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Comparison of iron, vitamin B12, and vitamin D levels in healthy children and children with speech and language disorders

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ABSTRACT

Aims: This study investigated the relationship between speech and language disorders in children and their levels of vitamin D (25(OH)D3), vitamin B12, and iron.

Methods: A total of 163 children participated in the study. Among 111 children diagnosed with speech and language disorders, the distribution included stuttering (n=12), articulation disorder (n=55), developmental language disorder (n=36), fluency disorder (n=4), atypical autism (n=3), and rapid speech disorder (n=1). Additionally, 52 healthy children were included as a control group. The levels of iron, vitamin B12, and vitamin D were recorded for both groups.

Results: Average levels in the study group were as follows: vitamin D at 24.88±14.788 ng/ml, vitamin B12 at 267.43±174.523 pg/ml, and iron at 74.19±34.479 µg/dl. Iron levels were significantly lower in children with speech disorders compared to those in the control group (z=1.986, p=0.049). However, no significant differences were found among the various subgroups of speech disorders in terms of iron, vitamin B12, or vitamin D levels. A positive correlation was observed between vitamin D and vitamin B12 levels within the speech disorder group (p<0.05).

Conclusion: This study suggests a potential link between lower iron levels and speech disorders, though further research is required to validate these findings in children with speech and language disorders.

Keywords: Speech sound disorder, stuttering, vitamin D, B12, iron

INTRODUCTION

Speech and language are essential aspects of daily life and serve as key tools for interpersonal communication. Language consists of two primary components: receptive language and expressive language.[1] There is a broad consensus that language development is a complex process.[2,3] The prevalence of speech disorders among children is estimated to be between 1% and 12% in preschool and school-age groups.[4]

Vitamin B12 is a crucial nutrient impacting various systems, including the central nervous system, where it plays an important role in neural metabolism. As a water-soluble vitamin, B12 is involved in the metabolism of every cell in the human body.[5] Vitamin B12 deficiency in infants has been associated with brain atrophy and demyelination, potentially affecting neural conduction velocities due to impaired myelination.[6] This slowing of transmission in the visual and auditory systems can hinder learning abilities.[7] Consequently, delayed myelination in infancy may lead to delays in cognitive skill acquisition, while brain atrophy may cause regression of these skills.

While vitamin D deficiency has long been linked to rickets, chronic vitamin D inadequacy is now also associated with a range of non-skeletal health outcomes. Epidemiological studies suggest possible links between low vitamin D levels and conditions such as diabetes, cancer, and certain autoimmune diseases. Experimental studies have shown that vitamin D has effects beyond bone health, including anti-proliferative, pro-differentiative, pro-apoptotic, and immunomodulatory functions.[8-10]

To our knowledge, no studies have investigated iron, vitamin D, and vitamin B12 levels simultaneously in children with speech and language disorders. This study aims to explore whether there is a connection between speech disorders and deficiencies in iron, vitamin D, and vitamin B12.

METHODS

Ethics committee approval was obtained from Kırşehir Ahi Evran University Faculty of Medicine Clinical Researches Ethics Committee (Date: 21/02/2023, Decision No: 2023-04/29). The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Our study was conducted by retrospectively reviewing the medical records of 163 pediatric patients who presented to the outpatient clinic with complaints of speech disorders between January 2021 and January 2023. Patients with chronic

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diseases, those taking vitamin supplements, and those with neurological or psychiatric conditions, hearing impairments, or anatomical abnormalities were excluded from the study. All children with speech disorders were assessed and treated by a certified speech and language therapist.

For children aged 2 to 8, articulation and phonological skills were evaluated using the Turkish pronunciation and phonology test (SST), administered by a speech and language therapist.[11] Receptive and expressive language skills were assessed with the Turkish early language development test (TEDIL), which comprises two parallel sets, Forms A and B. Each form includes subtests for receptive and expressive language that provide insights into morphological, semantic, and syntactic development. TEDIL results also allow for comparison with peers, offering a standardized score and an equivalent age range.[12] Additional information about each child's development was obtained from their family. Speech samples were collected by recording the child's natural speech patterns through video or casual conversation. These samples were analyzed to assess fluency and stuttering frequency.

All laboratory data were sourced from tests conducted in our hospital's biochemistry lab, and iron, vitamin B12, and vitamin D levels were recorded from patient files. Serum 25-OH vitamin D levels were categorized as follows: levels below 20 ng/ml indicated deficiency, levels between 20-30 ng/ml indicated insufficiency, and levels above 150 ng/ml indicated toxicity.[13] A serum vitamin B12 level below 200 pg/ml was considered deficient.[14]

Statistical Analysis

Data were analyzed using the IBM SPSS Statistics software (Version 25.0, IBM Corp., 2017, Armonk, NY, USA). Descriptive statistics were presented as mean±standard deviation, median (minimum-maximum), percentage, and frequency values. Normality and homogeneity of variances were assessed using the Shapiro-Wilk and Levene's tests, respectively.

