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An investigation into the validity and reliability of the Hyperacusis Handicap Questionnaire for adults with normal auditory function

Normal işitsel fonksiyona sahip yetişkinler için Hiperakuzi Engellilik Anketinin geçerlik ve güvenirliğinin araştırılması

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ABSTRACT

Objectives: The study aimed to investigate the validity and reliability of the Hyperacusis Handicap Questionnaire (HHQ) and to determine a cutoff score using the Khalfa Hyperacusis Questionnaire (KHQ).

Patients and Methods: A total of 210 participants (161 females, 49 males; mean age: 27.9±8.0 years; range, 18 to 65 years) were included between August 2023 and April 2024. The instrument was translated into Turkish, after which its validity and reliability were assessed through exploratory factor analysis and confirmatory factor analysis. The HHQ and KHQ were utilized to establish a cutoff score with receiver operating characteristic analysis.

Results: The scale demonstrated a high level of internal consistency, with a Cronbach's alpha of 0.92. Exploratory factor analysis indicated that the scale accounted for 52.51% of the total variance. Confirmatory factor analysis confirmed that the scale exhibited both perfect and acceptable fit. A cutoff score was established at 35.

Conclusion: The HHQ, comprising 21 items across three factors, was established as a valid and reliable measurement tool. Its application, in conjunction with other diagnostic instruments, will provide valuable guidance in the assessment and monitoring of hyperacusis.

Keywords: Hyperacusis, questionnaire validation, sound sensitivity.

ÖZ

Amaç: Çalışmanın amacı, Hiperakuzi Engellilik Anketi (HEA)'nin geçerlik ve güvenirliğini araştırmak ve Khalfa Hiperakuzi Anketi (KHA)'ni kullanarak bir kesme puanı belirlemekti.

Hastalar ve Yöntemler: Çalışmaya Ağustos 2023 - Nisan 2024 tarihleri arasında toplam 210 katılımcı (161 kadın, 49 erkek; ort. yaş: 27.9±8.0 yıl; dağılım, 18-65 yıl) dahil edildi. Ölçek Türkçeye çevrildi, ardından geçerlik ve güvenirliği açımlayıcı faktör analizi ve doğrulayıcı faktör analizi ile değerlendirildi. Alıcı işletim karakteristiği analizi ile kesme puanını belirlemek için HEA ve KHA kullanıldı.

Bulgular: Ölçek, 0.92 Cronbach alfa değeri ile yüksek düzeyde iç tutarlılık gösterdi. Açımlayıcı faktör analizi ölçeğin toplam varyansın %52.51'ini açıkladığını gösterdi. Doğrulayıcı faktör analizi ölçeğin hem mükemmel hem de kabul edilebilir uyum sergilediğini doğruladı. Kesme puanı 35 olarak belirlendi.

Sonuç: Üç faktörde 21 maddeden oluşan HEA'nın, geçerli ve güvenilir bir ölçüm aracı olduğu tespit edildi. Diğer tanısal araçlarla birlikte uygulanması, hiperakuzinin değerlendirilmesi ve izlenmesinde değerli bir rehberlik sağlayacaktır.

Anahtar sözcükler: Hiperakuzi, anket geçerliği, ses duyarlılığı.

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Hyperacusis can be defined as an unusual lack of tolerance to normal environmental sounds or excessive or inappropriate responses to sounds that are not normally threatening or disturbing.[1] Since hyperacusis is a subjective condition, it is difficult to define or measure using objective measures.[2] Sounds may be perceived as annoyingly loud, uncomfortable, frightening, or painful. When people with hyperacusis experience pain at much lower sound levels than people with normal hearing, this is referred to as painful hyperacusis. When sounds of moderate intensity are perceived as much louder than a person with normal hearing, this is called loudness hyperacusis. Hyperacusis also includes subcategories such as discomfort hyperacusis and anxiety hyperacusis.[3,4]

The number of population studies on hyperacusis is limited. Although the number of studies on hyperacusis has increased in recent years, there is limited consistency between the methods used in these studies and the populations studied. This can make comparisons between studies difficult. Prevalence stud report that it varies according to age, sex, medical condition, and hearing status.[5]

