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Original articles

Oral motor skills and growth of premature babies in their first two years of life

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ABSTRACT

Purpose: to analyze the development of oral motor skills of premature babies in their first 2 years of life and relate them to growth.

Methods: a longitudinal study conducted in a hospital in Southern Brazil with 40 premature babies at birth and 4, 6, 12, 18, and 24 months of corrected age. Anthropometric and oral motor skills were assessed using the Schedule for Oral Motor Assessment. Mean and standard deviation were used to describe the distribution of variables. The comparison between study variables was performed using Student's t-test. Statistical significance was set at $\leq$ 0.05.

Results: the mean gestational age at birth was 32.47 weeks. The corrected age at 4 months was 3.37 months, and 82.5% of the sample was already receiving complementary feeding and had oral motor dysfunction, which later evolved to normal. Growth was significantly associated with oral motor function for solid food at 12 months. Children with normal oral motor functions had better Z scores for weight-for-age, weight-for-height, and body mass index-for-age than those with oral motor dysfunction.

Conclusion: oral motor dysfunction predominated in preterm babies at 4 months of corrected age. However, at 6 months of corrected age, preterm babies already had adequate oral motor function for different food consistencies and maintained favorable evolution in this skill until the end of the second year of corrected age. Babies with adequate oral motor function had better growth indicators at 12 months, justifying early speech-language-hearing intervention in preterm babies' oral skills.

Keywords: Infant, Premature; Nutritional Status; Infant Nutrition; Feeding Behavior

A study conducted at the Universidade Federal de Santa Maria, Santa Maria, RS, Brazil.

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INTRODUCTION

Premature birth interrupts intrauterine development, causing the preterm newborn (PTNB) to require the help of a multidisciplinary team to adapt to the external environment[1,2]. These issues include feeding difficulties due to neurological immaturity, abnormal muscle tone, depressed oral reflexes, general weakness, and self-regulation difficulties. All these difficulties can decrease the quality of oral motor skills, interfering with the sucking-swallowing-breathing coordination[3,4].

Due to the need for special care and the global immaturity of the stomatognathic system, PTNBs are more likely to have feeding difficulties in the early stages of development. Small difficulties that may be considered almost unimportant, when combined, constitute a larger clinical problem and may indicate serious functional imbalances. These may be reflected in the overall development of the organism, with abnormalities in more advanced growth and development stages[5-8].

Regardless of gestational age, premature babies may present changes in the stomatognathic system, such as decreased tone and strength, interfering with the mobility of the lips, tongue, and jaw[3,5,6], which affect the feeding process[9]. Neonatal procedures, generally adopted during admission to the intensive care unit (ICU) (e.g., orotracheal intubation and prolonged tube use), associated with early weaning in many cases, may be related to problems in oral motor development, triggering malocclusion, mouth breathing, and orofacial motor changes[3,5,10-12].

The immaturity of the stomatognathic system and oral motor skills can also help trigger nutritional and growth deficits. Many PTNBs have abnormal muscle tone and oral reflexes and difficulty regulating organizational states, impacting oral feeding[5].

Studies on the development of oral motor skills in the PTNBs' first years of life are still scarce. However, knowledge on this subject is of great importance, because early assessment and intervention can reduce future eating problems and nutritional difficulties, optimizing their growth and development[5].

The presence of morbidities of different levels makes adequate monitoring after hospital discharge an extension of the care provided in the neonatal ICU (NICU). The concern of professionals and family members in identifying changes resulting from premature birth led to the creation of follow-up programs for these children, which mostly extend until 2 years of age. Developed countries have increasingly observed neurodevelopmental abnormalities. However, Brazilian data are still scarce[1,13].

It is not easy to establish the prognosis of PTNBs because of the complex interaction of biological and environmental factors acting on their immature and vulnerable brain[1,2,13-15]. Nevertheless, follow-up studies of premature babies are important to elucidate possible differences in the development of preterm and full-term children throughout childhood in different areas and situations[13].

Supervised and interdisciplinary monitoring of premature babies is an investment in survival, favoring lower new hospitalization rates, lower infection rates in the first years of life, and better growth and neurodevelopment rates. These can improve the premature baby's prognosis and reduce public health spending[5,13].