For comparisons between two groups, the Independent Samples t-test (Student's t-test) was used if parametric assumptions were met; otherwise, the Mann-Whitney U test was applied. For comparisons among three or more groups, One-Way Analysis Of Variance (ANOVA) followed by Tukey's HSD test was employed if assumptions were met, while the Kruskal-Wallis test and Bonferroni-Dunn test were used when non-parametric methods were required.

The relationships between continuous variables were assessed using the Pearson Correlation Coefficient when parametric assumptions were satisfied; otherwise, the Spearman Correlation Coefficient was used. The cutoff value for iron levels was determined via ROC analysis. Statistical significance was set at $p<0.05$ and $p<0.01$.

RESULTS

A total of 163 children, comprising 111 patients and 52 controls, were included in this study. The average age of the children was 6.41±3.32 years. Among the group, the mean vitamin D level was 24.88±14.79 ng/ml, the mean B12 level was 267.43±174.52 pg/ml, and the mean iron level was 74.19±34.48 µg/dl. Gender distribution was 44.8% female and 55.2% male.

Speech disorders were present in 68.1% of the children, while 31.9% had no speech disorders. Of the 111 children with speech disorders, 3.6% were diagnosed with fluency disorder, 2.7% with atypical autism, 32.4% with developmental language disorder, 10.8% with stuttering, and 49.5% with speech sound disorders (**Table 1**).

Table 1. Distribution of the children participating in the research by demographic characteristics

		Mean	SD
Age		6.41	3.321
D vitamin		24.88	14.788
B12		267.43	174.523
		n	**%**
Gender	Female	73	44.8
	Male	90	55.2
Speech disorder	Yes	111	68.1
	No	52	31.9
Diagnosis	Fluency disorder	4	3.6
	Atypical autism	3	2.7
	Developmental language disorder	36	32.4
	Stuttering	12	10.8
	Rapid speech disorder	1	0.9
	Articulation disorders	55	49.5

SD: Standart deviation

Since the distributions of B12 and iron values did not follow a normal distribution, the Mann-Whitney U test was used for analysis. Results showed a statistically significant difference in mean B12 levels based on the presence of a speech disorder ($z=3.117$, $p=0.011$), with children in the speech disorder group having higher mean B12 levels than those without speech disorders. Additionally, iron levels demonstrated a statistically significant difference based on the presence of a speech disorder ($z=1.986$, $p=0.049$) (**Table 2**), with lower iron levels observed in the group with speech disorders.

Table 2. Mann-Whitney U test results for speech disorder status

	Speech disorder	n	Mean	SD	z	p
B12	Yes	72	267.43	174.523	3.117	0.001
	No	52	249.12	87.99		
Iron	Yes	67	74.19	34.479	1.986	0.049
	No	52	86.88	34.704		

SD: Standart deviation

In the speech disorder group, iron levels were further evaluated with a ROC curve analysis, which identified a cutoff value of 44 µg/dl for iron, with 25.4% sensitivity and 92.31% specificity. This result may serve as a diagnostic criterion distinguishing between patient and control groups (**Figure**).

When evaluating the subgroups of speech disorders (fluency disorder, atypical autism, developmental language disorder, stuttering, and speech sound disorders) using the Kruskal-

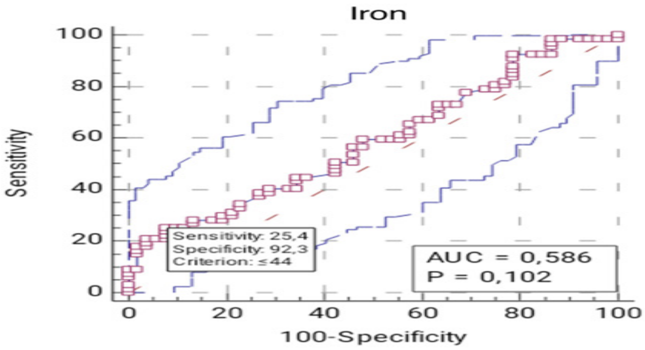

Figure. ROC Curve for iron in children with speech disorders
ROC: Receiver operating characteristic, AUC: Area under the curve

Wallis test, mean levels of vitamin D, vitamin B12, and iron showed no statistically significant differences across diagnostic subgroups (**Table 3**).

Finally, correlation analysis of vitamin D, B12, and iron levels indicated a positive correlation between vitamin D and vitamin B12 in the speech disorder group ($p<0.05$) (**Table 4**).

