and nutritional conditions in children from the city of Viçosa – MG*, which has a home and ambulatory approach. This study was a secondary data analysis based on an overall retrospective and descriptive cohort study design. Between May 2010 and January 2011, retrospective data of AGA-PTNs from the municipality of Viçosa born between January 2006 and December 2007 were collected, referring to the hospitalization after birth at Hospital São Sebastião. Children were born between 26 and 36 weeks of GA.

The study population included infants who met the following inclusion criteria: residence in Viçosa; birth between January 2006 and December 2007; admission to Hospital São Sebastião on the first day of life; GA <37 weeks; and AGA birth weight, according to the curves proposed by Williams *et al*[18].

Research exclusion criteria were death during hospitalization after birth and having information on GA that does not meet the following criteria: 1) GA reported by at least two techniques, confirming prematurity (last menstrual period – LMP,, ultrasound – US, or clinical evaluation – CE by the technique of Capurro[20] or New Ballard[21]); 2) GA <36 weeks, reported by LMP (in an attempt to prevent the inclusion of false-positives in the study); or 3) GA <36 weeks, reported by US.

When GA was determined by more than one technique, the following priority criteria were established: 1st, LMP; 2nd, US; and 3rd, CE. The degrees of prematurity were subdivided into moderate preterm, for children born between 32 and 36 weeks' gestation; very preterm, for those born between 28 and 31 weeks' gestation; and extreme preterm, for those born at less than 28 weeks' gestation[22].

Information for the present work (dependent and independent variables) was obtained using a semi-structured questionnaire, which was completed based on information provided by the medical records of the mother and the baby (if the latter existed). In cases where children were hospitalized and had specific records, the admission diagnoses were identified.

According to the report of professionals, anthropometric measures (weight, length, head circumference, and chest circumference) were taken by qualified nurses and doctors and followed the standardized protocol adopted by the hospital sector[23]. Weight was measured daily, whereas length and head and chest circumferences were measured weekly. Curves for the measures obtained at birth (cross-sectional curves) and postnatally (longitudinal curves, referring to the hospitalization after birth) were built, based on the data of weekly anthropometric development. Birth weight was classified as recommended by the World Health Organization (WHO)[3].

To evaluate diet, the number of days during which each infant stayed on a given feeding modality (type of diet, food/formula, route of administration, and breast milk [BM] offer), was obtained; in addition, the permanence percentage for each feeding modality was calculated, based on the number of hospitalized days. To do so, we divided the number of days during which each modality was offered by the total number of days the infant was hospitalized. The milk-based formulas were named A, B and C, emphasizing that A represents a semi-elemental and hypoallergenic diet; B, a diet for PTNs; and C, a diet for FTNs.

The characterization of the study population was presented based on measures of central tendency and dispersion. A third-degree polynomial function was adjusted to soften the growth curve and thus suppress measurement errors and small variations in curve form. The software programs Excel (version 2007, Microsoft Office) and Statistical Package for the Social Sciences (SPSS) for Windows (version 10.0, SPSS Inc., Chicago, IL) were used for database development and codification, typing and statistical analyses of data.

The study was approved by the Human Research Ethics Committee of Universidade Federal de Viçosa (UFV).

Results

A total of 141 AGA-PTNs were identified, coming from the municipality of Viçosa, born in 2006 or 2007, and that were hospitalized in the hospital. Among those, 68 were considered eligible to participate in the study, after the exclusion of 67 infants who did not have GA compatible with the established criteria and of six children who died.

It was observed that the majority of the 68 AGA-PTNs was female (52%); was Caucasian (60%); had married mothers (48%); went to at least four prenatal visits (70%); had weight below 2500g (74%); was admitted to the Neonatal Intensive Care Unit (NICU) (71.6%); was treated by the Brazilian Unified Health System (SUS, Sistema Único de Saúde) (72%); was born by cesarean delivery (57%); and was a moderate preterm infant (78%). Additionally, 18% were twins, 10% lived in the rural area, and 4% were extreme preterm infants. None of the children had a congenital malformation and/or chromosomal anomaly detected.

