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Comparison of cognitive skills of children to term and pre-term

Comparação de habilidades cognitivas de crianças a termo e pré-termo

Comparación de habilidades cognitivas de niños a término y pre-término

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Abstract

Introduction: Cognition is a set of mental skills essential to acquiring knowledge. It is during the first three years of life that great advances in cognitive development occur. This development is directly related to the nutritional, socioeconomic aspects, educational level of the family and family dynamics. Premature children are at risk for a change in the cognitive development process. **Objective:** To verify cognitive development in 20 preterm infants. **Method:** It is an observational and cross-sectional study. The sample consisted of 20 full-term infants and 20 preterm infants. Those responsible for the children answered a questionnaire, containing information regarding the participant's medical history and socioeconomic data. It was applied to the subpart of the Bayley III scale regarding cognitive abilities. Data analysis was performed using the Mann-Whitney statistical test, presented in quantitative data of means, standard deviation and alpha (p-value). **Results:** When analyzing the scores of the cognitive abilities of the groups it was observed that 16 children (80 %) had 2 below-average scores, 1 (5%) on average and 3 (15%) above the expected age-for-age. The preterm group obtained 13 children (65%) with below-average scores, 1 (5%) in the mean and 6 (30%) above the mean, noting that the premature group presented better results. There was no significant difference between the means of the two groups of the present study in relation to none of the variables. **Conclusion:** There was no statistical difference in cognitive performance between the groups in this age group. It should be considered that the performance of the participants may change in another age group.

Keywords: Cognition; Prematurity; Bayley III Scale; Child Development.

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Authors' contributions:
LGMT: Study design and data collection; CMP: Project and study design; ASS: Data collection and study review; ARLS: Data collection.

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Resumo

Introdução: A cognição é um conjunto de habilidades mentais essenciais para se adquirir conhecimento. É durante os três primeiros anos de vida que ocorrem os grandes avanços no desenvolvimento cognitivo. Este desenvolvimento está diretamente ligado aos aspectos nutricionais, socioeconômicos, nível educacional da família e à dinâmica familiar. Crianças pré-termo têm risco para alteração no processo do desenvolvimento cognitivo. **Objetivo**: Verificar o desempenho cognitivo em 20 crianças pré-termo. **Método:** É um estudo observacional e transversal. A amostra foi composta por 20 crianças nascidas a termo e 20 nascidas pré-termo. Os responsáveis pelas crianças responderam a um questionário contendo informações referentes à história clínica do participante e dados socieconômicos. Foi aplicada a subparte da escala Bayley III referente às habilidades cognitivas. A análise dos dados foi realizada pelo teste estatístico de *Mann-Whitney*, apresentados em dados quantitativos de médias, desvio padrão e alfa (p-valor). **Resultados:** Ao analisar as pontuações das habilidades cognitivas dos grupos observou-se que 16 crianças (80%) encontravam-se com pontuações abaixo da média, 1 (5%) na média e 3 (15%) acima da média esperada para a idade. O grupo pré-termo obteve 13 crianças (65%) com pontuações abaixo da média, 1 (5%) na média e 6 (30%) acima da média, notando-se que o grupo pré-termo apresentou melhores resultados. Não houve diferença significativa entre as médias dos dois grupos do presente estudo em relação a nenhuma das variáveis. **Conclusão:** Não houve diferença estatística no desempenho cognitivo entre os grupos nesta faixa etária. Deve-se considerar que os desempenhos dos participantes poderão mudar em outra faixa etária.

Palavras-chave: Cognição; Prematuridade; Escala Bayley III; Desenvolvimento Infantil.

