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ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

Sensory Sensitivity in Migraine without Aura Patients is Correlated with the Duration of the Disease and Comorbid Anxiety

Aurasız Migren Hastalarında Duyusal Hassasiyet, Hastalık Süresi ve Komorbid Anksiyete ile İlişkilidir

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ABSTRACT

Introduction: Migraine is a common neurological disease with a variety of sensory symptoms including pain, visual disturbances, nausea, vomiting, dizziness, hypersensitivity to light, sound and smell. Migraine patients can perceive some sensory signals as harmful and stressful due to differences in sensory processing. These signals can be a source of stress and anxiety for migraine patients. Related to these, the aim of our study was to examine the relationship between sensory profiles and pain characteristics and anxiety and depression findings in migraine patients.

Materials and Methods: A total of 28 female migraine patients were evaluated for pain characteristics, sensory modulation with the Sensory Profile Questionnaire, and depression and anxiety with Anxiety and Depression Scale. In order to investigate the relationships between these variables, correlation analyses were conducted.

Results: Our results suggest that migraine patients may have sensory processing disorders due to differences in their sensory profiles. Sensory profile scores representing sensory processing of migraine patients were found to be different from norm values. Migraine that starts at a younger age and lasts longer is associated with sensory processing disorders. In addition, patients with higher sensory sensitivity and sensory avoidance have more anxiety.

Conclusion: Our study results will shed light on treatments that holistically address the physical, cognitive, and emotional factors of migraine patients depending on the relationships between sensory processing, anxiety and depression states and pain characteristics.

Keywords: Migraine, sensory processing, pain, anxiety, depression

ÖZ

Giriş: Migren ağrı, ışığa, sese ve kokuya aşırı duyarlılık, görme bozuklukları, bulantı, kusma ve baş dönmesi gibi duyusal semptomlarla karakterize nörolojik bir hastalıktır. Duyusal uyarıları zararlı ve stresli olarak algıladıkları için migren hastalarının depresyon ve anksiyete bozuklukları yaşama olasılıkları daha yüksektir. Bunlara bağlı olarak çalışmamızın amacı migren hastalarında duyusal modülasyon, ağrı, anksiyete ve depresyon arasındaki ilişkiyi incelemektir.

Materyal ve Metot: Toplam 28 kadın migren hastasının ağrı özellikleri, Duyu Profili Anketi ile duyusal modülasyonları ve Anksiyete ve Depresyon Ölçeği ile anksiyete ve depresyon durumları değerlendirilmiştir. Bu değişkenler arasındaki ilişkiler korelasyon analizleri ile incelenmiştir.

Bulgular: Sonuçlarımız, migren hastalarının duyusal profillerindeki farklılıklara bağlı olarak duyusal işlemleme bozukluklarına sahip olabileceğini göstermektedir. Migren hastalarının duyusal işlemlerini temsil eden duyusal profil skorlarının norm değerlerden farklı olduğu bulunmuştur. Daha genç başlangıç yaşı ve daha uzun migren süresi duyusal işleme bozuklukları ile ilişkili bulunmuştur. Duyusal hassasiyeti ve duyusal kaçınması yüksek olanların anksiyeteleri daha fazladır.

Sonuç: Çalışma sonuçlarımız, duyusal işlemleme, anksiyete ve depresyon durumları ile ağrı özellikleri arasındaki ilişkilere bağlı olarak migren hastalarının fiziksel, bilişsel ve duygusal faktörlerini bütünsel olarak ele alan tedavilere ışık tutacaktır.

Anahtar Sözcükler: Migren,, duyusal işlemleme, ağrı, anksiyete, depresyon

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Introduction

Migraine, which is the second most common type of headache among primary headaches, is characterized by sensory symptoms including pain, nausea, vomiting, dizziness, hypersensitivity to light, sound and odor and visual disturbances (1,2).

Sensory processing is a continuum that involves the perception, modulation, and integration of sensations by the central nervous system and the generation of behavioral responses (3). Difficulties at any step in this process can lead to impaired sensory processing and altered reactions to sensory stimuli. The sensory processing model defined by Dunn explains the relationship between an individual's behavioral responses and neurological thresholds. Based on this model, patients with hypersensitivity have higher neurological thresholds, while neurons of patients with lower thresholds are more easily stimulated. Low neurological thresholds lead to increased response to stimuli from the environment and hypersensitivity (4).