Thus, this study aimed to analyze the development of oral motor skills of premature babies in their first 2 years of life and relate it to growth.

METHODS

This work met all the ethical criteria of Resolution 466/2012 of the Brazilian National Research Ethics Commission. It presented an informed consent form and a data confidentiality agreement and was approved by the ethics committee of the Federal University of Santa Maria, RS, Brazil, (REC approval number: 1.861.614 and CAEE approval number: 11155312.7.0000.5346).

This is a prospective, descriptive, quantitative, longitudinal study. The convenience sample consisted of 40 preterm children of both sexes, followed up until 24 months of corrected age in a public hospital in inland Rio Grande do Sul from 2014 to 2018.

The babies' study inclusion criteria were as follows: being born prematurely, being admitted to the NICU, and being followed up in the Premature Baby Follow-up Program of the hospital where the study was conducted. The exclusion criteria were perinatal asphyxia (5-minute Apgar score ≤ 5); head and neck malformation; genetic syndromes; grade III and IV intracranial hemorrhage diagnosed by cranial ultrasound; and bilirubin encephalopathy diagnosed by the medical team.

The children's chronological age was corrected using the Friedman and Baurnbaun formula[16]: corrected age = chronological age - (40 weeks - gestational age at birth).

Data were collected in a follow-up outpatient clinic, evaluating the children at six different moments: hospital admission/birth (moment 1 – M1), only to characterize the sample; at 4 months (moment 2 – M2); 6 months (moment 3 – M3); 12 months (moment 4 – M4); 18 months (moment 5 – M5); and 24 months of corrected age (moment 6 – M6), with a margin of 15 days.

Birth data were collected from medical records to characterize the sample. M2 to M6 assessments were performed in an outpatient clinic for monitoring premature babies. An experienced nutritionist performed anthropometric assessments, and a speech-language-hearing pathologist trained in the instrument used and experienced in evaluating babies assessed their oral motor skills.

The anthropometric assessment included the measurement of weight, length, and head circumference (HC). Weight was measured with the infant naked. The anthropometric assessment instruments were calibrated as recommended by the Brazilian Technical Standard of the Food and Nutrition Surveillance System – Food and Nutrition Surveillance System (SISVAN, in Portuguese)[17].

Weight was measured in grams using a Mic Baby® digital scale, exclusively for weighing babies, with a minimum of 5 g and a maximum of 15 kg. Length was measured in centimeters with the newborn in the supine position on a rigid surface, using a plastic ruler (approximately 0.1 cm), with one end fixed (cephalic) and the other movable (foot). The assistance of another person from the team was necessary to position the child properly. HC was measured in centimeters using a non-stretchable tape measure (approximately 0.1 cm), considering the largest occipitofrontal diameter.

Growth was monitored from the corrected age of 40 weeks (corresponding to birth), using the growth curves of the World Health Organization (WHO). The Z-scores of the anthropometric indicators weight-for-age (W/A), height-for-age (H/A), head circumference-for-age (HC/A), weight-for-height (W/H), and body mass index-for-age (BMI/A) were calculated at this age, considered full-term. The nutritional status classification followed that recommended by SISVAN[18], namely: W/A: very low, low, adequate, and high weight for age; H/A: very low, low, and adequate stature; HC/A: above, adequate, below; W/H and BMI/A: thin, normal-weight, risk of overweight, overweight, and obesity.

Oral motor skills were assessed using the Schedule for Oral Motor Assessment (SOMA) instrument[19]. SOMA was developed to objectively classify oral motor skills in pre-verbal children, helping to identify areas of dysfunction that may contribute to feeding difficulties. The instrument can be administered without special equipment and takes approximately 20 minutes to complete.

Oral motor skills are assessed using different food consistencies (liquid, pureed, semi-solid, solid, and crackers) and utensils (spoon, baby bottle, cup, and training cup). However, if a certain type of food is considered inappropriate to offer, the test may be performed with other types of food, depending on the child's age and preference. The items evaluated are answered with "yes" or "no" per diet category to measure the results. Each diet category presents a score to define the level of abnormal and normal motor function. The test helps to distinguish skills at closer levels of functioning, such as jaw, lips, tongue, and food control in the oral cavity.

