Özgün Çalışma / Original Article

Ankara Eğt. Arş. Hast. Derg., 2025 ; 58(2) : 46-49
DOI: 10.20492/aeahtd.1644557

An evaluation of auditory perception in patients with vitamin B12 deficiency

B12 vitamini eksikliği olan hastalarda işitme algısının değerlendirilmesi

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ABSTRACT

Aim: The aim of our study was to investigate the effect of vitamin B12 deficiency on auditory perception using the Amsterdam Inventory for Auditory Disability and Handicap (AIADH).

Material and Method: Fifty-one adult patients diagnosed with vitamin B12 deficiency (<200 pg/mL) and followed-up at the internal diseases clinic, and 51 age- and sex-compatible healthy controls with no vitamin B12 deficiency (>200 pg/mL) were included in this prospective, case-control study. All the patients' thyroid function tests, iron, ferritin, folic acid values and complete blood counts were within normal ranges. All underwent full ear, nose, and throat examinations and pure tone audiometry and tympanometry measurements. The AIADH was applied to all the participants, and the results were compared between the groups.

Results: Vitamin B12 deficiency and control groups both consisted of 34 women and 17 men, and no significant difference was observed between the groups in terms of age or gender (p=0.781 and p=1.00, respectively). AIADH scores were significantly higher in the vitamin B12 deficiency group than in the control group (p< 0.001). The AIADH scores of women with vitamin B12 deficiency were significantly higher than those of the women in the control group (p< 0.001). AIADH scores were also significantly higher in the men with vitamin B12 deficiency than in the men from the control group (p< 0.001). AIADH scores was significantly higher in individuals with vitamin B12 deficiency than in those with normal vitamin B12 levels.

Conclusion: The results of our study support that vitamin B12 deficiency has a deleterious effect on auditory perception in individuals without hearing loss, irrespective of gender.

Keywords: Vitamin B12, auditory perception, cochlear synaptopathy.

ÖZET

Amaç: Çalışmamızın amacı, Amsterdam İşitsel Engellilik ve Engellilik Envanteri (AIADH) kullanarak B12 vitamini eksikliğinin işitme algısı üzerindeki etkisini araştırmaktır.

Gereç ve Yöntem: Bu prospektif vaka kontrol çalışmasına, İç Hastalıkları Polikliniğinde B12 vitamini eksikliği (Vit B12 <200pg/mL) tanısıyla takip edilen 51 erişkin hasta ile yaş ve cinsiyet uyumlu, B12 vitamini eksikliği olmayan (Vit B12 >200pg/mL) 51 kişilik sağlıklı kontrol grubu dahil edildi. Hastaların tamamının tiroid fonksiyon testleri, demir, ferritin, folik asit değerleri ve tam kan sayımı normal aralıktaydı. Çalışmaya dahil edilen tüm katılımcılara tam kulak burun boğaz muayenesi ile saf ses odyometrisi ve timpanometri ölçümleri yapıldı. Daha sonra tüm katılımcılara AIADH uygulandı ve sonuçlar gruplar arasında karşılaştırıldı.

Bulgular: B12 vitamini eksikliği ve kontrol grubu 34'er kadın ve 17'şer erkek hastadan oluşmakta olup, gruplar arasında yaş ve cinsiyet açısından istatistiksel olarak anlamlı farklılık bulunmamıştır (sırasıyla p=0.781, p=1.00). AIADH skorları B12 vitamini eksikliği olan grupta kontrol grubuna göre anlamlı olarak artmıştır (p< 0.001). B12 vitamini eksikliği olan kadınların AIADH skorlarının, kontrol grubundaki kadınların AIADH skorlarına göre anlamlı olarak arttığı görülmüştür (p< 0.001). B12 vitamini eksikliği olan erkeklerin AIADH skorlarının, kontrol grubundaki erkeklerin AIADH skorlarına göre anlamlı derece arttığı görülmüştür (p< 0.001). AIADH puanları, B12 vitamini eksikliği olan bireylerde B12 vitamini seviyeleri normal olanlara göre önemli ölçüde daha yüksekti.

Sonuç: Çalışmamızın sonuçları B12 vitamini eksikliğinin işitme kaybı olmayan bireylerde cinsiyetten bağımsız olarak işitme algısı üzerinde olumsuz bir etkisi olduğu görüşünü desteklemektedir.

Anahtar Kelimeler: B12 vitamini, işitme algısı, koklear sinaptopati.

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Makale geliş tarihi / Submitted: Şubat / February 2025

Makale kabul tarihi / Accepted: Ağustos / August 2025

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INTRODUCTION

Vitamin B12 is a water-soluble vitamin largely found in meat, milk, eggs, fish, and shellfish. It is a micronutrient that serves as an assistant factor in essential biochemical reactions. It acts as a cofactor in the synthesis of methionine from homocysteine and folic acid, and in the synthesis of succinyl-CoA from biotin and methylmalonyl-CoA. The spectrum of diseases associated with vitamin B12 deficiency is a wide one. Deficiency can lead to hematological problems, particularly megaloblastic anemia, neurodegenerative diseases, sensory losses, paresthesia, weakness, and impaired reflexes (1). Myelin damage involving astrocytes and microglia, axonal degeneration with demyelination, and baroreflex dysfunction affecting the sympathetic regulation of the autonomous nervous system are thought to constitute the pathogenic mechanism involved in the development of neuropathy in vitamin B12 deficiency (2).

