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Do preschoolers born premature perform properly on lexical and verbal short-term memory abilities?

Pré-escolares nascidos prematuros apresentam desempenho adequado em vocabulário expressivo e memória de curto prazo verbal?

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Descritores

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ABSTRACT

Purpose: To investigate lexical performance and verbal short-term memory ability in premature infants at preschool age and compare the results with their full-term peers. **Methods:** Forty preschool children aged between 4 and 5 years and 11 months participated on the study and were equally divided into two groups considering their gestational age: preterm and full-term. Groups did not differ on age, family income and maternal education. Participants were paired according to their chronological age and their socioeconomic status. Their performance was assessed using expressive vocabulary and verbal short-term memory tests. Inferential statistical analysis was performed using the Mann-Whitney and the Fisher exact test. **Results:** Group performance did not differ on vocabulary, but premature children showed an inferior performance on nonword repetition tasks. **Conclusion:** These data indicates that preschoolers born premature performed statistically lower than their peers born full-term on nonword repetition task. Thus, premature birth was associated to vocabulary development on typically developing range, but also to verbal short-term memory impairments.

RESUMO

Objetivo: Investigar o desempenho lexical e a habilidade de memória de curto prazo verbal em crianças prematuras em idade pré-escolar, e comparar os resultados com seus pares nascidos a termo. **Método:** Participaram do estudo 40 pré-escolares com idade entre 4 e 5 anos e 11 meses divididos em dois grupos, sendo 20 nascidos prematuros e 20 nascidos a termo. Os grupos não diferiram quanto à idade, renda familiar e escolaridade materna. Foram utilizados testes de vocabulário expressivo e memória de curto prazo verbal. A análise estatística inferencial foi realizada por meio dos testes de Mann-Whitney e exato de Fisher. **Resultados:** O desempenho dos grupos não diferiu na tarefa de vocabulário, mas o grupo de prematuros apresentou desempenho inferior ao de seus pares na tarefa de repetição de não palavras. **Conclusão:** Nesta amostra, o desempenho dos pré-escolares que nasceram prematuros foi estatisticamente inferior ao daqueles nascidos a termo apenas na tarefa de repetição de não palavras. Assim, o nascimento prematuro esteve associado a desempenho no vocabulário expressivo compatível com o esperado para a idade, porém com prejuízos na memória de curto prazo verbal.

Study conducted at the Curso de Fonoaudiologia, Laboratório de Investigação Fonoaudiológica em Desenvolvimento da Linguagem e suas Alterações, Faculdade de Medicina, Universidade de São Paulo – USP; and at the Ambulatório de Seguimento do Recém-nascido de Risco, Centro Neonatal do Instituto da Criança, Instituto da Criança – ICr, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo – USP, – São Paulo (SP), Brasil. Data collection was performed at the Centro de Pesquisa Clínica do Instituto da Criança (ICr), Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo, and the Escola Municipal de Educação Infantil Monte Castelo.

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INTRODUCTION

A birth is considered premature when occurs before the pregnancy reaches 37 weeks⁽¹⁾ from the date of the woman's last menstruation, and is the leading cause of neonatal death worldwide⁽²⁾. According to the World Health Organization (WHO), about 15 million babies are born prematurely each year.

Babies can be classified as premature according to their gestational age: extreme preterm (gestational age less than 28 weeks), very preterm (from 28 weeks and 0 days to 31 weeks and 6 days), moderate preterm (32 weeks and 0 days to 33 weeks and 6 days), and late preterm (34 weeks and 0 days to 36 weeks and 6 days)⁽¹⁾.

Birth weight is another variable often related to prematurity. Newborns weighing less than 2500 grams are considered low weight, those born less than 1500 grams are considered very low weight, and those born less than 1000 grams are considered extremely low weight⁽³⁾.

It is also possible to classify newborns according to their weight/gestational age ratio. For each gestational age, there is a normal weight variation between the 10th and 90th percentiles for a given population. The categories are BGA (big for gestational age), above the 90th percentile; AGA (appropriate for gestational age), between the 10th and 90th percentiles; SGA (small for gestational age), below the 10th percentile⁽³⁾.

Prematurity and low birth weight are biological risk factors for children development^(4,5). In the first years of life, preterm infants may have impaired motor, cognitive, and language development compared to term infants⁽⁴⁻¹²⁾.