The assessment instrument recommends the following foods per consistency: fruit and vegetable puree (pureed), sliced bread without crust (semi-solid), seaweed candy without added sugar (solid), crackers (cracker), and water (liquid).

SOMA was applied at 4, 6, 12, 18, and 24 months of corrected age (M2 to M6):

- M2 – 4 months corrected age (assessed consistency: pureed).
- M3 – 6 months corrected age (assessed consistency: pureed, semi-solid, training cup, cup with liquid).
- M4 – 12 months corrected age (consistency assessed: semi-solid, cup with liquid, cracker, solid).
- M5 – 18 months corrected age (consistency assessed: cup with liquid, cracker, solid).
- M6 – 24 months corrected age (consistency assessed: cup with liquid, cracker, solid).

The data were entered and stored in a database created in Microsoft Office Excel 2016, and the analyses were conducted in the Statistical Package for the Social Sciences (SPSS), version 23.0. The normality of the variables was verified using the Shapiro-Wilk test. Measures of central tendency (mean and standard deviation) were used to describe the distribution of the variables. The study variables were compared with Student's t-test. The level of statistical significance was set at ≤ 0.05.

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RESULTS

The study followed up 40 premature babies in the follow-up clinic at 4 months, 6 months, 12 months, 18 months, and 24 months of corrected age. Their mean gestational age was 32.47±1.90 weeks (minimum of 28 and maximum of 35), and their mean birth weight was 1633.87 (±467.53) grams.

The oral feeding skills assessed by SOMA with the different consistencies from M2 to M6 are presented in Table 1.

Table 1. Oral feeding skills in preterm babies from 4 to 24 months corrected age

Variables	4 mos N (%)	6 mos N (%)	12 mos N (%)	18 mos N (%)	24 mos N (%)
SOMA (pureed)					
FMON	7 (17.5)	27 (67.5)	-	-	-
DMO	33 (82.5)	13 (32.5)	-	-	-
SOMA (semisolid)					
NOMF	-	34 (85)	37 (95.9)	-	-
OMD	-	6 (15)	2 (5.1)	-	-
SOMA (training cup)					
NOMF	-	38 (95)	-	-	-
OMD	-	2 (5)	-	-	-
SOMA (cup with liquid)					
NOMF	-	29 (72.5)	34 (87.2)	37 (94.9)	38 (97.4)
OMD	-	11 (27.5)	5 (12.8)	2 (5.1)	1 (2.6)
SOMA (cracker)					
NOMF	-	-	38 (97.4)	39 (97.5)	39 (97.5)
OMD	-	-	1 (2.6)	1 (2.5)	1 (2.5)
SOMA (solid–candy)					
NOMF	-	-	35 (89.7)	37 (92.5)	40 (100)
OMD	-	-	4 (10.3)	3 (7.5)	-

Values expressed in N and percentage (%)
Captions: SOMA = Schedule for Oral Motor Assessment (Reilly et al., 1995) / NOMF = normal oral motor function / OMD = oral motor dysfunction / mos. = months / N = number of premature babies
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At 4 months of corrected age, 82.5% of newborns had already started complementary feeding, with a mean chronological age of 5.35 (±1.29) and corrected age of 3.37 (±1.27) months. Oral motor dysfunction (OMD) occurred in the same percentage.

Tables 2 to 5 show the babies' growth pattern regarding their oral motor skills, comparing the average growth Z score with the presence of normal oral motor skills or OMD, at different moments (M2 to M6).

Table 2. Comparison of mean Z-scores for growth of premature babies regarding normal oral motor function and oral motor dysfunction for puree food at four months of corrected age

	Z-scores (mean±SD)		
	4 mos. – SOMA Puree		
	NOMF (n=7)	OMD (n=33)	p-value
W/A	-1.00±1.36	-0.39±0.92	0.152
H/A	-0.72±1.56	-0.19±1.36	0.368
W/H	-0.51±1.25	-0.23±0.82	0.455
BMI/A	-0.71±1.29	-0.36±0.83	0.363
HC/A	-0.20±0.78	0.19±1.36	0.460

Student's t-test (2 groups) / #p-value ≤ 0.05 /
Captions: NOMF = normal oral motor function / OMD = oral motor dysfunction / W/A = weight-for-age / H/A = height-for-age / W/H = weight-for-height / BMI/A = body mass index-for-age / HC/A = head circumference-for-age / n = number of premature babies / SD = standard deviation / mos. = months
.