Table 1 - Characteristics of the study population: Hospital São Sebastião, Viçosa, state of Minas Gerais, Brazil, 2006–2007

Characteristics		n	%	Mean±SD	Median (minimum–maximum)
Gestational age (weeks)		68	100	33.2±2.59	34 (26.14–36.42)
Maternal age (years)		68	100	25.2±7.54	23 (15–43)
Anthropometry at birth	Weight (g)	68	100	2.120.6±597.78	2.139 (865–3.155)
	Length (cm)	61	90	44.5±3.90	45 (35.5–51)
	Head circumference (cm)	59	87	31.1±2.42	31.5 (23–35)
	Chest circumference (cm)	59	87	28.4±2.77	28 (21.5–34.5)
	Rohrer's ponderal index	61	90	2.44±0.21	2.43 (1.93–2.94)
Variation in weight at the end of hospitalization (g)	Total gain/loss	46	68	271.06±507.13	35.50 (–195–.965)
	Daily gain/loss	46	68	-1.33±17.66	2.43 (–48.75–5.71)
Variation in length at the end of hospitalization (cm)	Total gain/loss	35	52	2.32±3.24	1 (–3–11)
	Daily gain/loss	35	52	0.07±0.17	0.08 (–0.6–0.66)
Variation in head circumference at the end of hospitalization (cm)	Total gain/loss	34	50	2.14±2.59	1 (–0.5–8)
	Daily gain/loss	34	50	0.06±0.06	0.06 (–0.03–0.25)
Variation in chest circumference at the end of hospitalization (cm)	Total gain/loss	33	49	1.63±3.6	0.5 (–6–10.5)
	Daily gain/loss	33	49	-0.09±0.55	0.03 (–2.75–0.20)
Length of stay (days)	NICU	48	71	23.9±23.88	14.5 (1–89)
	Total	68	100	19.8±23.46	12 (2–89)
Admission diagnosis*	Prematurity	46	68	-	-
	Respiratory changes	44	65	-	-
	Behavior changes	33	49	-	-
	Presumed sepsis	32	47	-	-
	Hyaline membrane disease	26	38	-	-
	Cyanosis	15	22	-	-
	Other†	30	44	-	-

*% ∑ different from 100%, because a child could have more than one diagnosis for admission; % values calculated based on the 68 AGA-PTNs, regardless of need for hospitalization.

According to the information obtained regarding GA, 60% (n=41) confirmed prematurity by at least two techniques (LMP, US, and/or CE – criterion 1), 17% (n=12) had GA <36 weeks according to LMP (criterion 2) and 22% (n=15) had GA <36 weeks according to US (criterion 3). GA could not be determined by LMP in 27% (n=18) of the cases; in such instances, US was considered. Other information on GA, maternal age, length of stay, admission diagnosis, anthropometry at birth, as well as total and daily gains and losses in anthropometric measures during hospitalization, are shown in Table 1. Adolescent mothers (10 to <20 years) corresponded to 29% of the population. From the total of AGA-PTNs, it was observed that 29% (n=20) did not require hospitalization together with their mothers, and the main admission diagnoses were prematurity and respiratory changes.

Enteral and parenteral nutrition were identified as the main feeding modalities among these infants. BM was part of the diet, although in a limited way, but it was usually offered by suckling of maternal breast, which can be considered a positive factor (Table 2).

Comparisons between intrauterine growth curves and those observed at birth and postnatally are shown in Graphs 1 and 2. Table 3 exhibits the number of children/measures used for building the curves, stratified by GA. In Graph 1 it can be observed that the medians of the four anthropometric variables measured at birth were similar to the 50th percentile of the same measures in the reference intrauterine growth curves. The growth channel presented by the children from this study was above that of Lubchenco *et al*[16] and Usher and McLean[17] but below that of Margotto[19] at almost all

Table 2 - Dietary profile of the study population during postnatal hospitalization: Hospital São Sebastião, Viçosa, state of Minas Gerais, Brazil, 2006–2007

