Non-Audiological and Audiological Factors as Indicators of Hearing Aid Satisfaction in Adults

Erişkinlerde İşitme Cihazı Memnuniyetinin Göstergesi Olarak Odyolojik ve Odyolojik Olmayan Faktörler

Ayşenur KÜÇÜK CEYHAN[a], Leyla TÜRE[b]

[a]Department of Audiology, Health Sciences University Health Sciences Faculty, İstanbul, Türkiye
[b]Department of Otorhinolaryngology, Başkent University Faculty of Medicine, Ankara, Türkiye

ABSTRACT Objective: This study aims to determine the prominent factor of hearing aid (HA) satisfaction in individuals using HAs by examining the effects of audiologic factors and self-esteem on HA satisfaction, and to create evidence-based data for counseling and rehabilitation services related to HA. **Material and Methods:** Eighty six individuals using bilateral HA aged from 55-80 (71.37±7.95) years participated. Word Recognition Scores (WRS), Random Gap Detection Test (RGDT), Rosenberg Self-Esteem Scale, and the Turkish version of International Outcome Inventory for Hearing Aids (IOI-HA-TR) were used as assessment tools. Linear regression and correlation analysis were used to determine the amount of variance explained by effective factors in HA satisfaction. **Results:** There was a significant positive and low-level relationship between the level of satisfaction with the HA (IOI-HA-TR) and the Rosenberg Self-Esteem Scale Score (Spearman correlation analysis; r=0.393, p<0.001). There was no significant relationship between the level of satisfaction with the HA (IOI-HA-TR) and the audiological factors evaluated in the study (RGDT and WRS) (Spearman correlation analysis, p>0.05). While self-esteem explains 26.2% of the variation in satisfaction (R²=0.262) (linear regression analysis; p<0.01), the ability to process temporal features of the sound (RGDT) explains 6.9% (R²=0.069) (linear regression analysis; p<0.05). **Conclusion:** This study emphasizes that the self-esteem of individuals is a prominent factor in satisfaction with hearing aids, and the importance of enriching audiological rehabilitation with multidisciplinary practices.

Keywords: Hearing aid satisfaction; auditory processing;
self-esteem; word recognition

ÖZET Amaç: Bu çalışmanın amacı, odyolojik faktörler ve benlik saygısının işitme cihazı [hearing aid (HA)] memnuniyeti üzerindeki etkisini inceleyerek, HA memnuniyetinde öne çıkan faktörü belirlemek ve HA ile ilgili danışmanlık ve rehabilitasyon hizmetleri için kanıta dayalı veriler oluşturmaktır. **Gereç ve Yöntemler:** Çalışmaya, 55-80 (71,37±7,95) yaş arası çift taraflı HA kullanan 86 kişi katılmıştır. Değerlendirme araçları olarak Konuşmayı Ayırt Etme Puanı (KAEP), Random Gap Detection Test (RGDT), Rosenberg Benlik Saygısı Ölçeği ve Uluslararası İşitme Cihazları Değerlendirme Envanteri Türkçe versiyonu [International Outcome Inventory for Hearing Aids (IOI-HA-TR)] kullanılmıştır. HA memnuniyetinde etkili olan faktörlerin açıkladığı varyans miktarını belirlemek için doğrusal regresyon ve korelasyon analizi kullanılmıştır. **Bulgular:** HA'dan memnuniyet düzeyi (IOI-HA-TR) ve Rosenberg Benlik Saygısı Ölçeği skoru arasında pozitif yönde ve düşük düzeyde anlamlı ilişki bulunmuştur (Spearman korelasyon analizi; r=0,393, p<0,001). HA'dan memnuniyet düzeyi (IOI-HA-TR) ve çalışmada değerlendirilen odyolojik faktörler (RGDT ve KAEP) arasında anlamlı bir ilişki bulunmamıştır (Spearman korelasyon analizi, p>0,05). Benlik saygısı memnuniyetteki değişimin %26,2'sini (R²=0,262) (doğrusal regresyon analizi; p<0,01) açıklarken, sesin zamansal özelliklerini işleme yeteneği (RGDT) %6,9'unu (R²=0,069) (doğrusal regresyon analizi; p<0,05) açıklamaktadır. **Sonuç:** Bu çalışma, bireylerin benlik saygılarının HA'dan memnuniyetlerinde öne çıkan bir faktör olduğunu ve odyolojik rehabilitasyonun multidisipliner uygulamalarla zenginleştirilmesinin önemini vurgulamaktadır.