Resumen

Introducción: La cognición es un conjunto de habilidades mentales esenciales para adquirir conocimiento. Es durante los tres primeros años de vida que ocurren los grandes avances en el desarrollo cognitivo. Este desarrollo está directamente ligado a los aspectos nutricionales, socioeconómicos, nivel educativo de la familia y la estimulación favorecida en la relación familiar. Los niños prematuros tienen valor predictivo para cambiar el proceso en el desarrollo cognitivo. **Objetivo:** Verificar el desarrollo cognitivo en 20 niños prematuros. **Método:** Es un estudio observacional y transversal. La muestra fue compuesta por 20 niños nacidos a término y 20 nacidos de pre-término. Los responsables de los niños respondieron a un cuestionario, conteniendo informaciones referentes a la historia clínica del participante y datos socieconómicos. Se aplica la prueba equivalente a las habilidades cognitivas de la escala Bayley III. El análisis de los datos fue realizado por los test estadísticos de Mann-Whitney, presentados en datos cuantitativos de promedios, desviación estándar y alfa (p-valor). **Resultados:** Al analizar las puntuaciones de las habilidades cognitivas de los grupos se observó que 16 niños (80%) se encontraban con puntuaciones por debajo de la media, 1 (5%) en la media y 3 (15%) por encima de la media esperada para la edad. El grupo anterior cuenta con 13 niños (65%) con puntuaciones por debajo de la media, 1 (5%) en la media y 6 (30%) por encima de la media, notando que el grupo prematuro presentó mejores resultados. En el diferencial diferencia significativa entre las medias de los de los grupos del presente estudio en relación a varias de las variables. **Conclusión:** En el intervalo diferencia estadística en el ritmo cognitivo de los de los grupos en este grupo de edad. Se debe considerar que estos resultados pueden cambiar en otro grupo de edad infantil.

Palabras claves: Cognición; Prematuridad; Escala Bayley III; Desarrollo Infantil.

Introduction

Cognition and language are interdependent and therefore they influence each other. Cognition may be defined as a set of mental skills essential to acquiring knowledge. These skills involve mostly thinking, reasoning, abstraction, memory, attention, creativity, and problem solving. In general, cognitive skills provide a reflection on information and actions in daily lives[1]. Great advances in cognitive, motor, social, and language development occur during the first three years of life and are indispensable for overall performance[2].

Nutritional and socioeconomic aspects, as well as the educational level of the family and favored stimulation in family relationship are directly related to the overall development of the child. When there is a negative influence of any of these aspects, there is a risk of child development delay and/or disorder[2]. Similarly, prematurity and low birth weight are some of the main risk factors to trigger some developmental changes[3].

A preterm newborn (PTNB) is a child who has less than 37 weeks of gestational age[3]. PTNBs have been identified with lower cognitive and memory skills. In addition to the prematurity, social risks are linked to development, and the sum of several factors potentially affects the cognitive development[4].

Longitudinal studies show that 30-50% of PTNBs have cognitive difficulties that can be detected at preschool age. Therefore, it is extremely important to investigate the cognitive development at an early age, identifying children at risk for changes, enabling early intervention and guiding parents on difficulties and possible treatments[5].

Early stimulation is a crucial priority, as it may provide quality of life not only for children and their families, but it also influences the financial planning of public policies for the whole society. The stimulation of executive functions should be emphasized, as they are directly related to cognition, such as working memory, impulse control, planning capacity and attention. These skills are not innate, but people are born with the potential to learn them. This learning begins at birth and it is developed through our acquired experiences[6].

Executive functions are essential not only for cognitive acquisition, but also for social and emotional acquisition. These skills become more evident from the age of three, when the child is able to follow two-step command, perform simple choices, maintain attention and retell. However, it is possible to see them in a more subtly way at the end of the first year of life[6].

The Bayley III scale that was developed by Nancy Bayley and colleagues in 2006 is among the gold-standard evaluative scales and it has been used in scientific research for the assessment of child development. The scale assesses five areas related to child development: cognitive, language (receptive and expressive), motor (fine and gross skills), social-emotional and adaptive behavior. This scale is a reference instrument used in many countries; however, it has not yet been validated in Brazil, being used only for scientific purposes[7,8].

Based on the assumption that prematurity can cause changes in the cognitive development, the present study aims to verify the cognitive development in PT children.

