

Habilidades auditivas e desenvolvimento de linguagem em crianças*****

Hearing abilities and language development in anemic children of a public daycare center

Juliana Nunes Santos*
Stela Maris Aguiar Lemos**
Silmar Paulo Moreira Rates***
Joel Alves Lamounier****

*Fonoaudióloga. Mestre em Ciências da Saúde pela Universidade Federal de Minas Gerais. Professora do Curso de Graduação em Fonoaudiologia da FEAD. Endereço para correspondência: Rua Coronel Pedro Jorge, 170 - Apto. 201 - Belo Horizonte - MG - CEP 30410-350 (juliana.santos@fead.br).

**Fonoaudióloga. Doutora em Distúrbios da Comunicação Humana. Professor Adjunto do Curso de Graduação em Fonoaudiologia da Universidade Federal de Minas Gerais.

***Médico. Mestrando em Ciências da Saúde da Faculdade de Medicina da Universidade Federal de Minas Gerais. Professor de Pediatria da Faculdade de Saúde e Ecologia Humana.

****Médico. Professor Titular do Departamento de Pediatria do Programa de Pós-Graduação em Saúde da Criança e do Adolescente da Faculdade de Medicina da Universidade Federal de Minas Gerais.

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Abstract

Background: the relationship between anemia and development. **Aim:** to compare the auditory and language development in anemic and non-anemic children, with ages ranging from three to six years, of a public daycare center in Belo Horizonte city. **Method:** a transversal study; blind case and control format. A digital puncture was performed in all children to detect iron-deficiency anemia (hemoglobin = 11.3g/dL). The research group was composed of 19 anemic children and the control group of 38 healthy children, selected through randomized paired sampling. The children's hearing was evaluated through otoacoustic emissions, tympanometry and a simplified evaluation of the central auditory processing was performed. The language development of each child was observed using the behavior observation guidelines for children with ages from zero to six years. Performance indexes were created in order to classify the language responses of the children. **Results:** the groups did not differ in terms of age, gender, breast-feeding and mother's literacy. The following variables presented statistically significant differences: hemoglobin values (10.6g/dL, 12.6g/dL); presence of the acoustic reflex (63%, 92%); reception performance indexes (72.8, 90.1); emission (50.6, 80.6) and cognitive aspects of language (47.8, 76.0) in anemic and non-anemic children respectively. The hearing abilities in the verbal and non-verbal sequential memory and the sonorous localization were inadequate in most of the children, especially in those with anemia. **Conclusions:** anemic children differed statically from non-anemic children in terms of alterations in the acoustic reflex and language development and also presented a higher prevalence of alterations in the hearing evaluation.

Key Words: Anemia; Hearing; Language; Child Day Care Centers.

Resumo

Tema: relação entre anemia e desenvolvimento. **Objetivo:** comparar o desenvolvimento auditivo e de linguagem de crianças anêmicas e não anêmicas entre três e seis anos de idade de uma creche pública de Belo Horizonte. **Método:** estudo transversal do tipo caso e controle unicego. Foi realizada punção digital em todas crianças para detecção da anemia (hemoglobina = 11,3g/dL). O grupo caso foi constituído de 19 crianças anêmicas e o controle, de 38 crianças saudáveis, selecionadas por amostragem aleatória pareada. A audição das crianças foi avaliada com emissões otoacústicas, imitanciometria e avaliação simplificada do processamento auditivo. O desenvolvimento de linguagem de cada participante foi observado, utilizando o roteiro de observação de comportamentos de crianças de zero a seis anos. Foram criados índices de desempenho para qualificar as respostas de linguagem das crianças. **Resultados:** os grupos não diferiram quanto à idade, gênero, aleitamento materno e escolaridade materna. As seguintes variáveis apresentaram diferenças estatisticamente significantes: valores de hemoglobina (10,6g/dL, 12,6g/dL); presença do reflexo acústico (63%, 92%); índices de desempenho de recepção (72,8 - 90,1), emissão (50,6 - 80,6) e aspectos cognitivos da linguagem (47,8 - 76,0) nas crianças anêmicas e não anêmicas, respectivamente. As habilidades auditivas de ordenação temporal para sons verbais e não verbais e localização sonora mostraram-se inadequadas em grande parte das crianças, especialmente, as anêmicas. **Conclusões:** as crianças anêmicas diferiram estatisticamente das crianças não anêmicas no que diz respeito às alterações do reflexo acústico e dos índices de desempenho de linguagem, e apresentaram maior prevalência de alterações na avaliação auditiva periférica.