Migraine patients have different visual, auditory and somatosensory stimulus processes than healthy individuals (5). It is also suggested that abnormal multisensory integration is observed in migraine patients. The interaction between different sensory modalities creates various clinical characteristics of a migraine attack. Studies have reported that stimulation from visual, auditory or other modality increases the severity of headache in migraine patients (6).

The sensitivities experienced during the migraine pain period (ictal period) inhibit the person from continuing his/her normal life with the anxiety of having pain at any time even if there is no pain (7,8). Studies have shown that individuals with migraine can experience these sensory symptoms even in the absence of pain and sensitivity and that they hesitate to make plans due to their anxiety about pain (9). Individuals who are more sensitive to sensory stimuli may see sensory events as a source of stress. These individuals are more likely to have psychiatric comorbidities such as anxiety disorders, avoidant personality disorder, social phobia and depression (10). In this context, the purpose of our study was to analyze the associations between sensory profiles and pain characteristics with anxiety and depression findings in migraine patients.

Material and Methods

Participants

In our study, 28 female migraine patients admitted to the Department of Neurology at Gazi University Hospital were analyzed. Ethical approval was obtained from the Local Ethics Committee before the study. All patients were informed before the study and their informed consents were obtained.

The inclusion criteria were having migraine without aura as defined by ICHD-III, being in the interictal period, being female between the ages of 18–35. Exclusion criteria were abnormal findings on neurologic examination, presence of chronic pain syndrome, prophylactic treatment for migraine, chronic migraine, pregnancy, and presence of intracranial space-occupying lesion. Our study was conducted with female migraine patients since migraine disease is more common in women and there are relatively few studies with female migraine patients (11,12).

Evaluation Tools

The participants were evaluated using the Sociodemographic Information Form, Clinical Characteristics Form, "Adolescent/Adult Sensory Profile Questionnaire (AASP)", and "Hospital Anxiety and Depression Scale (HADS)".

The Sociodemographic Information Form, which was prepared by the researchers for our study, includes information about the participants' age, educational status, and marital status.

"The Adolescent/Adult Sensory Profile Questionnaire" consists of 60 questions and is a 5-point Likert type scale (13). This scale evaluates a total of 6 different sensory areas including activity level, taste/smell, motor, visual, tactile, and auditory processing. Dunn's Sensory Processing Model, which forms the basis of the scale, consists of 4 quadrants: low registration (responding less or slower than normal to sensory stimuli), sensory seeking (enjoying sensory stimuli), sensory sensitivity (having a low threshold for sensory stimuli and responding more than normal to stimuli) and sensory avoidance (avoiding sensory stimuli) (10). The assessment of the scale is made over these 4 quadrants and each quadrant is scored between 5 and 75 points. The score obtained from a quadrant indicates the extent to which the person exhibits the characteristics of that processing pattern. The quadrant scores of the participants are evaluated according to the existing norm values by grouping them as "much less than most people, less than most people, similar to most people, more than most people and much more than most people" (14).

The Clinical Characteristics Form was developed by the researchers to obtain detailed information about the general pain characteristics of migraine patients. In this form, the age at which migraine started, frequency of pain, duration of migraine, the severity of the most recent migraine pain, intervals between hospital visits, and the most severe migraine pain, average pain level felt in the last 3 months, number of painful days in the last 3 months, and other findings accompanying the pain are questioned.

"The Hospital Anxiety and Depression Scale" assesses the emotional and cognitive aspects of anxiety and depression (15). The scale threshold value for anxiety score was determined as 10 and the threshold value for depression score was determined as 7 (16).

Statistical Analysis

We used the Statistical Package for Social Sciences® (IBM Statistical Package for Social Sciences (SPSS) program

version 28.0) to analyze the participant data. Numerical data are given as mean ± standard deviation and nominal data are given as %. Since the study included less than 50 participants, the Shapiro-Wilk test was used to examine the distribution of continuous variables. The α level was determined as 0.05. Pearson Correlation Analysis was used to analyze parametric data and Spearman Correlation Analysis was used for nonparametric data. Correlation coefficient was accepted as weak between 0–0.3, moderate between 0.3–0.5 and strong between 0.5–1. The level of significance was chosen as $p<0.05$ and a 95% confidence interval was determined. G*Power software (Düsseldorf, Germany) Version 3.1 to calculate the sample size was used. The sample was evaluated using a power of 95% (type II error rate=5%), type I error rate=0.05 and effect size=0.846.