Characteristics		n	%	Mean±SD	Median (minimum–maximum)
Type of diet	None (days)	36	52.94	3.36±2.23	3 (1–11)
	None (%*)	36	52.94	16.85±17.26	11 (3.03–100)
	Parenteral (days)	25	36.76	13.56±10.32	10 (1–51)
	Parenteral (%*)	25	36.76	34.00±13.25	33 (7.14–60)
	Enteral† (days)	38	55.88	21.47±20.53	13 (1–76)
	Enteral† (%*)	38	55.88	56.78±23.6	63 (16.67–93.75)
	Oral (days)	67	98.52	7.57±6.87	5 (1–31)
	Oral (%*)	67	98.52	65.41±33.1	72 (12.66–100)
Food	Fluids (days)	42	64.61	11.45±7.46	11 (2–32)
	Fluids (%*)	42	64.61	54.83±27.24	52 (16.36–100)
	Parenteral diet (days)	25	36.76	13.56±10.32	10 (1–51)
	Parenteral diet (%*)	25	36.76	34.00±13.25	33 (7.14–60)
	Formula A (days)	3	4.61	27.67±6.42	25 (23–35)
	Formula A (%*)	3	4.61	42.49±12.66	42 (30.26–55.56)
	Formula B (days)	37	56.92	17.05±17.92	12 (1–68)
	Formula B (%*)	37	56.92	50.07±28.73	42 (5.26–100)
	Formula C (days)	49	75.38	6.24±7.84	5 (1–47)
	Formula C (%*)	49	75.38	50.86±29.77	50 (2.08–100)
	Breast milk (days)	55	84.61	5.04±4.52	3 (1–19)
	Breast milk (%*)	55	84.61	52.33±33.62	50 (2.22–100)
	Water (days)	3	4.61	5.00±4.35	3 (2–10)
	Water (%*)	3	4.61	32.75±43.81	9 (6.25–83.33)
Breastfeeding‡	Present (days)	49	89.09	2.80±2.13	2 (1–9)
	Present (%)	49	89.09	76.96±30.23	100 (15.79–100)

*Percent value higher than 100% because a child could use more than one modality; †enteral nutrition was administered using orogastric tubes; ‡considering only the children who received breast milk.

Table 3 - Sample number for the development of birth and postnatal curves for weight, length, head circumference, and chest circumference, from both genders, stratified by gestational age of the study population

Gestational age (weeks)	Birth*				Postnatal†			
	Weight	Length	Head circumference	Chest circumference	Weight	Length	Head circumference	Chest circumference
26	2‡	2‡	2‡	2	0§	0§	0§	0§
27	1‡	1‡	1‡	1	2‡	1‡	1‡	0§
28	5‡	2‡	2‡	2	3‡	0§	0§	0§
29	2	0§	1	1	8	3	3	2
30	1	1	1	1	10	5	5	3
31	2	2	2	2	11	4	4	2
32	7	6	6	6	13	3	3	3
33	7	7	6	6	16	5	5	3
34	18	17	16	17	22	11	10	10
35	14	14	14	13	32	17	18	14
36	9	9	8	8	33	15	14	10
37	-	-	-	-	10	3	3	1
38	-	-	-	-	6	2	1	2
39	-	-	-	-	5	2	2	2
40	-	-	-	-	3	2	2	2
Total of children/ measures	68	61	59	59	163	73	71	54
Total of included children/ measures	60	56	54	59	158	72	70	54
Total of excluded children/ measures	8	5	5	0	5	1	1	0