Anahtar Kelimeler: İşitme cihazı memnuniyeti; işitsel işlemleme;
benlik saygısı; konuşmayı ayırt etme

New technologies are added to hearing aid (HA), which are one of the tools used in the rehabilitation of hearing loss, to support the verbal communication needs of users. However, in some cases, although the benefit of the individual from the HA is demonstrated by audiological tests, there are cases where the individuals are not satisfied with the HA. Benefiting from a HA does not always result in being satisfied with the HA.[1]

HA satisfaction is affected by factors relating to the person, the HA, and the environment.[2] Personal characteristics like age, gender etc., hearing thresholds, auditory processing, the features of HA, disability experiences, personal features, and expectations have been carried out.[3-7] The results of these studies vary. Speech recognition with HA is an important factor in HA satisfaction. In recent years, auditory processing abilities, which are involved in distinguishing speech, have also been investigated in this context.

Non-audiological factors such as personality traits also have a significant effect on HA satisfaction. Self-esteem is defined as individuals' positive or negative attitude towards themselves. High self-esteem is associated with assertiveness, strong coping skills, persistence, and happiness.[8] In clinical practices, it is observed that despite the inadequate audiological factors, personal traits can also ensure that the person is satisfied with the HA. In this context, our study aimed to determine the effect of temporal processing, speech discrimination and self-esteem on HA satisfaction and to determine the prominent factor thus to create evidence-based data for counseling and rehabilitation services related to HA. Determining the needs of individuals using HA or candidates for HA will provide a broad perspective in auditory rehabilitation and will help audiologists progress faster with multidisciplinary approaches.

MATERIAL AND METHODS

PARTICIPANTS

Eighty six individuals aged from 55 to 80 (71.37±7.95) years participated to the study at İstanbul Aydın University Hospital between October 2021 and February 2022. All were HA users, and the duration of HA use was from 2 to 6 year and have moderate sensorineural hearing loss. All participants passed the Mini Mental Test with a minimum score of 24, indicating normal cognitive function. And all participants stated that they received adequate counselation for HAs. None of them had chronical middle ear diseases, long-term use of ototoxic drugs, bothersome tinnitus complaint and a physical problem that makes it difficult to handled a HA. The composite gap detection thresholds were all (≤10 ms) and pure tone avarage (PTA) (0.5-1-2 kHz)

was 30-65 dB (49.72±10.19) for all individuals and they were users of middle or high segment HA. To reject the hypothesis with 80% power, it was found that at least 64 individuals with hearing loss is necessary (satisfaction score difference mean 0.5; standard deviation 1). The sample size was calculated using Power the Sample Size was calculated using SPSS (Version 22.0, IBM Corp., Armonk, NY USA) program. All individuals gave informed consent and patient anonymity was preserved. The study was approved by the ethics committee of İstanbul Aydın University (date: September 15, 2021, no: 2021-572) and written permission was granted from all individuals. All procedures followed were in accordance with the Helsinki Declaration (as revised in Tokyo 2004). The written informed consent was obtained from participants to participate in the study.

PROCEDURES

The study was a cross-sectional, single center design. Participants took part in the following measurement methods.

RANDOM GAP DETECTION TEST

Two tones are presented with a variable time interval between sounds. Patients state that the sound they hear is 1 or 2 tones. The gap detection threshold is the shortest time interval between 2 tones perceived by the patient.[9] The tests were performed in quiet rooms at Industrial Acoustic Company (IAC) standards using clinical audiometer (Resonance R37A; Italy). The composite gap detection threshold was the average of results reported across the 500-1,000-2,000 Hz at 40 dB SL.

PTA AND SPEECH AUDIOMETRY

Audiometric tests were performed in quiet rooms at IAC standards using clinical audiometer (Resonance R37A; Italy). Air conduction hearing thresholds were measured in the range of 125-8,000 Hz and bone conduction hearing thresholds in the range of 500-4,000 Hz. The speech reception threshold and Speech Discrimination Score were determined by live voice.

ACOUSTIC IMMITANCEMETRY

Tympanometric evaluation (with 226 Hz probe tone) and acoustic reflex measurements were performed using tympanometer (Resonance R36M; Italy).

INTERNATIONAL OUTCOME INVENTORY FOR HEARING AIDS (THE TURKISH VERSION)

This inventory consists of 7 questions in total. Each question is evaluated out of 5 points. One represents the worst and 5 the best. The higher the score determined by the inventory result, the higher the HA satisfaction is.[10]

ROSENBERG'S SELF-ESTEEM SCALE

The 10-item scale is 4-point Likert type. It contains 5 positive and 5 negative items. The scale ranges from 0-30. Scores between 15 and 25 are within normal range; scores below 15 suggest low self-esteem.