Auditory perception allows the individual to communicate with others via speech or music. It also plays an important role in warning against and directing events (3). Patients who are unable to understand speech in noisy settings and who experience communication difficulties in daily life, despite possessing normal audiometric threshold levels, can be encountered in otorhinolaryngological practice (4). Vitamin B12 deficiency is thought to be capable of causing cochlear pathology and hearing loss via dysmyelination, demyelination, or axonopathy by affecting cellular metabolism. However, some studies have found no evidence to support this (5).

Amsterdam Inventory for Auditory Disability and Handicap (AIADH) used to evaluate auditory perception was developed by Kramer et al. in 1995 (6). The reliability and validity of the Turkish-language version were confirmed by Müjdeci et al. in 2016 (7). The AIADH consists of 30 questions concerning sound distinction, speech intelligibility in noise, sound location, speech intelligibility in quiet, and detection of sounds. Possible answers for each question are almost always (0 points), frequently (1 point), occasionally (2 points), and almost never (3 points). Items 18 and 30 are concerned with music and are reverse-scored. Total possible scores vary between 0 and 90. Higher scores indicate a greater hearing disability (6,7).

No previous studies have shown the effect of vitamin B12 deficiency on auditory perception in adults without hearing loss. The aim of our study was to investigate the effect of vitamin B12 deficiency on auditory perception using the AIADH and thus to contribute to the existing literature.

MATERIAL AND METHOD

Approval for the study was obtained from Kastamonu University clinical research ethical committee, Türkiye, prior to commencement (decision No. 2024-KAEK-64, dated 26.09.2024). All procedures involving human participants were carried out in conformity with institutional ethical standards (the Kastamonu University ethical committee) and the 1964 Declaration of Helsinki. Also, written informed consent forms were obtained from the all patients.

Fifty-one adult patients diagnosed with vitamin B12 deficiency (<200 pg/mL) and followed-up at the Kastamonu Training and Research Hospital internal diseases clinic between October and December 2024, and 51 age- and sex-compatible healthy controls with no vitamin B12 deficiency (>200 pg/mL) were included in this prospective, case-control study. All the patients' thyroid function tests, iron, ferritin, folic acid values and complete blood counts were within normal ranges. Patients with anemia were excluded from the study. All patient underwent full ear, nose, and throat examinations and pure tone audiometry and tympanometry measurements. Participants with an average pure tone threshold above 20 dB were excluded from the study. Individuals with histories of outer or middle ear disease, with hearing loss, or with histories of otological surgery were excluded. The AIADH was subsequently applied to all the participants, and the results were compared between the groups.

The distributions of the research data were examined using skewness and kurtosis coefficients and histogram charts. Parametric tests were applied in case of normally distributed variables and non-parametric tests in case of non-normal distribution. Chi-square and Mann-Whitney U tests were used in the analysis of research data. Descriptive statistics for the research variables were expressed as mean, standard deviation, and mean values. Statistical analyses were performed on Statistical Package for Social Sciences version 26.0 software (IBM Corp., NY, USA). A significance level of $p<0.05$ was set for the analyses.

RESULTS

Vitamin B12 deficiency and control groups both consisted of 34 women and 17 men, and no significant difference was observed between the groups in terms of age or gender (p=0.781 and p=1.00, respectively). The clinical and laboratory characteristics of the study groups are summarized in

Table 1: The clinical and laboratory characteristics of the study groups

Characteristics	Vitamin B12 deficiency group (mean±SD)	Control group (mean±SD)
n	51	51
Age, years	41,02 ±13,47	41,69 ±10,43
Females, n (%)	34 (66,7)	34 (66,7)
Males, n (%)	17 (33,3)	17 (33,3)
Serum vitamin B12, pg/mL	134,98 ±26,72	280,84 ±74,77
AIADH score	17,75 ±9,83	7,29 ±4,38

Data were expressed as n (%) and mean±standard deviation. AIADH: Amsterdam Inventory for Auditory Disability and Handicap, SD: Standard deviation.

AIADH scores were significantly higher in the vitamin B12 deficiency group than in the control group ($p< 0.001$). The AIADH scores of women with vitamin B12 deficiency were significantly higher than those of the women in the control group ($p< 0.001$). AIADH scores were also significantly higher in the men with vitamin B12 deficiency than in the men from the control group ($p< 0.001$). The comparison of AIADH scores according to gender in vitamin B12 deficiency and control groups is summarized in

Table 2: A comparison of AIADH scores and gender in the vitamin B12 deficiency and control groups