Table 4. Correlations between vitamin D, B12, and iron variables

Speech disorder			Vitamin D	Vitamin B12
Yes	B12	r	0.319	-
		p	0.001	-
	Iron	r	-0.147	-0.112
		p	0.386	0.417
No	Iron	r	-	-0.052
		p	-	0.718

DISCUSSION

Language and speech are among the most complex human skills. There is a strong correlation between language development and early cognitive development.[15] Although the exact impact of cognitive abilities on language acquisition is not fully understood, language development typically progresses alongside cognitive development, with both functions interacting throughout the language learning process.[15] Experimental studies have indicated that active vitamin D may influence brain and neuron development through its neuroprotective and antioxidant effects.[16] Additionally, one experimental study found a correlation between low serum vitamin D levels and cognitive dysfunction, though this relationship remains inconclusive.[17-19]

According to Sagiroglu's research, no significant difference in vitamin D levels was found between children with articulation disorders and those who stutter compared to a control group. However, children with functional language development disorders had lower vitamin D levels compared to healthy children.[20] This study also reported that speech and language disorders were more common in males, particularly among those with functional language development disorders. Golding et al.[21] found that children of mothers with low vitamin B12 levels were more likely to have speech disorders. Another observational study showed that maternal B12 intake from food or supplements during the second trimester was associated with better receptive language skills in children at age 3, though this association was not observed at age 7.[22,23] In a study by Dror and Allen[24], including 48 cases, children with vitamin B12 deficiency exhibited clinical and radiological signs of demyelination, such as apathy, cerebral atrophy, and hypotonia. While neurological symptoms improved rapidly with vitamin B12 treatment, delays in cognitive and language development persisted in these children over the long term.

In contrast to previous studies, our study found that children in the speech disorder group had higher B12 levels than those in the healthy group. This may be due to prior vitamin B12 supplementation among children presenting with speech disorders. Additionally, a positive correlation was found between B12 and vitamin D levels within the speech disorder group, suggesting that both should be considered together when evaluating children with speech disorders.

A study by Lozoff et al.[25] found that children with iron deficiency anemia had poorer motor and cognitive functions

Table 3. Kruskal-Wallis test results regarding the subgroup diagnosis of children with speech disorder

	Diagnosis	n	Mean	SD	Test İst.	p
D vitamin	Fluency disorder	18.50	3.536	2.500	0.983	0.429
	Atypical autism	28.00	.	.		
	Developmental language disorder	22.91	8.792	2.651		
	Stuttering	18.57	5.442	2.057		
	Speech sound disorder	29.50	18.724	4.187		
B12	Fluency disorder	3	259.00	151.321	0.383	0.820
	Atypical autism	1	293.00	.		
	Developmental language disorder	23	293.11	104.530		
	Stuttering	9	261.86	117.675		
	Speech sound disorder	35	250.81	127.794		
Iron	Fluency disorder	87.50	10.607	7.500	1.422	0.245
	Atypical autism	.	.	.		
	Developmental language disorder	64.37	36.726	8.426		
	Stuttering	67.40	36.643	11.588		
	Speech sound disorder	82.23	31.738	5.365		

SD: Standard deviation

than children without anemia. Another study observed that language skills, environmental sound perception, and motor development were lower in children with chronic iron deficiency compared to those without iron deficiency.[26] In our study, children with speech disorders had significantly lower iron levels than the healthy group. The ROC curve analysis revealed that an iron threshold of 44 µg/dl distinguished between the patient and control groups with 25.4% sensitivity and 92.31% specificity. This threshold may serve as an important criterion for treatment planning and follow-up in the patient group.

In a study by Yasin et al.[27] the most common cause of language and speech delays in children was found to be developmental language disorders. Similarly, our study identified developmental language disorders as the most frequent cause.

Limitations

This study had a limited sample size, with 163 participants, which may impact the generalizability of the findings. Conducting studies with larger sample sizes would yield more reliable and comprehensive results. Additionally, the research was conducted in a single pediatric clinic, which may limit the diversity of the sample. Addressing these limitations in future studies and following the recommendations provided could enhance our understanding of the roles of iron, vitamin B12, and vitamin D in children with speech disorders, ultimately improving diagnostic capabilities and clinical practice.

CONCLUSION

Language and speech disorders appear to be common within society. When evaluating children with speech disorders, it is crucial to monitor iron, vitamin D, and vitamin B12 levels to enhance treatment success and prevent potential future complications. Further clinical studies are essential to establish stronger, evidence-based conclusions on this topic.

ETHICAL DECLARATIONS

Ethics Committee Approval

Ethics committee approval was obtained from Kırşehir Ahi Evran University Faculty of Medicine Clinical Researches Ethics Committee (Date: 21/02/2023, Decision No: 2023-04/29).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

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Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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