Subjective assessment questionnaires for hyperacusis are used to measure a patient's level of sensitivity to sounds, the discomfort the condition causes, and its impact on quality of life. The questionnaires provide a way of understanding the symptoms experienced by the individual, how sensitive they are to sounds, and how this sensitivity affects their daily life. It is also an important assessment tool for identifying symptoms, monitoring the treatment/therapy process, and creating a personalized treatment/therapy plan. These questionnaires are an important part of the clinical assessment process and provide valuable information for healthcare professionals to better understand the individual's condition.[3,6,7]

There are few questionnaires available to assess hyperacusis.[8-10] The most widely used of these is the 14-item Khalfa Hyperacusis Questionnaire (KHQ), which has been adapted to many languages including Turkish.[8,11-13] Studies on the psychometric properties of the KHQ show that the questionnaire is controversial in accurately identifying hyperacusis.[14-16] Another tool developed in Turkish is the Decreased Sound Tolerance Scale-Screening. It is a screening scale used for the preliminary examination to differentiate between types of decreased sound tolerance.[17] The Hyperacusis Handicap Questionnaire (HHQ), developed by Prabhu and Nagaraj,[2] is a questionnaire that takes into account the subtypes of hyperacusis, the effects of hyperacusis, and the reactions to hyperacusis, and it has been validated for Hindi. The HHQ was developed to assess the presence of hyperacusis in the population with tinnitus. However, validity and reliability studies have not been conducted for the general population.

The aim of this study was to adapt the HHQ into Turkish and to determine its validity and reliability for the general population, demonstrating that it accurately and consistently assesses the condition in individuals with hyperacusis. This could enable the HHQ to be reliably used in clinical and research settings.

PATIENTS AND METHODS

The HHQ was initially translated into Turkish. Subsequently, the Turkish adaptation of the HHQ was administered to a sample of 210 adults (161 females, 49 males; mean age: 27.9±8.0 years; range, 18 to 65 years) between August 2023 and April 2024. The participants were individuals who sought audiologic evaluation at the audiology clinic of the Ankara University and were confirmed to have normal hearing. Each participant completed both the HHQ and KHQ. Individuals with preexisting neurologic or otologic conditions, as well as those with hearing impairment, were excluded from the study. A written informed consent was obtained from each patient. The study protocol was approved by the Ankara University Ethics Committee (date: 27.07.2023, no: İ07-476-23). The study was conducted in accordance with the principles of the Declaration of Helsinki.

In determining the suitable sample size for studies focused on validity and reliability, it is advisable to aim for a participant count that is 5 to 10 times the total number of items within the scale. In the present study, we included a sample size that was 10 times the number of items, resulting in 210 participants (with the scale comprising 21 items). The HHQ and KHQ questionnaires were completed by the participants. Participation was voluntary, and data were fully stored and analyzed.

Hyperacusis Handicap Questionnaire contains a total of 21 questions. It consists of three subscales. Each item has one response: never (0 points), sometimes (2 points), and always (4 points). The scores are divided into a total scale ranging from 0 to 84 points and three subscales that address the functional, social, and emotional domains of the complaint.

The KHQ comprises two fundamental components designed to evaluate individuals with reduced sound tolerance. The initial component includes three open-ended questions aimed at gauging noise exposure, tolerance to noise, and auditory issues. The subsequent component consists of 14 self-reported items that are

quantifiable. Each response to the questions/items is rated on a 4-point scale: none (0 points), a little (1 point), quite a lot (2 points), and a lot (3 points). The highest possible score on the questionnaire is 42, with a cutoff score of 28. This assessment is divided into three subdimensions: *(i)* attention, *(ii)* social dimension, and *(iii)* emotional dimension. The Turkish validity and reliability of this tool were established by Erinc and Derinsu.[11]

Translation and retranslation of the HHQ

The creators of the questionnaire authorized the translation of the HHQ into Turkish. To facilitate this process, three independent translators rendered the original questionnaire into Turkish. An observer subsequently compared these three translations, resulting in the formation of the Turkish version of the questionnaire. A back-translation was then conducted to assess the equivalence between the original and the back-translated versions. This process involved multiple iterations of forward and backward translations until a satisfactory level of equivalence was achieved. The final version was then produced and underwent a thorough review for linguistic quality. Following all necessary modifications, the Turkish hyperacusis questionnaire was finalized.