Palavras-Chave: Anemia; Audição; Linguagem; Creches.

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Introduction

The first years of life are considered the most important for the development of auditory and language abilities, since it corresponds to the period of neural system maturation with larger growth of brain and establishment of new neuron synapses¹. This stage also coincides to the period of highest prevalence of iron-deficiency anemia (IDA)², which affects more than 50% of children between six months and five-years old in developed countries³.

The principal consequence of IDA is the impairment of the neuro-psychomotor development, on which repercussions can be even found one decade subsequent to adequate treatment⁴⁻⁵. Studies in children suffering from IDA have shown iron-deficiency associated with psychomotor and cognitive abnormalities, and also impacting language and learning acquisition in children⁶⁻⁷.

Language development and acquirement process are significantly complex involving neuron connections distributed into different brain regions that relate to speech perception, being dependent to the integrity of the peripheral and central auditory system⁷⁻⁹.

In Brazil, iron-deficiency anemia prevalence among preschoolers varies from 30.2% to 80.6%. This index is also high among children who attend public daycare¹³, reaching 37.5% of the public daycare children from the East Region of Belo Horizonte city¹⁴.

The high prevalence of anemia among preschoolers and its repercussions to the cognitive and language development make us to wonder on how the auditory information is processed among this population. Hence, the purpose of this current study is to compare the auditory and language development in children who have anemia to children who do not have anemia from an urban public daycare.

Methods

Transversal study likely blind case and control by means of assessment of language and auditory abilities in children who suffer from anemia and the ones who do not suffer from anemia between three to six years old, regularly attending a public daycare partnered with Belo Horizonte city department. This is a full time institution that is responsible for taking care of children with lower socioeconomic status. This study was approved by the Ethics Committee on Research Board of the Universidade Federal de Minas under the protocol 380/05.

The children parents were notified about the voluntary principle of this study, its objectives and repercussions, and also signed the consent memorandum. At the same time, the parents answered a questionnaire to identify themselves including information from their children's life history and development.

Procedures

The first phase of this study consisted anemia assessment. The children were tested by a high precision spectrophotometer HemoCue© through a digital puncture to detect the levels of hemoglobin (Hg). A microcuvette was used to obtain the precise blood volume in contact with the exact amount of dry reagent. Then, the microcuvette was inserted in the HemoCue© determining the hemoglobin rate between 15 and 45 seconds¹⁵. Through this method was attained a reliable Hg level rate from a small sample. Those children with Hg levels lower than 11.3g/dL (11.0g/dL + 0.3 from equipment HemoCue© variation) in the digital procedure were considered anemic, according to World Health Organization¹⁶.

An auditory assessment was performed on the children subsequently constituted by transient-evoked otoacoustic emissions (TEOAE) and acoustic immittance measures. The equipments used for the auditory assessment were: Heidji otoscopy, TEOAE device, AUDIX I, Biologic brand, mode 580- AX2191 and CATZA42 immitancimeter. In the beginning, the children undergone an otoscopy, and then examined by TEOAE, which criterion was pass or fail. This criterion met the parameters of noise and signal ratio greater or equal to 50%¹⁷. The immitancimetry test was used to measure tympanometry, static compliance and search for acoustic reflex¹⁸. The pressure values considered normal for the tympanometric peak were between -100 and +50daPa. The tympanometric curves analyses were performed according to literature¹⁹. All procedures were executed in a silent room at the public daycare, which the noise pressure level measured by the decibelimeter did not exceed 45dBNPS, therefore, avoiding artifacts or noise contamination.

The children with anemia were selected to constitute the study group (n=24). Five children from this group were excluded, three children due to prenatal complications and other two due to TEOAE test failure, exclusions criteria of this current study. Therefore, the study group was constituted by 19 children and the control group was selected by a pair-wise random sample, being constituted by 38 healthy children between three to six years.

Afterward, the researcher assessed the children without knowing their Hg levels. The simplified assessment protocol of auditory processing (ASPA) was used to evaluate auditory processing abilities. The assessment was performed in a silent room and the physiologic mechanism was studied through sequential non-verbal sound discrimination with sequential verbal memory test (MSNV), sequential verbal sound discrimination with sequential verbal sound memory (MSV); and the mechanism of sound source discrimination was tested by sound localization (LS) in five directions. The abilities were reviewed separately, using criteria defined by Pereira²⁰, which classifies the physiologic mechanisms into adequate or inadequate²¹.