STATISTICAL ANALYSIS

SPSS (Version 22.0, IBM Corp., Armonk, NY USA) program was used for statistical analysis. The conformity to normal distribution was evaluated by Shapiro-Wilk and Kolmogorov-Smirnov test. Descriptive statistics were given with frequency, percentage, mean, standard deviation (SD), minimum, maximum values. Correlation analysis was used when examining the relationship of continuous variables on each other, and simple and multiple regression analyses were used for the effects of dependent variables on the independent variable. In pairwise group comparisons of variables, independent samples t-test was used for normally distributed variables, and Mann-Whitney U test was used for non-normally distributed variables. All analyses were evaluated at the 95% confidence interval, and significance was evaluated at the $p < 0.05$ level.

█ RESULTS

Characteristics of the participants and descriptive statistics of all variables were presented in Table 1.

The relationship between Random Gap Detection Test (RGDT) and Turkish version of International Outcome Inventory for Hearing Aids (IOI-HA-TR) scores, the relationship between Speech Discrimination Score and IOI-HA-TR scores, the relationship between the Rosenberg's Self-Esteem Scale and IOI-HA score were presented in Table 2.

TABLE 1: Characteristics of the participants and descriptive statistics of all variables.

	n	Minimum-maximum	Mean±SD
Age (years)	86	55-80	71.37±7.95
Gender(male/female)	86 (36/50)		
PTA (dBHL)	86	30-65	49.72±10.19
WRS (%)	86	20-84	60.05±14.8
IOI-HA	86	15-35	27.32±6.1
Rosenberg Self-Esteem Scale	86	21-40	27.05±2.7
RGDT (ms)	86	2.0-10.0	5.23±1.9

SD: Standard deviation; WRS: Word Recognition Score; PTA: Pure tone average (average of values at 500, 1000, 2000 Hz); RGDT: Random Gap Detection Test.

TABLE 2: The relationship between IOI-HA scores and RGTD/WRS/Rosenberg's Self-Esteem Scale.

		IOI-HA	RGDT ms	WRS (%)	Rosenberg's Self-Esteem Scale
RGDT ms	r value	0.169*	1,000		
	p value	0.12			
	n	86	86		
WRS (%)	r value	0.041**		1,000	
	p value	0.709			
	n	86		86	
Rosenberg's Self-Esteem Scale	r value	0.393***			1,000
	p value	<0.001			
	n	86			86
IOI-HA	r value	1,000			
	p value				
	n	86			

*Spearman correlation analysis p>0.05; **Spearman correlation analysis; p<0.005; ***Spearman correlation analysis; r=0.393, p<0.001; IOI-HA: International Outcome Inventory for Hearing Aids; RGTD: Random Gap Detection Test; WRS: Word Recognition Scores.

There was no statistically significant relationship between the RGDT score and IOI-HA-TR score. There was no statistically significant relationship between the Word Recognition Scores (WRS) and the IOI-HA-TR scores. There was a significant positive and low level relationship between Rosenberg Self-Esteem Scale and IOI-HA scores (Spearman correlation analysis, p>0.05).

The effect of RGDT, WRS, and Rosenberg's Self-Esteem Scale scores on IOI-HA-TR score were presented in Table 3.

The Rosenberg's Self-Esteem Scale score has a statistically significant effect on the IOI-HA (linear regression analysis; p<0.001). A one-unit change on

TABLE 3: The effect of RGDT, WRS and Rosenberg's Self-Esteem Scale scores on IOI-HA score.										
The Independent variable **Rosenberg's Self-Esteem Scale**	**The dependent variable**	**B**	**Standard error**	**β**	**t**	**p value**	**R**	**R²**	**F**	**p value**
		1.133	0.207	0.512	5.467	<0.001	0.512	0.262	29.885	<0.001**
RGDT (ms)	**IOI-HA**	0.816	0.331	0.263	2.494	0.015	0.263	0.069	6.221	0.015*
WRS (%)		-0.003	0.045	-0.008	-0.076	0.939	0.008	0.001	0.006	0.939

*p<0.05; **p<0.01 linear regression analysis; RGDT: Random Gap Detection Test; WRS: Word Recognition Scores; IOI-HA: International Outcome Inventory for Hearing Aids.

Rosenberg's Self-Esteem Scale score increases satisfaction by 0.512 times, and Rosenberg's Self-Esteem Scale score IOI-HA explains 26.2% of the change (R^2=0.262). The RGDT score has a statistically significant effect on the IOI-HA score (linear regression analysis; p=0.015<0.05). A one-unit change on RGDT increases the IOI-HA-TR score by 0.263 times, and the RGDT score explains 6.9% of the change in the IOI-HA-TR score (R^2=0.069).