Results

We examined 34 voluntary women migraine patients who met the eligibility criteria. Since 1 patient had migraine with aura and 5 patients subsequently refused to participate, a total of 28 participants were evaluated.

Sociodemographic Characteristics

Patients' sociodemographics are presented in Table 1.

Pain Characteristics

The distribution of age of migraine onset of participants (CF1), migraine duration (CF2), pain frequency (CF3), severity of the most recent migraine pain (CF4), severity of the most severe migraine pain (CF5), intervals between hospital visits (CF6) number of painful days in the last 3 months (CF7) and average pain level felt in the last 3 months (CF8) are given in Table 2. The distribution of other findings accompanying the participants' pain is given in Figure 1.

According to Spearman Correlation Analysis, it was found that the CF8 had a positive moderate correlation with CF4 (r=0.461, p=0.014) and a positive strong correlation CF5 (r=0.535, p=0.003). In addition, a moderate positive correlation was found between CF8 and the symptoms of vomiting (r=0.408, p=0.031), numbness (r=0.410, p=0.030), and dizziness (r=0.383, p=0.044) accompanying migraine.

Results of Sensory Profile Assessment

The sensory profile assessment consists of 4 quadrants: "Q1: Low registration, Q2: Sensory seeking, Q3: Sensory sensitivity and Q4: Sensory avoidance". The average quadrant values of the participants were 33.82±5.51 for Q1, 45.43±6.54 for Q2, 47.79±8.88 for Q3 and 47.11±7.63 for Q4. The quadrant scores of the participants and their distribution according to norms are given in Table 3.

Table 1. Sociodemographics

N=28	Participants
Age, mean ± SD	
Years	22.92±4.92
Education, n (%)	
Bachelor's degree	24(85.7)
Master's degree	2(7.1)
Doctorate degree	2(7.1)
Marital Status, n (%)	
Single	24(85.7)
Married	4(14.3)

N: Total number of participants; **SD:** Standard deviation.

Table 2. Clinical features of migraine patients

	N=28	Migraine patients
CF1	**Age at onset of migraine,** mean ± SD	15.75±4.52
CF2	**Migraine duration,** mean ± SD	7.18±5.84
CF3	**Pain frequency,** n (%)	
	Less than once a month	1(3.6)
	1–4 times a month	17(60.7)
	Many times a week	10(35.7)
CF4	**Severity of the most recent migraine pain,** mean±SD	6.68±1.39
CF5	**Severity of the most severe migraine pain,** mean±SD	8.75±1.29
CF6	**Intervals between hospital visits,** n (%)	
	1–6 months	3(10.7)
	6 months-1 year	5(17.9)
	1 year and more	20(71.4)
CF7	**Number of painful days in the last 3 months,** mean±SD	23.18±24.74
CF8	**Average pain level felt in the last 3 month,** mean±SD	6.33±2.45

N: Total number of participants, **SD:** Standard deviation

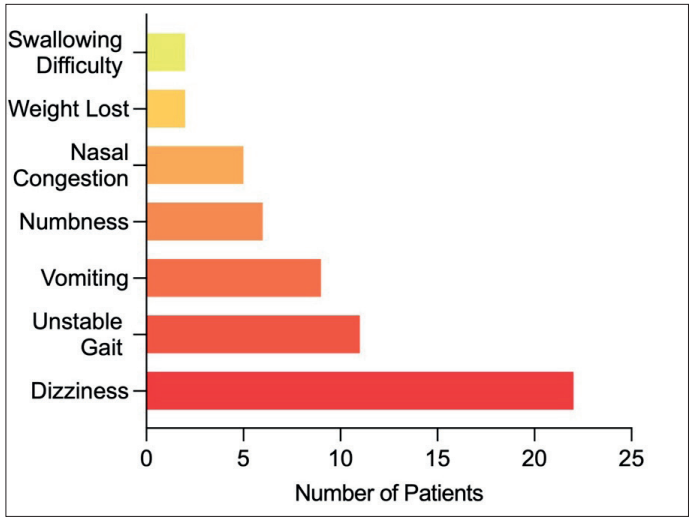

Figure 1. Distribution of other findings accompanying the participants' pain.