Table 3. Comparison of mean Z-scores for growth of premature babies regarding the presence of normal oral motor function and oral motor dysfunction for pureed, semi-solid food, training cup, and cup with liquid at six months of corrected age

	Z scores (mean±SD)											
	6 mos. - SOMA Pureed			6 mos. - SOMA Semi-solid			6 mos. - SOMA Training cup			6 mos. - SOMA Cup with liquid		
	NOMF (n=27)	OMD (n=13)	p-value	NOMF (n=34)	OMD (n=6)	p-value	NOMF (n=38)	OMD (n=2)	p-value	NOMF (n=29)	OMD (n=11)	p-value
W/A	-0.16±0.78	-0.57±1.12	0.188	-0.29±0.88	-0.33±1.16	0.922	-0.29±0.92	-0.41±0.75	0.858	-0.27±1.02	-0.35±0.57	0.755
H/A	0.10±1.38	-0.66±1.19	0.093	-0.16±1.35	-0.02±1.49	0.818	-0.14±1.35	-0.15±1.99	0.996	-0.12±1.43	-0.19±1.20	0.891
W/H	-0.17±0.75	-0.13±0.84	0.884	-0.15±0.79	-0.18±0.67	0.922	-0.15±0.78	-0.26±0.50	0.846	-0.14±0.84	-0.19±0.57	0.865
BMI/A	-0.27±0.74	-0.24±0.86	0.918	-0.25±0.78	-0.32±0.77	0.833	-0.25±0.79	-0.41±0.48	0.784	-0.24±0.85	-0.31±0.55	0.792
HC/A	0.42±1.19	-0.28±1.36	0.103	0.14±1.24	0.50±1.56	0.535	0.18±1.28	0.40±1.70	0.818	0.18±1.26	0.21±1.37	0.948

Student's t-test (2 groups) / # p-value ≤ 0.05 /
Captions: NOMF = normal oral motor function / OMD = oral motor dysfunction / W/A = weight-for-age / H/A = height-for-age / W/H = weight-for-height / BMI/A = body mass index-for-age / HC/A = head circumference-for-age / n = number of premature babies / SD = standard deviation / mos. = months
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Table 4. Comparison of mean Z-scores for growth of premature babies regarding the presence of normal oral motor function and oral motor dysfunction for semi-solid food, cup with liquid, and solid food at 12 months of corrected age

	Z scores (mean±SD)								
	12 mos. - SOMA Semi-solid			12mos. - SOMA Cup with liquid			12 mos. - SOMA Solid		
	NOMF (n=37)	OMD (n=2)	p-value	NOMF (n=34)	OMD (n=5)	p-value	NOMF (n=35)	OMD (n=4)	p-value
W/A	-0.00±0.89	0.17±0.75	0.790	0.05±0.84	-0.42±1.12	0.266	0.11±0.81	-1.10±0.77	0.007#
H/A	0.03±0.97	0.46±0.53	0.542	0.05±1.01	0.05±0.48	0.995	0.09±1.00	-0.29±0.39	0.447
W/H	-0.03±0.99	-0.51±0.70	0.507	0.02±0.90	-0.62±1.33	0.165	0.09±0.87	-1.34±1.02	0.004#
BMI/A	-0.05±1.03	-0.61±0.62	0.461	-0.00±0.96	-0.64±1.31	0.191	0.05±0.99	-1.32±1.04	0.009#
HC/A	0.44±1.27	1.99±0.40	0.099	0.55±1.25	0.37±1.67	0.773	0.62±1.18	-0.30±1.98	0.175

Student's t-test (2 groups) / # p-value ≤ 0.05 /
Captions: NOMF = normal oral motor function / OMD = oral motor dysfunction / W/A = weight-for-age / H/A = height-for-age / W/H = weight-for-height / BMI/A = body mass index-for-age / HC/A = head circumference-for-age / n = number of premature babies / SD = standard deviation / mos. = months
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Table 5. Comparison of mean Z-scores for growth of premature babies regarding the presence of normal oral motor function and oral motor dysfunction for cups with liquid and solid food at 18 months of corrected age