Method

This is an observational and cross-sectional study, which was submitted and approved by the Research Ethics Committee, under the no. 48561115.0.0000.5011. The enrollment of children between 24-30 months of age was carried out in a maternity school in the State of Alagoas. The sample was selected from this group through individual invitations to legal guardians of minors, those who accepted, signed a Free and Informed Consent Term (FICT) and the Assent Term.

This research included 40 participants who did not undergo speech-language therapy until the time of data collection. The sample consisted of 20 full-term born children (FT) and 20 preterm born children (PT) of both genders, as well as without visual, auditory, neurological and/or any degree of autism spectrum disorder (ASD) diagnosed.

The data of participants, such as clinical history, socioeconomic data, height and weight, were considered for further analysis. The subpart of the Bayley Scales of Infant Development - BSID-III, or simply Bayley III, corresponding to the cognitive domain was applied, in addition to these data. The starting point of the test was equivalent to the chronological age of the child, and the test was concluded after five consecutive errors. Every stage of the scale received a score, in which 0 was for the non-execution and 1 was for the appropriate performance of the proposed test, according to the guide. The interns of the speech-language

pathology course were responsible for applying the scale and were supervised by a Speech-Language Pathologist and a Psychologist.

The tasks proposed in the cognitive subpart involve presenting one or more objects to the child individually. These objects are used to perform an activity, for example, pins - as crayon style - to fit into a board with small holes. The test was applied on one or at most two visits, lasting approximately one hour for each visit. The most convenient day, place and time for participants were scheduled for data collection.

The scores obtained on Bayley III scale were recorded in forms for further analysis (Figure 1). The count of correct responses was converted into scores, determining if the participant had a BSID-III score above average, on average or below average, according to their age. These scores were compared between the two groups, as well as other variables, that is: nutritional status (weight-height and weight-age), educational level of legal guardian and monthly family income.

The data collected were tabulated in the Excel Office 2010 and later analyzed through the BioEstat 5.3, with data descriptive statistics (mean, median and standard deviation) being performed. In addition, the Mann-Whitney U test was applied to compare FT and PT born children, with respect to the cognitive development. The p-value (alpha) was considered as 0.05.

Results

When analyzing the scores of the cognitive abilities of the two groups, it was possible to notice a mean of 2.65 (standard deviation of 0.74) of the FT group, 16 children (80%) with below average scores, 1 (5%) on average and 3 (15%) above the average expected for the age. However, the PT group had a mean of 2.35 (standard deviation of 0.93) with 13 children (65%) with below-average scores, 1 (5%) on average and 6 (30%) above average; therefore, the PT group had more children above average, but there was no significant difference between the means of both groups in this study. (Insert Table 1 and 2)