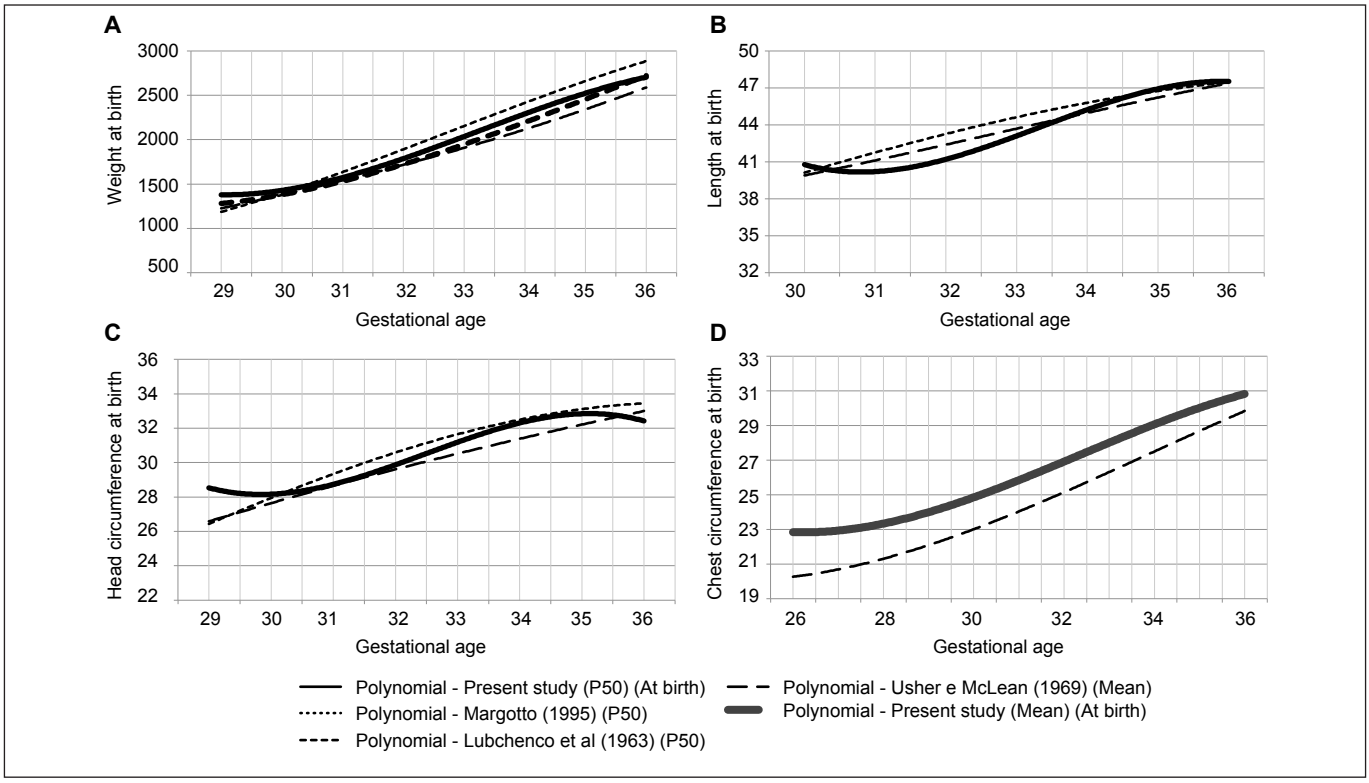
*Number of children included for each gestational age; †number of measures included for each gestational age; ‡data excluded due to the lack of information for comparison according to intrauterine growth curves; §: missing information on birth/postnatal measure

moments. However, the 50th percentile of postnatal curves for the same variables was similar to the 10th percentile or -2 of standard deviation (SD) of the reference intrauterine growth curves (Graph 2). The lower channel of the weight curve was even more remarkable when considered from 37th week of GA on.