Finally, the language assessment was carried out in an appropriated room for observation in the public daycare, one-on-one sessions for approximately 40 minutes, and in the recreational environment when it was necessary, using a behavioral guidance for children from zero to six years old²¹. The language development was observed and classified according to two large areas: communicative aspects (reception and emission) and language cognitive aspects. The answer records related to the expecting behavior for each group age were executed on individual forms, assigning yes or no, respectively, according to their presence or absence.

Although the instrument utilized is not considered a standardized test but a protocol of behavioral observation, there were created performance indexes (ID) to qualify obtained answers from the children. For each child, the IDs were calculated in percentage within each area, with a maximum value of 100%. It was considered cognitive performance index (IDAC), the aspects rated by the author within the language cognitive aspects, reception performance index (IDR), and emission performance index (IDE), the aspects rated for language reception and emission, respectively. The ID was analyzed according to the presence or absence of iron-deficiency anemia throughout the different age groups (Figure 1).

For data analysis was used the software EPI-INFO- version 6.04 and the Chi-Square Test, T-Student and Anova.

Results

Fifty seven children from the public daycare were evaluated (mean= 51 months \pm 1.2). The distribution of the variables gender, children age and measures of hemoglobin level during evaluation and the data collected through the questionnaire answered by the participants are presented on Table 1.

All the children (100%) revealed TEOAE presents bilaterally. The results are found on table 2.

The physiologic mechanisms of temporal ordinance to verbal sounds and non-verbal sounds, sound source localization and language assessment are described on Table 3.

Discussion

The children assessed in this research are homogenous in regards to their socio-economic characteristics. The study and control group are similar on the distribution of gender, age, breastfeeding, neither birth anomalies nor recent health disorders, except for the presence of iron-deficiency anemia. From maternal perspective on children learning process, the offspring were exposed to the same environment factors (Table 1).

There are evidences that anemia is associated to socio-economic factors that can also affect child development²³, considering low maternal scholastic a risk factor for anemia¹¹. In this present study, these confound factors were minimized since families reside within the same socio-demographic area and have similar educational background.

The employed hearing assessment methods have been utilized in newborn and preschooler hearing screening programs²⁴. TEOAE present high sensibility and specificity index compared to pure tone audiometry²⁵, and are found in 98% of subjects with normal hearing thresholds¹⁷. Although all children included in this current study passed the otoacoustic emissions, it was necessary to repeat the exams TEOAE and/or tympanometry in 26 children at another moment (45.6%) to reach this result (Table 2).

The increased retest index for the hearing assessment is an attributed factor to otitis, wax blockage, eustachian tube disorders, and presence of foreign bodies in the external auditory meatus that contribute to transitory hearing loss, frequently found in daycare settings²⁶. When compared to retest frequency between two groups, there was observed a statistically significant clinical finding ($p=0.08$), showing that the anemic children fail more often (52%) in the first hearing assessment than the non-anemic (28%). Other studies demonstrate that these retest indexes are higher in hearing screening programs²⁶, not considering nutritional conditions. In this manner, it has been observed that children with anemia have more vulnerability to peripheral hearing impairment.

In the tympanometry, it has been also observed higher occurrence of middle ear disorders in the study

FIGURE 1. Language Performance Index.

$$ID: \frac{\text{number of assessed behavior} - \text{number of non-assessed behavior}}{\text{numbered of assessed behavior}} \times 100$$

TABLE 1. Distribution of the children and mothers characteristics randomized in two groups according to iron-deficiency occurrence.

Characteristics		Study Group (n=19)	Control Group (n=38)	Fisher Scale	P
Gender	Female	09	17	0.01	0.92
	Male	10	21		
Natural breastfeeding	Yes	17	34	0.00	1.00
	No	02	04		
Learning difficulties	Yes	03	05	0.02	0.89
	No	16	33		
Mother believe hear well	Yes	17	38	3.12	0.10
	No	02	0		
		Mean ±	Mean ±	Anova	P
Hemoglobin (Hg)		10.6 0.59	12.6 0.60	135.5	0.00*
Age (months)		49.2 8.8	51.8 9.8	0.99	0.32
Period of breastfeeding (months)		13.7 13.9	14.6 12.9	0.02	0.87
Mother educational level (years)		7.2 2.5	7.2 2.9	0.01	0.91

Chi- square test, Fisher Scale, Anova

TABLE 2. Auditory assessment results in two randomized group from daycare children according to iron-deficiency anemia occurrence.