	Groups	n	Mean ±SD	Median (min-max)	Z	p
AIADH Score	Vitamin B12 deficiency	51	17,75 ±9,83	16 (1-41)	-5,85	<0.001
	Control	51	7,29 ±4,38	6 (2-19)		
	Vitamin B12 deficiency (F)	34	16,97 ±9,94	15 (1-39)	-4,38	<0.001
	Control (F)	34	7,5 ±4,55	5,5 (2-19)		
	Vitamin B12 deficiency (M)	17	19,29 ±9,72	17 (7-41)	-3,99	<0.001
	Control (M)	17	6,88 ±4,12	6 (3-15)		
	Vitamin B12 deficiency (F)	34	16,97 ±9,94	15 (1-39)	-0,96	=0.33
	Vitamin B12 deficiency (M)	17	19,29 ±9,72	17 (7-41)		
	Control (F)	34	7,5 ±4,55	5,5 (2-19)	-0,36	=0.71
	Control (M)	17	6,88 ±4,12	6 (3-15)		

Chi-square and Mann-Whitney U tests were applied. Data were expressed as n, mean±standard deviation and median values (min-max). SD: Standard deviation, F: Female, M: Male, AIADH: Amsterdam Inventory for Auditory Disability and Handicap.

DISCUSSION

Audiological complaints may be present in individuals with normal hearing. Individuals with normal audiograms are known to be capable of experiencing difficulty in understanding speech, particularly in acoustically unsuitable settings (8). Hind et al. reported audiograms within normal limits in 4% of adults who underwent

audiological examination due to difficulty understanding speech in noise (9). This shows that hearing is not only associated with sensory transduction, but is also a complex phenomenon linked to central auditory processing (8). Bruckmann et al. reported that even mild loss of hearing in elderly individuals exerts a significant effect on speech recognition. This supports the idea that auditory perception is also linked to variables such as auditory processing, attention, and memory (10). Hearing is a cognitive function directly related to the pathophysiological processes that cause dementia. As age progresses, cognitive decline and auditory loss become a significant problem. Diagnosis of hearing loss may be delayed due to cognitive disorders. When auditory processing is examined, it is seen that hearing interacts with attention, executive skills, working memory, motor response, language and socio-emotional condition (11). It is also known that estrogen has a protective effect on hearing function. Since hearing sensitivity is related to estrogen levels, women are protected against hearing loss until menopause, and it is known that high levels of endogenous estrogen are associated with better hearing function (12).

Lunardelo et al. examined mental awareness, auditory perception, and speech perception in a noisy environment in patients who described hearing difficulty despite having normal audiograms. The authors concluded that changes perceived by individuals but that could not be identified at auditory sensitivity evaluations occurred in auditory performances in daily living activities in individuals aged over 30. They also reported that elderly individuals in particular experienced difficulty in speaking in the presence of noise. They recommended that further studies be performed to assess other mechanisms in the auditory process (13). Vasilkov et al. investigated cochlear neural degeneration in individuals with tinnitus and normal hearing. Those authors reported that tinnitus is an important predictor of cochlear nervous reactions. They concluded that participants with tinnitus but normal hearing had peripheral nerve deficiencies, and that the impact of cochlear damage on the central auditory pathways resulted in the development of abnormal perception. They also emphasized the importance of developing diagnostic analyses capable of detecting cochlear neural degeneration in order to be able to rebuild the damaged inner ear and treat tinnitus in the future (14).

Karlı et al. investigated the effects of vitamin B12 deficiency on otoacoustic emissions. Those authors reported a significant association between cochlear dysfunction and vitamin B12 deficiency in individuals with normal hearing and recommended the routine measurement of vitamin B12 levels in the evaluation of auditory functions (15). In contrast, in their study of elderly individuals, Berner et al. reported no association between folic acid, vitamin B12, or homocysteine and hearing levels (16). Rodrigues et al. performed a recent systematic review of the relationship between vitamin B12 deficiency and hearing loss. That research reported that vitamin B12 has a potential role in the preservation of auditory health, observed findings indicating cochlear dysfunction in vitamin B12 deficiency, and concluded that vitamin B12 supplementation can lead to improvements, albeit minor, in the severity of tinnitus and hearing thresholds. However, those authors also concluded that further studies were now needed to fully elucidate the link between auditory health and vitamin B12 levels and the effect of possible treatments (17). In the present study, auditory perception measured using the AIADH in individuals with vitamin B12 deficiency and normal hearing thresholds was significantly lower compared to individuals with normal vitamin B12 levels. No difference in AIADH scores was observed between men and women with vitamin B12 deficiency. This also supports the idea that vitamin B12 deficiency has a deleterious effect on auditory perception in individuals without hearing loss, irrespective of gender.

Limitation of our study is subjective nature of the method employed. Auditory perception can be affected by individual, cultural, and social factors. Objective assessments in electrophysiological studies such as electrocochleography are needed to fully determine the effect of vitamin B12 deficiency on auditory perception and cochlear functions.

CONCLUSION

AIADH scores was significantly higher in individuals with vitamin B12 deficiency than in those with normal vitamin B12 levels. This supports that vitamin B12 deficiency has a deleterious effect on auditory perception in individuals without hearing loss, irrespective of gender.

Acknowledgements

We want to thank to Mr. Carl Austin Nino Rossini for his precious contribution in language approval and Sezai Sacid Anbar for his precious contribution in statistical analysis.

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