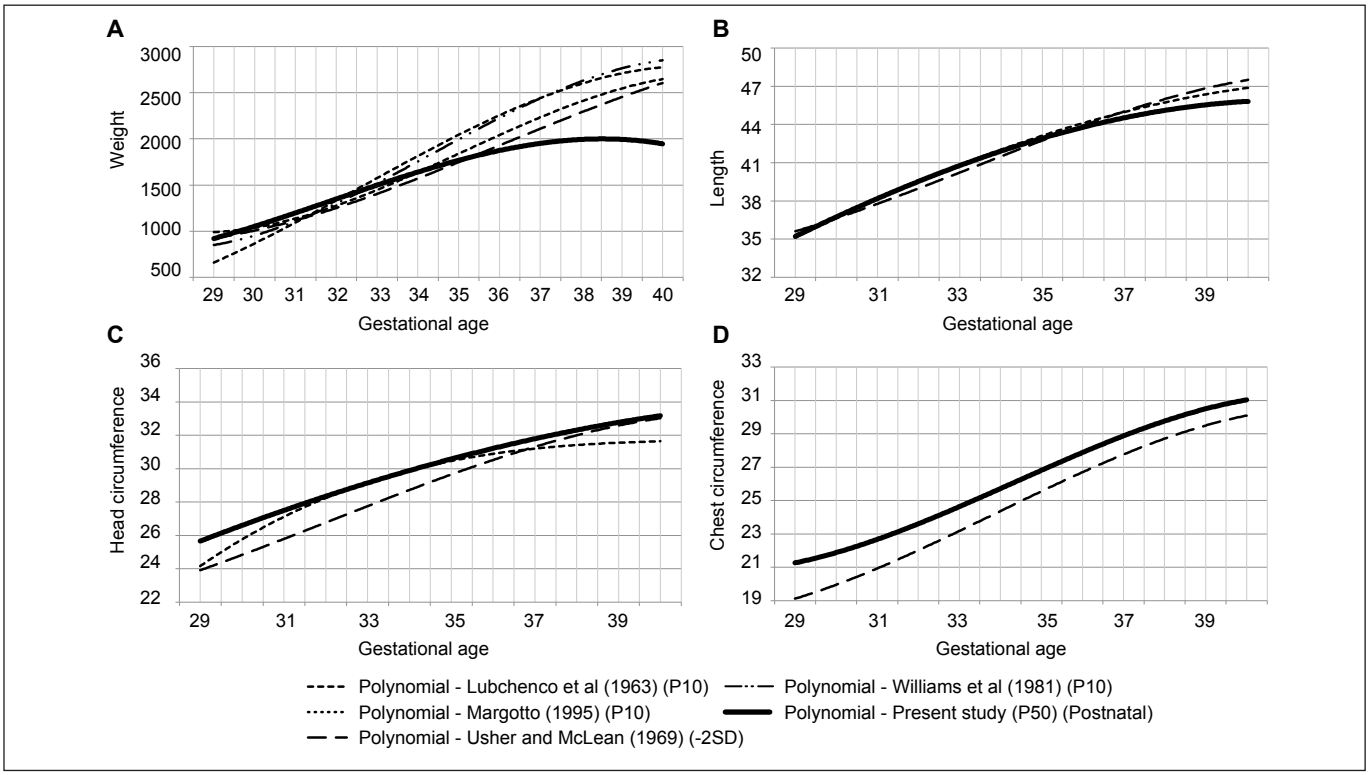
Discussion

Currently, there is an increasing trend of prematurity both in Brazil[24] and in other countries[25]. In the last decades, studies on postnatal growth of PTNs were hampered mainly by the barriers of inadequate enteral and parenteral feeding and inadequate perinatal care[9]. With the current development, PTNs are expected to grow in the extrauterine environment with similar gains to those observed in the intrauterine environment.

Cross-sectional curves of intrauterine growth have become an essential instrument in the NICU and are presented by several authors, who used representative sample sizes for their respective populations. The intrauterine growth curve of Lubchenco *et al*[16] was produced in Denver (Colorado, USA), far from sea level, and included the weight of 5,635 Caucasian children between 24 and 42 weeks of GA, not excluding those with diseases that affect intrauterine growth. Usher and McLean[17] assessed seven anthropometric measures in 300 Caucasian children born with 25 to 44 weeks of GA from Montreal (Quebec, Canada), a city situated at sea level. The curve of Williams *et al*[18] was built in California (USA), with a population of 2,288,806 children of different races and ethnic groups between 22 and 44 weeks of GA. Margotto[19], in turn, included three anthropometric measures (weight, length, and head circumference at birth) of 4,413 children from Brasília (Distrito Federal, Brazil) with GA between 29 and 44 weeks, considering the exclusion of interfering factors of fetal growth. Additionally, although it was not included in this study, the curve of Alexander *et al*[26] stands out for being broadly adopted in the United States and includes the weight of singe live births in 1991 (n=3,134,879)



Graph 1 - Comparison between intrauterine growth curves and weight, length, head circumference, and chest circumference measured at birth, for both genders, stratified by gestational age of the study population



Graph 2 - Comparison between intrauterine growth curves and postnatal weight, length, head circumference, and chest circumference, for both genders, stratified by gestational age of the study population

with GA between 20 and 44 weeks, children of mothers living in the country.