Changes have been reported in the language development, such as late-onset of first-word utterance, delay in expanding vocabulary and linguistic functionality^(6,13), and difficulties with grammatical, phonological, pragmatic and linguistic comprehension skills^(4,10,11). In some cases, these issues may appear in the preschool and school stages and last for a lifetime^(5,6,10,14,15).

In addition to the impact on language development, other cognitive skills such as memory may also have their development affected. Recent studies have shown that premature children performed worse than their full-term peers on verbal short-term memory tasks, such as non-word repetition and digit span⁽¹¹⁾ and verbal working memory⁽¹⁶⁾.

Verbal short-term memory is directly related to language acquisition and comprehension. It supports the formation and stabilization of phonological representations of new words in long-term memory, being related to morphosyntactic and functional learning, and the understanding of short narrative sentences⁽¹⁷⁻²⁰⁾.

Studies on language development and verbal short-term memory in preterm infants are scarce⁽¹¹⁾ and predominantly international. Investigating these skills in the Brazilian context is relevant to deepen the understanding of prematurity in the development of communication in early childhood and, especially, to investigate whether this population is at higher risk for developing neurodevelopmental disorders that will impact their learning. Thus, this study aimed to verify lexical performance and verbal short-term memory ability in preschool

children (4 to 5 years and 11 months old) born prematurely and to compare the results with their full-term peers.

METHODS

The Research Ethics Committee of the Institution approved this study under number 53465416.0.0000.0068. All individuals agreed to participate in the study through graphic registration and had an informed consent signed by their guardians.

Participants

The study included a research group (RG) and a control group (CG). Individuals in both groups were aged between 4 years and 5 years and 11 months old (average RG 61.0 ± 7.41 months old; average CG 61.4 ± 4.86; p=0.841). As it was a convenience sample, the groups were matched by age with up to six months variation. This variation occurred because, despite the individuals matched by date of birth, they underwent data collection at different times. The RG was composed of eight 4-year-old and twelve 5-year-old individuals with an age range between 48 and 71 months, while the CG was composed of seven 4-year-old and thirteen 5-year-old individuals with age range between 53 to 68 months. Although the RG had greater age variation in months than the CG, the groups did not differ by age.

Family socioeconomic status was characterized by monthly incomes (median RG R\$ 3000.00; interquartile range (IQ) 2125.00 - 5000.00; median CG R\$ 2000.00 IQ 1500.00 - 4000.00; p = 0.147) and maternal education level (85% of mothers completed at least high school in both groups). The groups also did not differ regarding monthly family income and maternal education.

The research group (RG) was composed according to the demand of the ICr-HCFMUSP Newborn at Risk Follow-up of the Neonatal Center. Twenty preschoolers of both genders (ten boys), premature and under pediatric outpatient follow-up during the data collection period, were evaluated. Of those, 85% attended preschool regularly, and none underwent speech therapy.

The eligibility criteria included gestational age of less than 37 complete weeks; absence of sensory deprivation, neurological changes, and developmental diagnoses that could interfere with language acquisition and development.

The participants clinical data were consulted through analysis of electronic medical records. We considered information related to gestational age, type of delivery, birth weight, gestational age/weight ratio, height, head circumference, Apgar score, and length of stay.

Regarding the classification of prematurity⁽¹⁾, the sample consisted of 55% very preterm, 30% moderate preterm, 10% late preterm, and 5% extreme preterm. Regarding birth weight, 15% of the individuals were extremely underweight, and 45% of the individuals were classified as SGA. Due to the highlighted variability, these variables were not considered in the analyses of this article (Chart 1).

The control group (CG) was composed of 20 preschool children with typical language development, born at term, within the same age range as the research group, both genders (14 boys),

regularly enrolled in a public kindergartens in the west of São Paulo. The inclusion criteria included gestational age equal or greater than 37 complete weeks, absence of complaints, referral or attendance in force for speech, psychological or neurological demands of diagnosed conditions that could interfere with language acquisition and development (Chart 2).

Materials and procedures

Data collection from the research group was performed in a silent office at the ICr-HCFMUSP Clinical Research Center, and the data collection from the control group was performed in a silent classroom at the school. In both cases, the children interacted with the researcher and all procedures were performed in a single session, with an average duration of 20 minutes, recorded on a digital recorder for later transcription.