Statistical analysis

Data were analyzed using IBM SPSS version 27.0 and IBM SPSS Amos version 23.0 software (IBM Corp., Armonk, NY, USA). Frequency, percentage, and mean ± standard deviation (SD) were used to summarize the data. Prior to factor analysis, the suitability of the data for factor analysis was assessed using the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were conducted to examine construct validity, and item-total correlation coefficients and Cronbach's alpha internal consistency coefficients were calculated for reliability studies. Fit indices that could be considered as commonly used fit indices, including goodness-of-fit index (GFI), adjusted GFI (AGFI), comparative fit index (CFI), normed fit index (NFI), incremental fit index (IFI), relative fit index (RFI), root mean square residual (RMR), and root mean square error of approximation (RMSEA), were reported. In addition, the chi-square test and the ratio of the chi-square value to degrees of freedom were also considered. Receiver operating characteristic analysis was used to calculate the cutoff value. A p-value <0.05 was considered statistically significant.

RESULTS

The majority of participants (76.7%) were female. The mean age of the males and females were 28.9±8.5 and 27.5±7.9 years, respectively.

Before conducting the construct validity analyses of the HHQ, KMO and Bartlett's tests were conducted to examine the suitability of the sample.

As the KMO coefficient approached 1, the data were considered suitable for analysis, with 1 meaning that there was a perfect fit. Data sets >0.70 were suitable for factorization. Bartlett's test of sphericity was used to assess whether the correlation matrix was suitable for factor analysis. If the resulting values were statistically significant, Bartlett's test indicated that the data were suitable for factor analysis. According to the test results shown in Table 1, the KMO coefficient was 0.923, and the chi-square value of Bartlett's test was 1852.754 (df=210), with statistical significance (p<0.001).

Exploratory and confirmatory factor analysis

The breakpoints of the scale are shown in a scree plot in Figure 1, which demonstrates that the scale has a three-factor structure.

Table 2 shows the mean, standard deviation, item-total correlation, extraction, factor loading, and factors of the items of the scale. The item with the highest mean was Item 2, and the items with the lowest mean were Items 7 and 14. Factor one consisted of seven items, factor two consisted of nine items, and factor three consisted of five items. The item with the highest factor loading was Item 12, and the item with the lowest factor loading was Item 7.

Table 1
Results of the KMO test and Bartlett's test

Kaiser-Meyer-Olkin	Measure of sampling adequacy	0.923
Bartlett's test of sphericity	Chi-square	1852.754
	Degree of freedom	210
	Significant	<0.001

KMO: Kaiser-Meyer-Olkin.

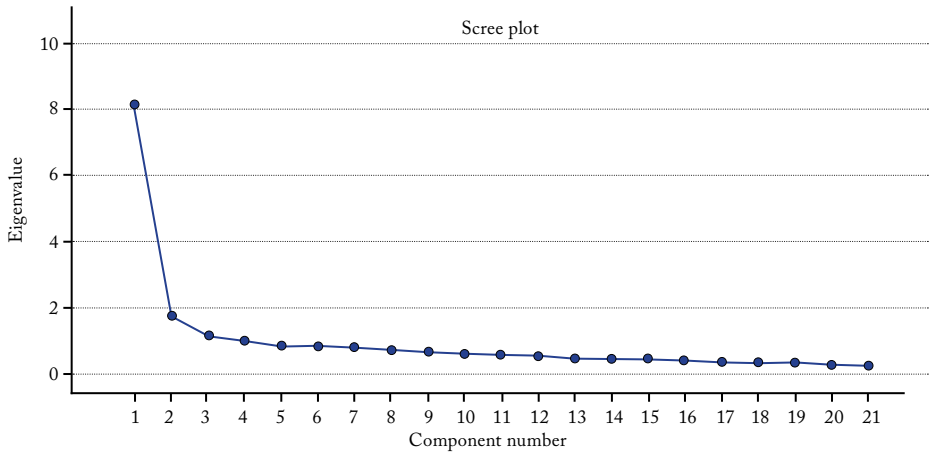

Figure 1. Scree plot of the Hyperacusis Handicap Questionnaire.