PTNs are expected to present maximal growth rate between 36 and 40 weeks of post-conceptional age, as well as catch-up growth by the age of two or three years, more specifically in the first six months, reaching the normal percentiles for full-term infants[10]. However, Graph 2 does not show a growth recovery dynamic similar to that described in catch-up growth, with regard to reference intrauterine growth curves, which suggests that this event tends to occur after the period covered in our study. Children's clinical conditions are inferred as a possible factor associated with the non-occurrence of catch-up in the present study: PTNs in better health conditions were possibly discharged and did not contribute to the data of this survey as much as children who required a longer hospital stay did. Therefore, these results should be interpreted with caution, bearing in mind that this is the discharge profile of PTNs and not their growth profile. In addition, it bears emphasizing that the adopted gold-standard (intrauterine growth curves) uses measures obtained at birth as a reference instead of postnatal measures referring to the development of preterm children.

Xavier *et al*[9] followed 141 AGA-PTNs with GA at birth between 26 and 36 weeks from birth until the postmenstrual age of 42 weeks. The average postnatal growth curves (weight, length, and head circumference) obtained in this study, when compared with intrauterine growth curves, showed to be similar to the 10th percentile of Lubchenco *et al*[16] for the 29th to 37th week, reaching average/median values between 40th and 42th postmenstrual weeks, which indicates a dynamic that characterizes growth recovery.

According to Rugolo[10], postnatal growth is characterized by an initial weight loss, followed by a recovery, whose intensity and duration are inversely related to GA, birth weight, and severity of newborn's clinical condition. Moreover, it is stated that extreme preterm infants admitted to the NICU present cumulative protein and energy deficiency in the first weeks of life and that in general, at the moment of hospital discharge, the anthropometric parameters of PTNs are below the lower normal percentile of the intrauterine growth curves, corroborating the findings of the present study[11,27].

An adequate environment is essential for a good prognosis for PTNs, allowing them to reach growth conditions similar to those of FTNs in the short term[9]. Unavoidably, nutrition and the identified pattern of growth become related. Besides the physiological and metabolic stress that directly affects nutritional needs, PTNs have a lower nutrient reserve at birth compared to FTNs. There is still controversy regarding the most appropriate diet for PTNs, with different information on their nutritional needs. However, such needs are not usually met, resulting in important nutritional deficits[27].

In general, healthy PTNs with GA >34 weeks are able to coordinate suckling, swallowing, and breathing, which allows the effective establishment of breastfeeding. This practice is not considered safe before that age because of neurological immaturity and respiratory compromise[27]. Bicalho-Mancini and Velásquez-Meléndez[28] found that, during hospital stay at a NICU, 77% of children were fed enterally and 20% parenterally. On the other hand, a lower use of enteral feeding (56%; n=38) and a higher use of parenteral feeding (37%; n=25) were observed in our study population compared with that of the above mentioned investigation.

In the present study, 85% of children received BM at some point during hospital stay, a similar value to that found at discharge from a NICU in Belo Horizonte, state of Minas Gerais, Brazil, before the implementation of the Baby Friendly Hospital Initiative policies (83%), and a lower value to that observed after their implementation (92%)[28]. Mean length of stay of the children analyzed in Belo Horizonte (before and after implementation) was 23.4±19.5 days, against a mean of 19.8±23.5 days in the present study. It bears stressing that the present study also included children who did not require hospitalization separated from their mothers. However, the presented data indicate that the median percentage of days of BM use calculated as a function of the length of stay was only 50% (2.2 to 100%), considering the children who received it at some point during hospitalization. PTNs admitted to the NICU and deprived of BM can therefore have intestinal colonization with an unbalanced microbiota, made up with resistant bacteria from that unit[29]. The WHO and the United Nations Children's Fund (Unicef) state that there is a duty to teach mothers how to begin or maintain lactation if separated from their children[28].

BM, whether administered enterally or orally, is the recommended nutrition for PTNs, including in some cases the need of BM with additives to provide the characteristic additional needs, and can come from the mother

or from a donor from the Human Milk Bank (HMB)[27]. PTNs may not receive protective levels of antibodies, which are transferred mostly after 34 weeks' gestation. Therefore, preterm infants are highly susceptible to infection, with a risk for sepsis inversely proportional to GA. The possibilities of intervention in this system are still very limited, but BM is composed of immunoglobulins, which are passively transferred from mothers to children and protects the latter while the maturation of their immune system is underway[29]. Hospital São Sebastião, in a partnership with UFV, has been developing, through the Breastfeeding Support Program (Programa de Apoio à Lactação, PROLAC), intervention protocols aiming at advising mothers and promoting breastfeeding by means of a maternity and outpatient approach. The building of the hospital's HMB began in December 2004; however, the effective beginning of its activities occurred only in July 2008, meaning that it was not fully working during the period of the present study.