Table 3. Distribution of participants' quadrant scores according to norms

N=28	Much less than most	Less than most	Similar to most	More than most	Much more than most
Q1, n (%)	-	-	20(71.4)	6(21.4)	2(7.1)
Q2, n (%)	2(7.1)	7(25)	19(67.9)	-	-
Q3, n (%)	-	-	8(28.6)	9(32.1)	11(39.3)
Q4, n (%)	-	-	6(21.4)	8(28.6)	14(50)

N: Total number of participants; **Q1:** Low registration; **Q2:** Sensory seeking; **Q3:** Sensory sensitivity; **Q4:** Sensory avoidance".

Table 4. Correlation of sensory profile quadrant scores with clinical features

N=28	CF1	CF2	CF3	CF4	CF5	CF6	CF7	CF8	Q1	Q2	Q3	Q4
CF1	1											
CF2	-0.710**	1										
CF3	-0.166	-0.100	1									
CF4	-0.003	-0.123	0.178	1								
CF5	-0.232	0.198	0.112	0.391*	1							
CF6	-0.102	-0.075	-0.181	-0.285	-0.111	1						
CF7	-0.101	-0.240	0.788**	0.227	0.373	-0.003	1					
CF8	-0.200	0.034	0.117	0.461*	0.535**	-0.233	0.240	1				
Q1	-0.460*	0.323	-0.065	0.111	-0.134	0.004	-0.249	-0.012	1			
Q2	-0.054	0.028	0.098	-0.437*	-0.180	-0.125	0.005	-0.206	0.010	1		
Q3	-0.518**	0.481**	0.050	0.148	0.178	0.163	-0.123	0.108	0.656**	-0.056	1	
Q4	-0.246	0.130	0.128	0.121	0.145	0.104	-0.041	0.102	0.518**	-0.170	0.694**	1

Spearman correlation analysis: *Correlation is significant at 0.05 level; **Correlation is significant at 0.01 level.
N: Total number of participants; CF1:Age at onset of migraine; CF2:Migraine duration; CF3:Pain frequency; CF4:Severity of the most recent migraine pain; CF5:Severity of the most severe migraine pain; CF6:Intervals between hospital visits; CF7:Number of painful days in the last 3 months; CF8:Average pain level felt in the last 3 months; Q1:Low registration; Q2:Sensory seeking; Q3:Sensory sensitivity; Q4:Sensory avoidance.

According to the results of Pearson Correlation Analysis, strong positive correlation was found between Q1 and Q3 (r=0.758, p=0.000) and Q4 (r=0.527, p=0.004) scores of migraine patients. There was also a strong positive correlation between Q3 and Q4 scores (r=0.690, p=0.000). A negative moderate correlation was found between Q2 and Q4 scores (r=-0.399, p=0.035).

Adolescent/Adult Sensory Profile Questionnaire also examined a total of 6 different sensory domains: activity level, taste/smell, motor, visual, tactile, and auditory processing. Motor processing shows the reaction to sensory and vestibular stimuli, taste/smell processing shows the response to taste and smell stimuli, visual processing shows the response to visual stimuli, tactile processing shows the response to skin and tongue touch stimuli, auditory processing shows the response to what is heard, and activity level shows participation and desire in activities of daily living. The mean sensory processing scores of the participants were 23.57±3.93 for taste/smell, 24.36±4.44 for motor, 29.32±5.96 for visual, 35.61±7.14 for tactile, 29.21±4.34 for activity, and 32.07±5.99 for auditory.

According to Pearson Correlation Analysis, there was a positive correlation between motor and tactile processing scores (r=0.396, p=0.037). There was also a positive correlation between visual and auditory processing scores (r=0.561, p=0.002).