	Z scores (mean±SD)					
	18 mos. - SOMA Cup with liquid			18 mos. - SOMA Solid		
	NOMF (n=37)	OMD (n=2)	p-value	NOMF (n=37)	OMD (n=3)	p-value
W/A	0.07±0.97	-0.15±1.13	0.757	0.11±0.95	-0.78±0.57	0.118
H/A	-0.02±0.96	0.02±1.44	0.950	0.03±0.95	-0.25±1.55	0.622
W/H	0.10±1.18	-0.21±0.60	0.709	0.13±1.17	-0.88±0.35	0.149
BMI/A	0.13±1.20	-0.21±0.40	0.689	0.15±1.19	-0.87±0.59	0.156
HC/A	0.47±0.94	-0.20±1.19	0.335	0.41±0.92	1.00±1.20	0.300

Student's t-test (2 groups) / # p-value ≤ 0.05 /
Captions: NOMF = normal oral motor function / OMD = oral motor dysfunction / W/A = weight-for-age / H/A = height-for-age / W/H = weight-for-height / BMI/A = body mass index-for-age / HC/A = head circumference-for-age / n = number of premature babies / SD = standard deviation / mos. = months
.

Growth was statistically significantly associated with oral motor function with solid food at 12 months. In other words, children with normal oral motor function (NOMF) had better Z scores for W/A, W/H, and BMI/A than those with OMD ($p \leq 0.05$).

DISCUSSION

The analysis of the oral motor skills development of premature babies in the first 2 years of life in relation to growth found that oral motor skills at M2 (4 months) were altered in most premature babies evaluated. This reinforces the recommendation not to offer complementary foods to milk before 6 months. This procedure is recommended for complementary feeding, respecting the corrected age and other aspects of the child's development, readiness, and interest in feeding[13,20,21]. The premature babies' OMD had decreased at 6 months, corroborating the recommendation of introducing complementary feeding at this age. Almost the entire sample had NOMF at 12 and 24 months. All babies had NOMF for solid food at 24 months.

The authors of another study investigating the association between OMD and feeding difficulties while introducing food to PTNBs found that most infants began introducing food at 6 months and that mothers reported some feeding difficulties. The study showed that extreme prematurity was associated with defensive feeding behavior and the initial introduction of liquid foods in complementary feeding, whereas OMD was not associated with feeding difficulties[22]. Other authors, however, did not identify any difference in oral motor function when comparing food introduction between preterm and full-term infants. On the other hand, they observed that bottle feeding and invasive oral procedures are important predictors of OMD in infants[23].

SOMA, developed and validated by Reilly et al.[19], is an objective tool developed to assess the oral motor skills of infants aged 6 months (when complementary feeding begins) until 24 months old (when they reach mature oral motor skills). Although this protocol was not developed and validated for PTNBs, it has been applied to this population[24-26].

SOMA results were compared to those obtained by the Preterm Oral Feeding Readiness Scale (POFRAS) in a group of PTNBs at the beginning of oral feeding. The results showed that SOMA can be a complementary instrument in the evaluation of oral motor function in preterm babies, adding helpful information in determining feeding difficulties in this group of children. The authors showed that all PTNBs evaluated who were ready to start the oral route had NOMF, and those who had OMD were not ready[24].

Few studies in the literature have assessed preterm babies' oral motor skills longitudinally. The authors of a study assessing the development of oral motor feeding skills in preterm infants in the first year of life using SOMA found a satisfactory percentage of children with NOMF at 4, 6, and 12 months in all assessments. This result was found with different food consistencies, although with some specific episodes of immaturity, such as abnormal lip seal. The authors emphasized that oral skills development is a sequential and continuous process[25]. The authors of another study using the same assessment instrument found that preterm infants aged 10 to 12 months had a delay in oral skills for solid and semi-solid foods in comparison with their full-term peers. Moreover, they found that oral motor development was related to gross motor development[26].

Based on these studies and the findings of the present one, it is suggested that SOMA may be an appropriate instrument for observing the presence of NOMF or OMD in the follow-up of premature babies. By considering different consistencies and utensils, this resource may help guide families on how to deal with or adjust possible changes in feeding, thus avoiding greater harm to the premature baby's overall development.