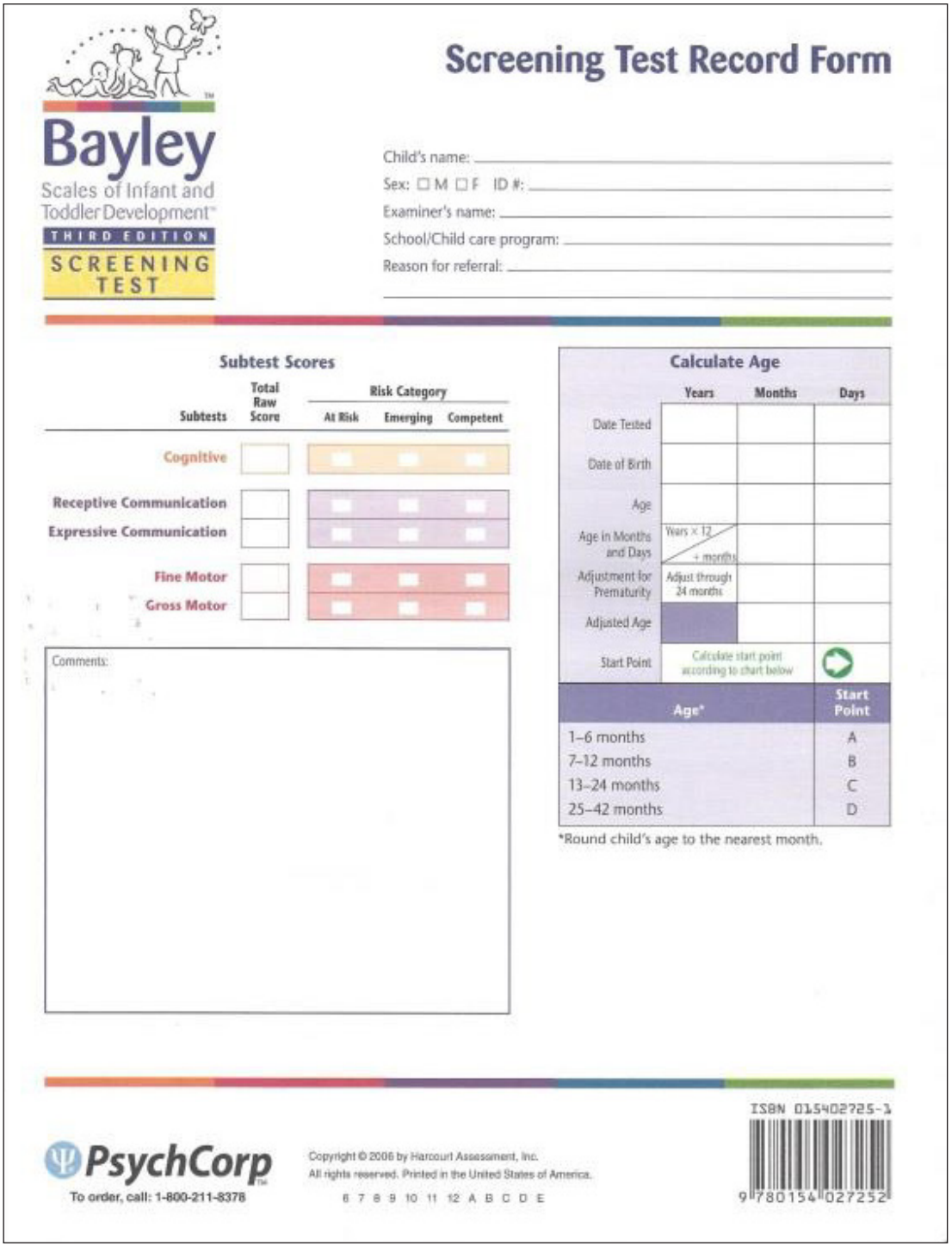
The FT group had a mean of 4.2 (standard deviation of 1.07) as nutritional status in relation to the weight and height, 2 (10%) of the 20 children were obese, 7 (35%) were overweight, 6 (30%) were at risk of overweight, 4 (20%) were eutrophic and only 1 (5%) child was malnourished. The PT group had a mean of 4.20 (standard deviation of 1.11), in which 3 (15%) children were obese, 5 (25%) overweight, 5 (25%) were at risk of overweight and 7 (35%) were eutrophic, and no child was malnourished (Table 1).

In the analysis of nutritional status in relation to the weight and age of the FT children, there was a mean of 2.95 (standard deviation 0.51), 1 (5%) with a high weight for the age, 18 (90%) with normal weight for their ages and 1 (5%) with very low weight for the age. The PT group had a mean of 3.05 (with a standard deviation of 0.22), and 1 (5%) child presented a high weight for age, while 19 (95%) children had adequate weight for their ages (Table 1).

As for educational level of legal guardians, a mean of 10.45 of mothers was recorded in the FT group, while a mean of 10.20 was recorded in the PT group. It is worth mentioning that 4 (20%) of those in the PT group studied for 17 years and 11 (55%) studied for less than 12 years. On the other hand, only 2 (10%) of legal guardians studied for 17 years in the FT group, but only 9 (45%) studied for less than 12 years. The family income of FT children had a mean of 1034.20 (standard deviation of 737.66) and a mean of 1324.7 (standard deviation of 865.0) in the PT group, with no significant difference between the two groups (Table 1).

Through the Mann Whitney U test, a statistical inferential analysis was performed on these scores obtained by the performance in cognitive abilities between the FT and PT children, and it was observed that the two groups showed no statistically relevant difference, having a p-value of 0.3942 in relation to the scores (Table 3).