Results of Anxiety and Depression Assessment

The mean anxiety score of migraine patients was 10.07±1.09, while the mean depression score was 5.64±2.97. The analysis revealed that 57.2% of the participants had anxiety and 35.7% had depression according to HADS. In addition, a moderate positive correlation was found between anxiety scores and depression scores of migraine patients (r=0.390, p=0.040).

Sensory Profile Correlation with Clinical Features

According to the results of Spearman Correlation Analysis, a negative moderate correlation was found between Q1-low registration scores and age at migraine onset (r=-0.460, p=0.014). A negative moderate correlation was found between Q2-sensory seeking scores and the severity of their most recent headache (r=-0.437, p=0.020). In addition, moderate positive correlation was found between Q3-sensory sensitivity score and migraine duration (r=0.481, p=0.010). A negative strong correlation was found between Q3-sensory sensitivity score and age at migraine onset (r=-0.518, p=0.005) (Table 4).

According to Spearman Correlation Analysis, when the relationship between sensory processing scores and clinical characteristics was examined, a negative strong correlation was found between tactile (r=-0.619, p=0.000) and motor processing (r=-0.559, p=0.002) scores and age at migraine onset. In addition, a positive moderate correlation was found between the activity process score and pain frequency (r=0.411, p=0.030).

When the relationship between the symptoms accompanying migraine and sensory profile was examined, a negative moderate correlation was found between Q3-sensory sensitivity scores and weight loss (r=-0.378, p=0.047) and between Q2-sensory seeking scores and swallowing difficulty (r=-0.414, p=0.029).

Sensory Profile Correlation with Anxiety and Depression

According to Pearson Correlation Analysis, a positive moderate correlation was found between anxiety scores of migraine patients and Q3 (r=0.377, p=0.048) and Q4 scores (r=0.381, p=0.045), while a negative strong correlation was found between Q2 scores (r=-0.520, p=0.005) (Table 5).

Table 5. Correlation of sensory profile quadrant scores with anxiety and depression scores

N=28	Depression score	Anxiety score	Q1	Q2	Q3	Q4
Depression score	1					
Anxiety score	0.390*	1				
Q1	0.323	0.264	1			
Q2	-0.099	-0.520**	-0.060	1		
Q3	0.306	0.377*	0.758**	-0.191	1	
Q4	0.132	0.381*	0.527**	-0.399*	0.690**	1

N: Total number of participants; Q1:Low registration; Q2:Sensory seeking; Q3:Sensory sensitivity; Q4:Sensory avoidance.

Discussion

In our study, we examined the relationship between sensory profiles representing sensory processing, clinical characteristics and anxiety and depression levels of female migraine patients. The main findings of this study are as follows: *i)* Sensory processing disorders can be seen in migraine patients, *ii)* Younger age of onset and longer duration of migraine are associated with sensory processing disorders, *iii)* Sensory processing disorders and anxiety levels of migraine patients are related.

According to the literature, migraine is a common public health problem especially among women in the reproductive age group (11). In our study, female migraine patients between the ages of 18–35 were analyzed in accordance with the literature.

Migraine is described as a neurological disorder caused by the dysfunction in the brain stem and diencephalon regions that alters the perception of sensory stimuli. Sensory threshold changes in migraine explain the sensitivities in the somatosensory system, auditory system, visual system, taste, and smell system. A wide range of symptoms and neurologic disorders observed in all stages of migraine are associated with involvement of complex and extensive brain areas. Migraine patients are thought to have involvement of more than one neural network due to symptoms such as sensory, affective, cognitive and autonomic dysfunctions (7). It is known that migraine patients have stronger connections between the central grey substance, a modulator of somatic pain, and many cortical areas involved in pain processing than healthy controls (17). Parallel to the literature, in our study, it was found that the sensory profile scores representing the sensory processing of migraine patients differed from the norm values. According to our results, migraine patients were found to have much higher sensory sensitivity and sensory avoidance than most individuals. Patients scoring much higher in the sensory sensitivity and sensory avoidance quadrants than most individuals perform better on sensory perception or discrimination tasks (4). High sensory sensitivity indicates a stronger physiological response to stimuli and slower habituation with a lower neurological threshold. High sensory avoidance is associated with a stronger physiological reaction to the stimulus, in other words, avoidance and neutralization of sensory stimuli (18,19). Depending on the sensitivity that develops against sensory stimuli, painful disturbing responses in individuals lead to a defense reaction and cause the development of social isolation (20).