Growth could not be related to oral motor skills at some assessment moments because one of the groups (with NOMF or OMD) had only one or no individuals. These moments were SOMA at 12 months and 18 months in the assessment with cracker; and SOMA at 24 months in the assessments with cup with liquid, cracker, and solid (candy).

Regarding growth indicators, there was no statistically significant difference between infants with NOMF and OMD. However, in the evaluation of solid food at 12 months, children with OMD had lower Z-scores for W/A, W/H, and BMI/A than premature babies with NOMF. This finding may be associated with the hypothesis of this study, that an adequate growth pattern is associated with better oral motor function, although this was only observed at 12 months of age.

Researchers[27] evaluated PTNBs' oral motor skills in relation to oral feeding and growth during their NICU stay. They found that their level of oral skills had a positive impact on the transition from tube feeding to full oral feeding and on their hospital stay. However, no relationship was observed with growth, represented by weight gain during this period.

Few studies have evaluated PTNBs' oral motor skills longitudinally. Studies that compare these skills with growth are even scarcer, reinforcing the need for more research with this population and topic.

However, it is known that premature birth disrupts the metabolic-endocrine maintenance of the immature fetus, with consequences for its growth and body composition. Weight gain in this specific population may be a critical contributor to chronic diseases in the short and long term. Establishing ideal growth trajectories and timely referral to health professionals can be of great value in clinical practice[28,29].

The growth rates of premature babies, considering weight and height, are significantly lower than in full-term newborns, especially during the first 3 months of life. Weight gain plays a decisive role in adequate growth. Hence, feeding should begin early, and the mothers of newborns should receive health education and feeding guidance to minimize the consequences of low weight gain[30,31].

It is important to note that oral motor intervention in the NICU is extremely important for improving the oral feeding of premature infants and is associated with reduced hospital stay, increased weight gain, benefits for behavioral regulation, and better oral motor control[32-34]. These findings reinforce the need for further studies to identify detailed and effective intervention processes for more assertive clinical practice. Furthermore, breastfeeding tends to improve oral motor development, in addition to several other benefits for newborns. It should be encouraged during neonatal hospitalization of premature infants, with specialized support after hospital discharge as well, so that it is maintained for the recommended time[20].

One of the main contributions of this study is to highlight the OMD of premature infants at 4 months of corrected age, thus justifying, from the standpoint of oral motor development, that oral feeding of premature infants should not be initiated early. Additionally, the relevance of multidisciplinary action in the follow-up of premature babies should be considered, including speech-language-hearing pathologists in the team, besides the aspects related to auditory and communication development. This professional has much to contribute to oral motor development, so that breastfeeding and complementary feeding are safe and enjoyable for the infant and family[35], also favoring growth through better oral motor skills.

The development of oral skills and lip, tongue, and cheek structures through the infant's comfortable experiences and sensations provides excellent training and learning of the most varied movements necessary for feeding. Furthermore, early identification of oral limits that may prevent or hinder the child's feeding ensures the chance for the child to develop a positive relationship with food, minimizing the risks of food selectivity and pediatric feeding disorder[35].

Authors demonstrated through a cohort of premature babies that this population has an increased risk of oral motor problems and selective feeding at 2 years of corrected age[36]. Thus, the adequate development of oral motor skills contributes to PTNBs' development[5,37].

The importance of monitoring the PTNB is essential to guide conduct, because when better guidelines are made early, they can enhance more favorable outcomes and reduce problems. This contributes to public healthcare measures to prevent problems in premature children, helping reduce health problems and costs.

Specifically, regarding aspects of growth pattern and oral motor skills, the findings of the present study may favor outpatient follow-up by reviewing procedures and protocols, especially concerning the time to introduce complementary feeding and speech-language-hearing intervention.

CONCLUSION

OMD predominated in premature infants at 4 months of corrected age. Premature infants already had adequate oral motor function for different food consistencies at 6 months of corrected age and maintained favorable development in this skill until the end of the second year of corrected age.

Regarding growth, newborns with OMD had lower Z-scores than those with NOMF at 12 months – i.e., in this age group, infants with NOMF had better growth indicators, justifying early speech-language-hearing intervention in the oral skills of premature babies.

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Data Sharing Statement:

All data relevant to the study are included in the article or uploaded as supplementary information.