The same statistical correlation was performed among other variables, always comparing the two study groups. No significant statistical evidence of $p < 0.05$ was observed among the variables analyzed (Table 3).



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School/Child care program: _____
Reason for referral: _____

Subtest Scores

Subtests	Total Raw Score	Risk Category: At Risk	Emerging	Competent
Cognitive				
Receptive Communication				
Expressive Communication				
Fine Motor				
Gross Motor				

Comments:

Calculate Age

	Years	Months	Days
Date Tested			
Date of Birth			
Age			
Age in Months and Days	Years × 12 + months		
Adjustment for Prematurity	Adjust through 24 months		
Adjusted Age			
Start Point	Calculate start point according to chart below		

Age*	Start Point
1–6 months	A
7–12 months	B
13–24 months	C
25–42 months	D

*Round child's age to the nearest month.

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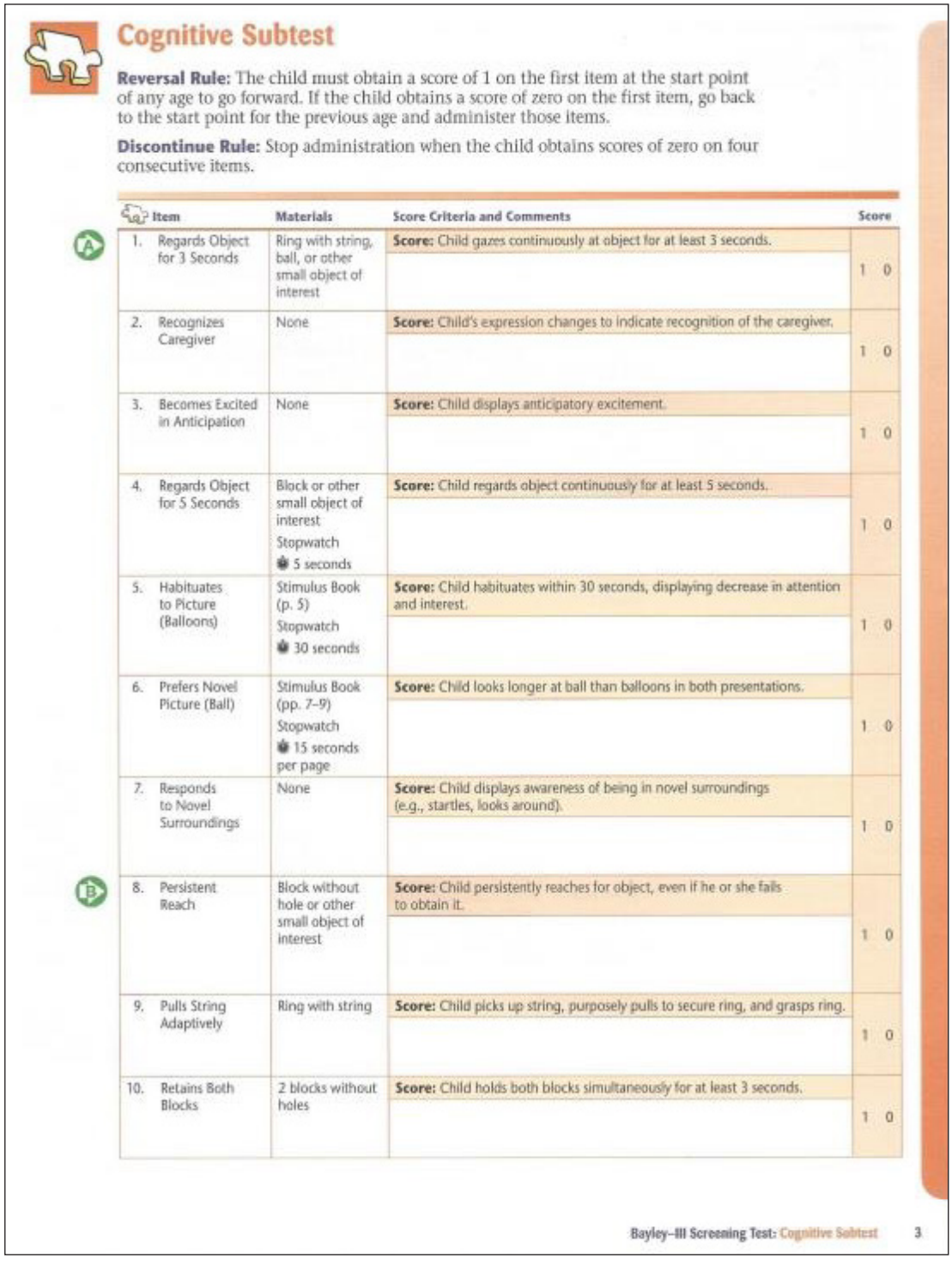
Figure 1.