The need of adopting a more critical and scientific approach to growth patterns and nutrition of preterm children should be reinforced, recognizing the importance and need of short-term and long-term follow-up of the growth of PTNs and allowing the implementation of follow-up care at the public health level[9].

The extrapolation of the present results and discussions warrants caution, because both are related to a study with a limited sample number that refers to characteristics of preterm infants treated at Hospital São Sebastião, in the city of Viçosa, selected by non-probabilistic sampling, and describes the profile of these children during postnatal hospitalization. However, we emphasize the importance of conducting studies in municipalities characterized as "small", considering that almost 90% of Brazilian municipalities have less than 50,000 inhabitants, according to the Brazilian Geography and Statistics Institute (Instituto Brasileiro de Geografia e Estatística, IBGE)[30].

Moreover, it bear emphasizing that 71% of the children from the present study required hospitalization at the NICU, and 72% were treated by the SUS, a fact that represents an important cost for the public health system, taking into account that great part of these expenses could be possibly avoidable with the reduction in preterm births. By means of the evaluation of a small sample of medical records of AGA-PTNs (n=7) and AGA-FTNs (n=5) born in the study period, the mean daily expenses from the moment of maternal admission until child's discharge are estimated to be R$ 323.47 for full-term infants and R$ 1,159.09 for preterm infants who needed NICU care. Therefore, the mean expenses are 3.58 times higher with the birth of a preterm child, who requires NICU admission, compared to those of full-term children. This analysis considered only the period before the children were discharged after birth, not considering thus essential expenses after this point.

Morley and Lucas[4], in an epidemiologic study, provided evidence that low weight until one year of age is associated with an increased risk for cardiovascular disease in adulthood, which suggests that growth in infancy may have a long-term influence. Moreover, other authors[12-14] demonstrated that prematurity is associated with the most prevalent chronic diseases of today. Therefore, besides the evident concern with the quality of life of these children, it is necessary to consider the long-term cost of prematurity, questioning: who will pay for this burden? How to pay for it?

In conclusion, the children evaluated in this study were born presenting anthropometric measures as expected by four intrauterine growth curves. However, further gains were insufficient and can affect the health prognosis of these patients. There is a need of greater inclusion of BM during the entire period of hospitalization, and it is necessary to evaluate the associations of dietary, medication and clinical profiles with the identified pattern of growth. In addition, the influence of these findings on the main health indicators of these children should be evaluated in the long-term. We emphasize the need of follow-up and care for preterm infants after discharge by basic care units, which are responsible for their place of living. The community health agents could act as an important bridge between prematurity and health.