Our study revealed that sensory processing disorders in migraine patients were correlated with migraine onset age and disease duration. According to our results, patients with longer disease duration and lower migraine onset age had more sensory processing impairments. Prior studies have shown that lower migraine onset age is correlated with more severe symptoms (21).

Migraine is a neurological disorder that can be accompanied by many different medical and psychiatric comorbidities. It is important to identify and treat comorbidities in order to prevent increased disability and reduced quality of life due to migraine. When community-based studies in the literature are examined, it is revealed that various psychiatric comorbidities are quite common in migraine patients (22). Zwart et al. using the HADS reported that people with migraine had a higher risk of having depression (relative risk 2.7) or anxiety disorders (relative risk 3.2) compared to healthy controls. In addition, depression and anxiety were found to be more likely to occur as the frequency of pain increased (23). Sharma et al. conducted a study on 71 migraine patients using the same scale with us and found that depression and anxiety were more prevalent in migraine patients than in healthy controls. In our study, mean anxiety scores of women with migraine were found to be above the threshold value (24). According to HADS, 57.2% of the participants had anxiety symptoms and 35.7% had depression symptoms. Price et al. reported that anxiety was associated with sensory avoidance and sensitivity in migraine patients in their study using AASP and HADS (25). In our study, a positive correlation was found between sensory sensitivity and sensory avoidance scores and anxiety scores. The results of our study are consistent with other studies showing that anxiety levels are high in people with sensory processing disorders (26,27).

Conclusion

Based on previous studies highlighting the correlations between sensory processing disorders and emotional state, intervention programs for migraine patients should be designed from a holistic perspective. Considering the relationships between the sensory processing, anxiety and depression states and pain characteristics of migraine patients, our study will guide treatment plans that holistically address the physical, cognitive, and emotional factors of migraine patients.

Ethics Committee Approval: Ethical approval was obtained from Yüksek İhtisas University Non-Invasive Research Ethics Committee (dated 05.11.2021 and numbered 2021/16/02).