We used the Expressive Vocabulary Test - ABFW⁽²¹⁾ to investigate lexical development, consisting of 118 figures divided into nine semantic fields: clothing, food, animals, means of transport, furniture and utensils, professions, places, shapes and colors, toys and musical instruments. The analysis classifies the answers into usual verbal designations (UVD), non-designations (ND), and substitution processes (SP), giving the percentage of correct answers in each semantic field, with normality pattern. The test followed the instructions available in the user manual. For this study, the analysis considered the total percentage of

usual verbal designation (UVD), which corresponds to the sum of the UVD of all semantic fields divided by the total number of test items and multiplied by 100.

We used the Phonological Short-Term Memory test⁽²²⁾ to investigate verbal short-term memory ability, composed of 40 non-words divided equally into groups of monosyllables, disyllables, trisyllables, and polysyllables. For this study, we considered the total percentage of correct answers, which corresponds to the sum of the correct answers in the different syllable extensions of non-words divided by the total number of items and multiplied by 100.

The individuals' performance was considered "adequate" when it reached the performance parameters indicated by age in both instruments, and considered "inadequate" when below the expectations.

The individuals of the research group were characterized regarding pregnancy and birth factors: maternal diseases (diabetes, hypertension, others), gestational age, type of delivery, birth weight, length of stay, clinical status (occurrence of neonatal jaundice, time of phototherapy, infections, intracranial hemorrhage, others). These factors were obtained from the analysis of the electronic records of the outpatient clinic mentioned above.

The control group was also characterized as to gestational and birth factors, through a questionnaire answered by their parents and/or guardians.

Chart 1. Characterization of the group of premature children

	average	SD	Range
Gestational age (weeks)	30.9	2.61	25 - 36
Maternal age (years old)	27.3	6.04	17 - 37
Birth weight (grams)	1264.7	301.34	720 - 2070
Average hospitalization (days)	49.6	21.61	17 - 106
	n	%	
Extreme preterm	1	5	
Extreme low weight	3	15	
SGA	9	45	
Cesarean section	20	100	
Twins	6	30	
Maternal hypertension	9	45	
Maternal diabetes	2	10	
Jaundice	18	90	
Phototherapy	16	80	

Captions: SD: Standard Deviation; Range: Showing the minimum and maximum value; n: Number of individuals; %: Percentage of individuals in the sample; SGA: Small for Gestational Age

Chart 2. Characterization of the group of children born at term

	average	SD	Range
Gestational age (weeks)	38.8	1.51	37 - 42
Birth weight (grams)	3093.8	551.40	2000 - 4200
	n	%	
Normal birth weight	18	90	
Twins	0	-	
Maternal hypertension	2	10	
Maternal diabetes	2	10	
Jaundice	0	-	
ICH	0	-	

Captions: SD: Standard Deviation; Range: Showing the minimum and maximum value; n: number of individuals; %: Percentage of individuals in the sample; ICH: Intracranial Hemorrhage

To characterize and pair the researched groups, we measured family socioeconomic aspects by a questionnaire based on the Brazil Economic Classification Criteria⁽²³⁾, answered by the participants' guardians.

We recorded all the data through the specific protocols of each test, transcribed and also stored in digital voice file.

Statistical analysis

The data were analyzed with the software SPSS version 21. Descriptive analysis of categorical variables occurred by the gross value and its distribution frequency. Numerical variables were described by the median and interquartile range when the distribution did not respect normality, and by the mean and standard deviation when the distribution respected normality. The individuals' performance was compared with inferential analysis by the nonparametric Mann-Whitney test; and Fisher's exact test compared the frequency distribution of the performance classification between the groups. The adopted significance level was 5%.

RESULTS

The research and control groups were characterized by their gestational data - maternal and fetal - and data at birth, as can be observed in Tables 1 and 2.

When comparing the groups' performance, the preterm infants performed similarly to their peers in the vocabulary test but presented inferior performance in the verbal short-term memory. However, even in the case of vocabulary, the values of the interquartile range of preterm infants are lower compared to the control group in the first and third quartiles (Table 1).

By analyzing only the research group, we compared the performance of individuals classified as AGA or SGA, since the latter would present a higher risk for developmental changes. However, there was no difference between individuals in the percentage of vocabulary UVD (median AGA 64, median SGA 69, $p = 0.062$), nor in the percentage of verbal short-term memory hits (median AGA 83, median SGA 85, $p = 0.152$). When comparing the vocabulary performance classification,

three (27.3%) AGA and only one (11.1%) SGA participants were inadequate, which was not statistically significant ($p = 0.375$). In verbal short-term memory, seven (63.6%) AGA and six (66.7%) SGA participants were inadequate, which also does not configure a statistical difference ($p = 0.630$).