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References

1. Romani SA, Lira PI. Determinant factors of infant growth. Rev Bras Saude Mater Infant 2004;4:15-23.
2. World Health Organization. Public health aspects of low birth weight. Technical Report Series, n. 217. Geneva: WHO; 1961.
3. World Health Organization. An evaluation of infant growth: the use and interpretation of anthropometry in infants. WHO Working Group on Infant Growth. Bull World Health Organ 1995;73:165-74.
4. Morley R, Lucas A. Randomized diet in the neonatal period and growth performance until 7.5-8 y of age in preterm children. Am J Clin Nutr 2000;71:822-8.
5. Tucker J, McGuire W. ABC of preterm birth: Epidemiology of preterm birth. BMJ 2004;329:675-8.
6. Motta ME, Silva GA, Araújo OC, Lira PI, Lima MC. Does birth weight affect nutritional status at the end of first year of life? J Pediatr (Rio J) 2005;81:377-82.
7. Olinto MT, Victora CG, Barros FC, Tomasi E. Determinants of malnutrition in a low-income population: hierarchical analytical model. Cad Saude Publica 1993;9 (Suppl 1):S14-27.
8. Casey PH, Kraemer HC, Bernbaum J, Yogman MW, Sells JC. Growth status and growth rates of a varied sample of low birth weight, preterm infants: a longitudinal cohort from birth to three years of age. J Pediatr 1991;119:599-605.
9. Xavier CC, Abdallah VO, Silva BR, Mucillo G, Jorge SM, Barbieri MA. Growth of preterm infants. J Pediatr (Rio J) 1995;71:22-7.
10. Robertson C. Catch-up growth among very-low-birth-weight preterm infants: a historical perspective. J Pediatr 2003;143:145-6.
11. Rugolo LM. Growth and developmental outcomes of the extremely preterm infant. J Pediatr (Rio J) 2005;81 (Suppl 1):S101-10.
12. Barker DJ, Winter PD, Osmond C, Margetts B, Simmonds SJ. Weight in infancy and death from ischaemic heart disease. Lancet 1989;2:577-80.
13. Silveira PP, Portella AK, Goldani MZ, Barbieri MA. Developmental origins of health and disease (DOHaD). J Pediatr (Rio J) 2007;83:494-504.
14. Simmons RA. Developmental origins of adult disease. Pediatr Clin North Am 2009;56:449-66.
15. Lopes JM. Crescimento fetal e neonatal. Por que não utilizar curvas nacionais? J Pediatr (Rio J) 1995;72:3-4.
16. Lubchenco LO, Hansman C, Dressler M, Boyd E. Intrauterine growth as estimated from liveborn birthweight data at 24 to 42 weeks of gestation. Pediatrics 1963;32:793-800.
17. Usher R, McLean F. Intrauterine growth of live-born Caucasian infants at sea level: standards obtained from measurements in 7 dimensions of infants born between 25 and 44 weeks of gestation. J Pediatr 1969;74:901-10.
18. Williams RL, Creasy RK, Cunningham GC, Hawes WE, Norris FD, Tashiro M. Fetal growth and perinatal viability in California. Obstet Gynecol 1982;59:624-32.
19. Margotto PR. Intrauterine growth curves: study of 4413 single live births of normal pregnancies. J Pediatr (Rio J) 1995;71:11-21.
20. Capurro H, Konichezky S, Fonseca D, Caldeyro-Barcia R. A simplified method for diagnosis of gestational age in the newborn infant. J Pediatr 1978;93:120-2.
21. Ballard JL, Khoury JC, Wedig K, Wang L, Eilers-Walsman BL, Lipp R. New Ballard score, expanded to include extremely premature infants. J Pediatr 1991;119:417-23.
22. Moutquin JM. Classification and heterogeneity of preterm birth. BJOG 2003;110 (Suppl 20):30-3.
23. Euclydes MP. Nutrição do lactente: base científica para uma alimentação saudável. 3rd ed. Viçosa: UFV; 2005.
24. Silveira MF, Santos IS, Barros AJ, Matijasevich A, Barros FC, Victora CG. Increase in preterm births in Brazil: review of population-based studies. Rev Saude Publica 2008;42:957-64.
25. Tucker J, McGuire W. ABC of preterm birth: epidemiology of preterm birth. BMJ 2004;329:675-8.
26. Alexander GR, Himes JH, Kaufman RB, Mor J, Kogan M. A United States national reference for fetal growth. Obst Gynecol 1996;87:163-8.
27. McGuire W, Henderson G, Fowlie PW. ABC of preterm birth: feeding the preterm infant. BMJ 2004;329:1227-30.
28. Bicalho-Mancini PG, Velásquez-Meléndez G. Exclusive breastfeeding at the point of discharge of high-risk newborns at a neonatal intensive care unit and the factors associated with this practice. J Pediatr (Rio J) 2004;80: 241-8.
29. Mussi-Pinhata MM, Rego MA. Immunological peculiarities of extremely preterm infants: a challenge for the prevention of nosocomial sepsis. J Pediatr (Rio J) 2005;81 (Suppl 1):S59-68.
30. Brasil. Ministério do Planejamento, Orçamento e Gestão. Instituto Brasileiro de Geografia e Estatística. Pesquisa de informações básicas municipais: perfil dos municípios brasileiros. Rio de Janeiro: IBGE; 2009.