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References

1. Rasmussen BK, Jensen R, Schroll M, Olesen J. Epidemiology of headache in a general population -a prevalence study. J Clin Epidemiol. 1991;44(11):1147–1157. https://doi.org/10.1016/0895-4356(91)90147-2
2. Boran HE, Bolay H, Gantenbein HA. R, Pohl H. Sensory processing and sensorimotor integration in migraine. In: Coppola G, Chen W-T, editors. Neurophysiology of the Migraine Brain. Cham, Switzerland: Springer; 2021. pp. 113-131. https://doi.org/10.1007/978-3-030-56538-1_9
3. Ayres AJ. Sensory integration and learning disorders. Western Psychological Services; 1973. 294 p.
4. Dunn W. The impact of sensory processing abilities on the daily lives of young children and their families: a conceptual model. Infants Young Child. 1997;9(4):23–35. https://doi.org/10.1097/00001163-199704000-00005
5. Noseda R, Burstein R. Migraine pathophysiology: anatomy of the trigeminovascular pathway and associated neurological symptoms, cortical spreading depression, sensitization, and modulation of pain. Pain. 2013;154:S44–S53. https://doi.org/10.1016/j.pain.2013.07.021
6. Kelman L, Tanis D. The relationship between migraine pain and other associated symptoms. Cephalalgia. 2006;26(5):548–553. https://doi.org/10.1111/j.1468-2982.2006.01075.x
7. Goadsby PJ, Holland PR, Martins-Oliveira M, Hoffmann J, Schankin C, Akerman S. Pathophysiology of migraine: a disorder of sensory processing. Physiol Rev; 2017. https://doi.org/10.1152/physrev.00034.2015
8. Schwedt TJ. Multisensory integration in migraine. Curr Opin Neurol. 2013;26(3):248. https://doi.org/10.1097/WCO.0b013e328360edb1
9. Harriott AM, Schwedt TJ. Migraine is associated with altered processing of sensory stimuli. Curr Pain Headache Rep. 2014;18:1–7. https://doi.org/10.1007/s11916-014-0458-8
10. Brown C, Dunn W. Adolescent/adult sensory profile. San Antonio, TX, USA; Pearson; 2002. https://doi.org/10.1037/t56705-000
11. Bolay H, Ozge A, Saginc P, Orekici G, Uludüz D, Yalın O, et al. Gender influences headache characteristics with increasing age in migraine patients. Cephalalgia. 2015;35(9):792–800. https://doi.org/10.1177/0333102414559735
12. Ertas M, Baykan B, Kocasoy Orhan E, Zarifoglu M, Karli N, Saip S, et al. One-year prevalence and the impact of migraine and tension-type headache in Turkey: a nationwide home-based study in adults. J Headache Pain. 2012;13(2):147–157. https://doi.org/10.1007/s10194-011-0414-5
13. Brown C, Tollefson N, Dunn W, Cromwell R, Filion D. The adult sensory profile: Measuring patterns of sensory processing. Am J Occup Ther. 2001;55(1):75–82. https://doi.org/10.5014/ajot.55.1.75
14. Aydın MŞ. Adolesan/yetişkin duyu profili anketi Türkçe uyarlamasının geçerlilik güvenilirlik çalışması; 2015.
15. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand. 1983;67(6):361–370. https://doi.org/10.1111/j.1600-0447.1983.tb09716.x
16. Aydemir O. Hastane anksiyete ve depresyon olçeği Türkçe formunun geçerlilik ve güvenilirliği. Turk Psikiyatri Derg. 1997;8:187–280.
17. Mainero C, Boshyan J, Hadjikhani N. Altered functional magnetic resonance imaging resting-state connectivity in periaqueductal gray networks in migraine. Ann Neurol. 2011;70(5):838–845. https://doi.org/10.1002/ana.22537
18. Dunn W, Brown C. Factor analysis on the Sensory Profile from a national sample of children without disabilities. Am J Occup Ther. 1997;51(7):490–495. https://doi.org/10.5014/ajot.51.7.490
19. Metz AE, Boling D, DeVore A, Holladay H, Liao JF, Vlutch KV. Dunn's model of sensory processing: an investigation of the axes of the four-quadrant model in healthy adults. Brain Sci. 2019;9(2):35. https://doi.org/10.3390/brainsci9020035
20. Senkowski D, Höfle M, Engel AK. Crossmodal shaping of pain: a multisensory approach to nociception. Trends Cogn Sci. 2014;18(6):319–327. https://doi.org/10.1016/j.tics.2014.03.005
21. Stewart WF, Bigal ME, Kolodner K, Dowson A, Liberman JN, Lipton RB. Familial risk of migraine. Variation by proband age at onset and headache severity. Neurology. 2006;66(3):344–348. https://doi.org/10.1212/01.wnl.0000196640.71600.00
22. Smitherman TA, Burch R, Sheikh H, Loder E. The prevalence, impact, and treatment of migraine and severe headaches in the United States: a review of statistics from national surveillance studies. J Headache Pain. 2013;53(3):427–436. https://doi.org/10.1111/head.12074
23. Zwart JA, Dyb G, Hagen K, Ødegård K, Dahl A, Bovim G, et al. Depression and anxiety disorders associated with headache frequency. The Nord-Trøndelag health study. Eur J Neurol. 2003;10(2):147–152. https://doi.org/10.1046/j.1468-1331.2003.00551.x
24. Sharma K, Remanan R, Singh S. Quality of life and psychiatric co-morbidity in Indian migraine patients: A headache clinic sample. Neurol India. 2013;61(4):355. https://doi.org/10.4103/0028-3886.117584
25. Price A, Sumner P, Powell G. Subjective sensory sensitivity and its relationship with anxiety in people with probable migraine. J Headache Pain. 2021;61(9):1342–1350. https://doi.org/10.1111/head.14219
26. Engel-Yeger B, Dunn W. The relationship between sensory processing difficulties and anxiety level of healthy adults. Br J Occup Ther. 2011;74(5):210–216. https://doi.org/10.4276/030802211X13046730116407
27. Rieke EF, Anderson D. Adolescent/Adult Sensory Profile and obsessive-compulsive disorder. Am J Occup Ther. 2009;63(2):138–145. https://doi.org/10.5014/ajot.63.2.138