When comparing the groups' performance classification in each evaluated domain, we observed no association between the group and the vocabulary classification; i.e., the distribution of individuals in the classifications is similar in both groups. In verbal short-term memory, preterm infants had their performance rated as less adequate than their peers (Table 2).

DISCUSSION

This research aimed to verify the performance of children between 4 and 5 years and 11 months old with a history of prematurity in vocabulary tasks and verbal short-term memory and to compare it with their term peers.

We observed no statistical difference between the groups in the expressive vocabulary, either by the total percentage of UVD or by the performance rating. This result differs from previous studies that showed difficulties with expressive and receptive vocabulary in preterm children in different age groups^(9,10,13). In two of these studies, children aged 12 to 36 months old with a history of extreme and moderate prematurity^(9,13) were analyzed, while the other study evaluated children aged 4 to 5 years old and with a history of extreme prematurity⁽¹⁰⁾. Therefore, both the difference in gestational age and the age of the children at the time of research may justify the divergence observed between the results presented since. Our study shows a predominance of gestational age between 28 weeks and 0 days to 33 weeks and six days.

However, these findings corroborated with two international studies^(24,25). In the first study, the longitudinal comparison of language development at 10, 22, and 30 months of children with and without a history of premature birth found no statistical difference between the groups in comprehension and production of words, phrases, communicative, and cognitive skills⁽²⁴⁾. Another study showed no statistical difference was observed between preterm and term children in cognitive, language and

Table 1. Comparison of group performance (score) in expressive vocabulary and verbal short-term memory tasks

Domain	Group	Median	Interquartile range		p
			Q1	Q3	
Vocabulary	Control	68.0	65.3	74.8	0.110
	Research	65.5	53.3	72.0	
Verbal short term memory	Control	96.5	93.0	100.0	<0.001*
	Research	83.0	65.5	88.0	

*statistical difference $p < 0.05$ - non-parametric Mann-Whitney test.

Table 2. Comparison of group performance classification in expressive vocabulary and verbal short-term memory tasks

Domain	Performance	Group		Total	p
		Research	Control		
Vocabulary	Adequate	16	20	36	0.053
	Inadequate	4	0	4	
Verbal short term memory	Adequate	7	20	27	<0.001*
	Inadequate	13	0	13	

*statistical difference $p < 0.05$ - Fisher's exact test

motor tasks at 12 months of corrected age. However, their research group consisted of healthy individuals with no clinical risk, so that, even with different gestational ages (very preterm and late preterm), all of them achieved scores adequate to the experimental test parameters⁽²⁵⁾.

The individuals of this research did not differ as much by chronological age as by family socioeconomic level, nor did they present high-risk clinical conditions, meeting the eligibility criteria already mentioned. However, the literature used as reference uses similar eligibility criteria, i.e., the aspects in which there is a divergence from the literature cannot be justified by the possibility of comparisons with premature children with high clinical risk for developmental changes^(4,6-16,24,26).

Environmental factors may also interfere with the language performance of premature children. In children below five years old who were born too premature or small for gestational age, factors such as low parental education, low birth weight, and male gender may act as predictors of changes in overall cognitive development. From five years old, only the influence of parents' educational level seems to be sustained, suggesting that the influence of perinatal risk factors decreases over time and that the social and environmental factors become more important⁽²⁶⁾.

Although many studies have shown a risk of impaired language development in premature children, developmental recovery may occur throughout the maturation of the nervous system, in the absence of brain damage, and when the child interacts with the healthy environment around him⁽¹³⁾. Thus, considering that in this study most premature children attended kindergartens regularly, as provided for in Brazilian legislation for children of this age group, it is possible that this factor contributed to the development of language, specifically lexical acquisition, which could justify similar performance with term-born children who also attend kindergarten.

However, despite the absence of statistical difference, the median obtained in the group of premature infants indicated a narrower performance than children born at term. This result may be due to familiarity with the task and the items, but it does not necessarily imply that performance would be the same with less frequent lexical elements, which may impact the future academic performance of these children. Only the isolated vocabulary task is not able to evaluate the linguistic performance of these groups and allows discussion only about vocabulary.