DISCUSSION

Individuals' satisfaction with HAs is not always consistent with the benefit of HAs determined by audiological measurements. Despite the relatively weak audiological factors, there are people who are very satisfied with their HA and vice versa. In this context, it was aimed to examine the effect of certain audiological factors and non-audiological self-esteem factor on HA satisfaction and to determine the prominent factor. Linear regression and correlation analyzes were used to determine the amount of variance explained by the predictive factors in HA satisfaction declared by individuals. The research revealed that individuals' self-esteem is an important factor in their satisfaction with HA.

In this study, significantly positive and low level relationship between self-esteem scale and HA satisfaction were found. Consistent with the results of our study, there are studies that determined that personal characteristics affect HA satisfaction.[11,12] A review by Knudsen et al. stated that personality is consistently related to HA satisfaction, while other factors like age, gender, hearing sensitivity, age of onset hearing loss had non-significant or mixed relationships.[13] Saunders and Cienkowski found that self-esteem is linked to successful HA use.[14] Regarding to

theese studies and ours, self-esteem is an important factor for HA satisfaction due to its association with feelings of self-confidence, self-worth, self-awareness and self-acceptance. An individual with high self-esteem may have a high level of awareness and acceptance of the difficulties arising from hearing loss. In addition, they may be more willing to take action to recognize the HA, know its limitations, and take the necessary measures to increase its usefulness. It is thought that all these will contribute to creating the right expectations for the HA, and thus to the level of satisfaction.

The other factor whose effect on HA satisfaction was investigated in this study is temporal processing (RGDT), which contributes significantly to speech intelligibility in noise. The significant effects of both self-esteem and RGDT score on HA satisfaction were observed. However, self-esteem explains the alter in satisfaction with HA with a larger ratio than temporal processing skill. According to the our results, no significant correlation was found between temporal resolution ability and satisfaction with the HA. There are studies which stated a positive correlation between the central auditory processing disorder (CAPD) tests scores and satisfaction with the HA. Davidson et al., used the Gap in noise (GIN) test for temporal resolution in their study with the elderly population and stated that GIN test score was an important predictor of HA satisfaction. In the same study, the effect of self- efficiency, which is one of the non-audiological factors, was evaluated. Similar to our results, they found that self- efficiency had a greater effect on explaining variance than GIN test.[5] In another study about HA satisfaction, the combined spectral and temporal resolution (F&T) test and interaural-phase-difference detection test were used for

auditory processing. It was found that temporal resolution may influence the ability to benefit from fluctuations in background noise, and thus HA satisfaction.[15] However, Kwak et al. found there were no significant and consistent relationship between patient's HA satisfaction (IOI) with CAPD tests.[16]

In our study, there wasn't a significant relationship between WRS and HA satisfaction levels. Contrary to our results, many studies have concluded that WRS is an important predictor for estimates of HA satisfaction. Wu et al. and Chang et al. determined the speech recognition rates in quiet environment, and found that WRS was strongly correlated with overall IOI-HA scores.[3,17] Mendel and Davidson et al. evaluated speech recognition using speech in noise tests and found a positive correlation between the obtained results and objective-subjective HA usage performance.[5,18] The comparision between the results in noise and in quiet environment is believed to be valuable. Lack of testing in noise is seen as a limitation of our study. On the other hand, Kwak et al., Dornhoffer at al., and Wang et al., stated that HA benefit assessed with audiologic measures were poor predictors of patient-reported benefit.[16,19,20]

It should be noted that all of the patients included in the study stated that they received adequate counseling on HA. Despite the lack of objective measures for contents and effects of counselation, it is thought to help establish realistic expectations about HA. In our study, it is thought that realistic expectations may have an effect on the lack of a relationship between audiological factors and HA satisfaction.

Similar to the results we obtained, the studies which show no relationship between audiological factors and HA satisfaction that when validating the HA outcome, both the objective audiometric tests and subjective questionnaire should be performed.

CONCLUSION

The results obtained from our study show that personality traits may be a factor that can take precedence over audiological features on the satisfaction of HA users. These results emphasize the importance of determining the personality traits of HA candidates, including self-esteem. It is thought that planning the auditory rehabilitation process by taking into account personality characteristics, increasing the duration and scope of counseling services in auditory rehabilitation, and maintaining the auditory rehabilitation process within a multidisciplinary studies when necessary will increase the success in the use of HA.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: Ayşenur Küçük Ceyhan, Leyla Türe; Design: Ayşenur Küçük Ceyhan; Control/Supervision: Ayşenur Küçük Ceyhan, Leyla Türe; Data Collection and/or Processing: Leyla Türe, Ayşenur Küçük Ceyhan; Analysis and/or Interpretation: Ayşenur Küçük Ceyhan, Leyla Türe; Literature Review: Ayşenur Küçük Ceyhan, Leyla Türe; Writing the Article: Ayşenur Küçük Ceyhan; Critical Review: Ayşenur Küçük Ceyhan.

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