Characteristics		Study Group (N = 19)	Control Group (N = 38)	Chi-square and Fisher Scale	P
Auditory re -assessment	Yes	10	11	3.05	0.08
	No	09	27		
Tympanometry	Peak A	14	34	2.38	0.12
	Peak B, C, AR	05	04		
Acoustic reflex	presence	12	35	5.47	0.01*
	absence	07	03		
		Mean ±	Mean ±	Anova	p
TEOAE (noise/signal ratio)	RE	8.6 2.9	8.4 2.4	0.10	0.75
	LE	6.8 2.1	7.9 2.7	2.23	0.14
Tympanometry (static compliance)	RE	0.48 0.2	0.53 0.2	0.77	0.38
	LE	0.57 0.2	0.52 0.2	0.36	0.54

TABLE 3. Simplified evaluation of auditory processing and language assessment in two randomized group of children from daycare according to iron-proficiency anemia (IDA) occurrence.

Physiologic Mechanisms		Study Group (N = 19)	Control Group (N = 38)	Chi-square and Fisher Scale	P
Sound localization	adequate	18	35	0.13	0.71
	inadequate	1	03		
Discrimination of sequential non verbal sounds	adequate	07	20	1.27	0.26
	inadequate	12	18		
Discrimination of sequential verbal sounds	adequate	12	27	0.37	0.54
	inadequate	07	11		
		Mean ±	Mean ±	Anova	p
Reception performance index		72.8 29.5	13.2 90.1	9.4	0.003*
Emission performance index		50.6 18.9	80.6 14.2	44.8	0.000*
Cognitive performance index		47.8 19.9	76.0 15.5	34.4	0.000*

group (26%) than the control group (10%). In the overall analysis, the occurrence of these disorders among group was 15%. Correlating the presence of acoustic reflex within the groups, there was a statistically significant difference ($p=0.01$), showing that the children with iron-deficiency anemia have more discrepancies for the acoustic reflex. The literature relates the reflex absence to auditory processing disorders²⁷. Although it has not been found in the reviewed literature specific studies about auditory processing using behavioral tests on children who suffer from iron-deficiency anemia, electrophysiological researches have revealed slower conduction for the auditory stimuli on these children who are iron-deficient^{6,10}.

The physiologic mechanism of sound localization, verbal sound discrimination, and sequential non-verbal were better within the children with anemia, even though it was not a statically significant finding (Table 3). The percentage of correct answers for both groups on tests involving auditory processing corroborate to the auditory system maturation, which happens on the peripheral auditory system, then auditory cerebral pathway, and then finally, in the cortex²⁸. The sound localization was the best ability performed within all children, and most part of it is attributed to the superior olivary complex located in the trapezoid body, in which has neurons sensible to interaural time difference. The other auditory abilities evaluated as well as its language aspects have worsen progressively, since these complex abilities require response from higher levels in the auditory pathway.

It has been found that children with anemia have lower language development than children without anemia ($p<0.05$) on tasks involving reception, emission and cognitive language aspects (Table 3). These findings corroborate with the international literature, on studies from Chile⁴ and Costa Rica⁵ that have found lower scores for cognitive and neuro-psychomotor tests in children with anemia.

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Nonetheless, on this current study children with anemia have shown more vulnerability to auditory peripheral disorders, discrepancies of reflex acoustic and auditory abilities disorders, considering that all these features are risk factor for auditory processing disorders¹¹. The reviewed literature shows evidence of a close relationship between auditory processing and language development⁹, since that the communication is a complex central process in the human being and requires in addition to auditory processing, multimodal, cognitive and social processes²⁸.

Supposedly, children with anemia are more vulnerable to auditory processing disorders³⁰. The hearing mechanism engages complex neural connections and different auditory abilities enable the neural system to process the sound information. Those processes such as attention and memory are fundamental for learning⁹. Hence, it can not be neglected hearing assessment and auditory processing on children, especially, children with anemia, that represent higher vulnerability to development disorders⁴⁻⁶ and those who attend daycare full-time¹⁶. It is essential to enlighten health sciences professionals and educators to involve on primary prevention of nutritional disorders, furthermore, oral and written language.

Conclusion

Children with anemia differed statically from children without anemia in what concerns to alterations in the acoustic reflex and language development and also present more occurrence of alterations on the auditory peripheral disorders.

The auditory abilities in the verbal and non-verbal sequential memory and the sound localization had been showed inappropriate in grand part of children, independent of nutritional status. This study showed the importance of programs of health promotion in this day care center, avoiding unfavorable subsequent education and social consequences.

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