Cognitive Subtest

Reversal Rule: The child must obtain a score of 1 on the first item at the start point of any age to go forward. If the child obtains a score of zero on the first item, go back to the start point for the previous age and administer those items.

Discontinue Rule: Stop administration when the child obtains scores of zero on four consecutive items.

Item	Materials	Score Criteria and Comments	Score
A 1. Regards Object for 3 Seconds	Ring with string, ball, or other small object of interest	**Score:** Child gazes continuously at object for at least 3 seconds.	1 0
2. Recognizes Caregiver	None	**Score:** Child's expression changes to indicate recognition of the caregiver.	1 0
3. Becomes Excited in Anticipation	None	**Score:** Child displays anticipatory excitement.	1 0
4. Regards Object for 5 Seconds	Block or other small object of interest Stopwatch 5 seconds	**Score:** Child regards object continuously for at least 5 seconds.	1 0
5. Habituates to Picture (Balloons)	Stimulus Book (p. 5) Stopwatch 30 seconds	**Score:** Child habituates within 30 seconds, displaying decrease in attention and interest.	1 0
6. Prefers Novel Picture (Ball)	Stimulus Book (pp. 7–9) Stopwatch 15 seconds per page	**Score:** Child looks longer at ball than balloons in both presentations.	1 0
7. Responds to Novel Surroundings	None	**Score:** Child displays awareness of being in novel surroundings (e.g., startles, looks around).	1 0
B 8. Persistent Reach	Block without hole or other small object of interest	**Score:** Child persistently reaches for object, even if he or she fails to obtain it.	1 0
9. Pulls String Adaptively	Ring with string	**Score:** Child picks up string, purposely pulls to secure ring, and grasps ring.	1 0
10. Retains Both Blocks	2 blocks without holes	**Score:** Child holds both blocks simultaneously for at least 3 seconds.	1 0

Bayley–III Screening Test: Cognitive Subtest 3

Figure 1. Cover sheet template and activities of the Bayley III Scale

Table 1. Descriptive data on mean and standard deviation of social and nutritional variables of pre-term and full-term groups

Nutritional status (weight-height)	Full-term	4.25	1.07	4.0
	Preterm	4.20	1.11	4.0
Nutritional status (weight-age)	Full-term	2.95	0.51	3.0
	Preterm	3.05	0.22	3.0
Educational level of legal guardian (years)	Full-term	10.45	3.64	12.0
	Preterm	10.20	4.45	9.0
Household income (BRL)	Full-term	1034.20	737.66	865.0
	Preterm	1324.7	1211.71	930.0
Scale score	Full-term	2.65	0.74	3.0
	Preterm	2.35	0.93	3.0

Table 2. Scores of children on the BSID-III scale

Variables	No. of Full-term	No. of Preterm
Above average	3	6
On average	1	1
Below average	16	13

Table 3. Statistical correlations between social, nutritional and cognitive skills of pre-term and full-term groups

Variables	Crianças	p-valor
Nutritional status (weight-height)	Full-term Preterm	0.7972
Nutritional status (weight-age)	Full-term Preterm	0.7972
Educational level of mothers (years)	Full-term Preterm	0.6652
Income (BRL)	Full-term Preterm	0.4989
Scale score	Full-term Preterm	0.3942

Legend: p-value calculated from the Mann–Whitney U test

Discussion

The FT group had more scores below the average (80%) than the PT group (65%) in this study. Nevertheless, the results were not significant. These results are not determinant, that is, some cognitive difficulties may appear with increasing age. Most cognitive and behavioral disorders or deficits may be better noticed during school age[9]. This finding justifies the fact that there were no significant results in this study when comparing both groups, since participants were at preschool age.