Another relevant aspect to be considered in this group is that the sample is composed of 30% of twins and 45% of infants born small for gestational age, which increases the risk for language development disorders^(27,28). A recent study⁽²⁷⁾ presented a multivariate analysis regarding the association of perinatal and postnatal factors with delayed twin language development. The results indicated an association of perinatal factors, such as gestational diabetes and monozygotic pregnancy, but postnatal factors, such as socioeconomic status and maternal education, were not associated with delayed language development.

When comparing the classification of the groups' performance in vocabulary, the statistical significance was borderline, probably due to the sample size. Therefore, we need to be careful when generalizing these data, since a larger sample size could be

able to replicate the difference in vocabulary performance of premature and term infants observed by other authors.

Children born prematurely presented verbal short-term memory performance impairments. This finding corroborates with an Italian study that points out that premature children had difficulties with this ability and other cognitive abilities, detected from the age of three, and observed in children of five years old⁽¹¹⁾.

Gestational age may interfere with the development of memory skills and, consequently, language development. Verbal short-term memory is associated with receptive language skills, while expressive skills are associated with working memory⁽¹⁶⁾. In this study, working memory and receptive language skills were not verified, so it is not possible to determine if these relationships would be replicated.

As shown in the literature, changes in memory skills, including short-term verbal skills, may cause difficulties in language development, both comprehension and expression, at different levels⁽¹⁶⁾ and may even lead to impairments for the lexical enlargement during school.

Brazilian researchers⁽²⁸⁾ demonstrated that at two months of life it is already possible to identify risk for neurodevelopmental changes when comparing SGA to AGA infants. SGA infants may be at greater risk for mild abnormalities in neuronal development, cognitive, behavioral, and academic changes⁽²⁸⁾. As shown by our results, 66.7% of SGA infants had difficulties with verbal short-term memory ability. Nevertheless, in this study, no difference was observed between the performance of SGA and AGA infants in this ability, nor in expressive vocabulary, which may suggest that SGA infants may overcome impairments observed at the beginning of development, in the absence of neurological changes and conditions adequate postnatal care.

Our study suggests that the relationship between prematurity, cognitive, and language development is complex. Even when finding similar vocabulary test performance between the groups, it is not possible to state that the language development of premature children will not be affected, because, according to the literature, impairments in verbal short-term memory can negatively impact lexical development⁽¹⁷⁻²⁰⁾.

As mentioned earlier, environmental factors such as language stimulation from the school environment and maternal education may have positively influenced the lexical acquisition of preterm infants, while verbal short-term memory may not have been equally benefited by such factors. Thus, even though premature children did not statistically differ from their term-born peers in lexical ability, the difficulties observed in verbal short-term memory ability, may start to differentiate the groups with increased demand in communicative and educational contexts in the future.

Finally, although there is still no consensus on language impairment in preterm infants, recent studies showed that even children born after 32 weeks of gestation have a higher risk for language disorders than those born at term^(29,30).

Thus, it would be interesting to continue these investigations, especially performing the longitudinal follow-up of premature children and larger sample size to also measure the impact of environmental factors on their development.

The generalization of the results of this study was limited by the formation of the research group, difficult to obtain due to the low adherence of those responsible and the high rate of absences in the scheduled evaluations, which culminated in a small sample number. Moreover, as it was a cross-sectional study, conducted with a timely assessment of each child, some factors on language development could not be widely explored.

Also, the results presented here show that the lexical development of premature children might occur similarly to typically developing children, indicating the importance of investing in monitoring and early stimulation programs, as well as their insertion in the school environment.

Regarding verbal short-term memory, the difficulties observed in this sample indicated that prematurity might be a biological risk factor for cognitive development, reinforcing the need to follow up premature children in their learning process of language and academic development.

Finally, this study contributes to clinical practice, emphasizing the importance of understanding prematurity as a risk factor for child development and contributes to the debate on the importance of monitoring language development in populations at risk for developing neurodevelopmental disorders.

CONCLUSION

By comparing the performance of children aged 4 to 5 years and 11 months old and a history of prematurity to their term-born peers, we identified that those born prematurely presented similar performance to their peers in vocabulary, but had verbal short term impaired memory.

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Authors contributions

MQV was the author of the Master's dissertation that originated this article, responsible for data collection, analysis and tabulation, literature survey and general writing of the article; *AMCA* contributed to the elaboration of the project, responsible for the statistical analysis of the data, interpretation of the results, collaborated with the writing and review of this article; *VLJK* and *WBC* contributed to the elaboration of the project; *DMBL* contributed to the elaboration of the project, guided the dissertation and the elaboration of this article and responsible for the approval of its final version.