In addition, it was noted that PT children had results equivalent when compared to those of FT children in relation to all variables, as well as the cognitive evaluation scores performed through BSID-III, as previously mentioned. According to the literature, social factor may influence the development more than biological factors; however, the older, the greater the impact of early biological factors, such as preterm birth, if there is no specific care, which may change cognitive behavior. It can be assumed that as biological factors do not have the potential to impact significantly at the present moment, since the risk for development is not pre-

maturity alone, there was no significant difference between the participants of the study[10,11,12].

In the analysis of the socioeconomic variables of participants, no relevant statistical difference was found among the families of children from both groups, considering that both groups belong to vulnerable economic classes. According to the literature, the economic factor impact in the emotional well-being of legal guardians, influencing the adequate growth and development of children. There was an indication in studies with preschool children that a lower socioeconomic level may impair their cognitive development[8, 13, 14].

Findings in the literature suggest that the cognitive development in childhood depends on environmental conditions, implying that, placing a child in economically more favorable environments would promote an improvement in their development. In addition, factors associated with poverty, such as consumer goods, services and inadequate psychosocial stimuli have been considered risk factors for child development[8]. It should be noted that even if there are no adverse biological factors at birth for FT children assessed in this study, an inappropriate environment may lead to negative developmental conditions and thus impact in this process.

Another study assessed the cognitive and linguistic development, quality of educational environments, home environment and the quality of the neighborhood of 92 children aged 24 to 36 months. There was a prevalence of below-average results for cognitive and linguistic development of participants who showed negative results in relation to environmental and socioeconomic factors. In addition, the environmental variables, such as neighborhood, home, and early childhood education, have shown a greater association with the development of these children[8].

The PTNB is in a situation of risk for changes or delay in the overall development, therefore, a differentiated care is recommended to this group of children. To this end, care and communication between the various levels of care should be prioritized, as well as, guidance to the family and the mother, more specifically. [15] Due to this priority given to the families of children in the PT group, they may have more information than FT families on the importance of adequate stimulation and feeding (such as breastfeeding and its benefits) to support the overall development of these children.

This may have influenced the results in this study, since most PT children, despite having prematurity as a risk factor in development, had an eutrophic nutritional status. It can be concluded that the families of children at greatest risk for change were more concerned with care and guidance received through the guidelines on adequate feeding and stimulation provided in the maternity.

No significant difference between those in the FT group and those in the PT group was noticed when comparing the educational level (in years) of legal guardians of both groups in this study. According to the literature, the education level of mothers has a significant impact on the neurological development of children, especially PT children. The educational level factor of the legal guardian may be more important in the neurological development of the newborns than the gestational age and neonatal morbidities[16]. However, studies show that the positive impact of family educational level are observed more clearly with the cognitive outcomes of children of school age[17,18]. This information is in line with the hypothesis that FT children, who have a higher mean of educational level of legal guardians than the PT group, despite no statistically significant difference, can have higher cognitive results later in life when they reach school age.

The results of this study do not corroborate others that indicate that FT born children have a better development than PT born children, considering those with lower cognitive abilities. In addition, these authors report that the changes in PT children can be detected before school age, which did not occur in the sample analyzed in this study[4, 19].

Results analyzed in this study suggest that FT children have better cognitive development with the increase of their age group. In this way, these children may eventually stand out in the future when compared to those PT born. On the other hand, children from both groups that had below-average scores should be monitored and encouraged in order to avoid any future impairment in their development[10, 13, 20].

Conclusion

The results suggest that children with indicators of biological and social risk should be monitored and stimulated during development, in order to remedy any difficulties that may arise in the cognitive development process.

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