As a result of the EFA, the eigenvalues and variances explaining the final form of the structure are shown in Table 3. Exploratory factor analysis revealed that three of the scale items had eigenvalues >1 and explained 52.51% of the total variance. The percentage of total variance explained by the factors was 38.84% for the first factor, 8.24% for the second factor, and 5.43% for the third factor.

Table 2
The HHQ's distinguishing characteristics and factor structure

Item	Mean±SD	Item-total correlation	Extraction	Factor loading	Factors
1	1.714±1.013	0.509	0.455	0.626	1
2	2.314±1.139	0.572	0.553	0.691	1
3	1.961±1.106	0.656	0.615	0.672	1
4	1.428±1.259	0.641	0.559	0.561	3
5	1.109±1.178	0.534	0.575	0.713	3
6	1.695±1.150	0.488	0.464	0.632	3
7	0.628±1.064	0.310	0.349	0.494	2
8	1.523±1.072	0.622	0.505	0.534	3
9	1.604±1.132	0.664	0.532	0.512	3
10	1.285±1.207	0.666	0.521	0.489	2
11	1.095±1.222	0.580	0.467	0.571	2
12	0.781±1.140	0.586	0.581	0.715	2
13	1.000±1.111	0.597	0.595	0.623	2
14	0.628±1.028	0.478	0.546	0.695	2
15	1.066±1.223	0.496	0.407	0.521	2
16	2.123±1.313	0.612	0.583	0.574	1
17	1.952±1.097	0.561	0.469	0.605	1
18	1.314±1.184	0.506	0.565	0.68	1
19	0.981±1.057	0.603	0.563	0.685	2
20	0.676±1.025	0.617	0.561	0.673	2
21	1.600±0.934	0.622	0.562	0.602	1

HHQ: Hyperacusis Handicap Questionnaire; SD: Standard deviation.

Table 3
Factor eigenvalues and explained variances

Initial eigenvalues			Rotation sums of squared loadings		
Total	Variance (%)	Cumulative (%)	Total	Variance (%)	Cumulative %
8.156	38.84	38.84	3.965	18.882	18.882
1.732	8.246	47.086	3.946	18.792	37.674
1.14	5.43	52.516	3.117	14.841	52.516

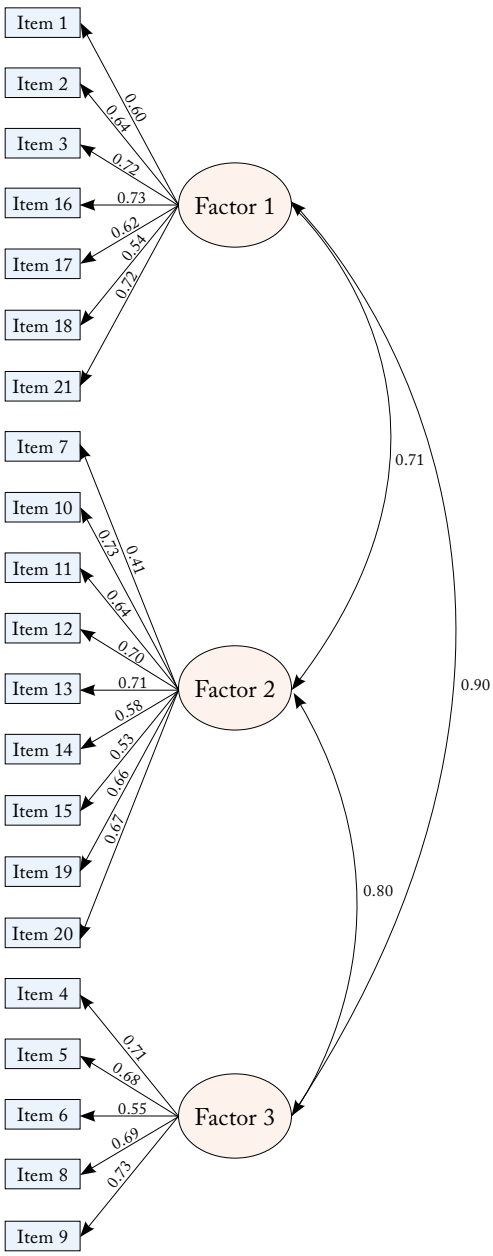

Figure 2. Confirmatory factor analysis path diagram of the Hyperacusis Handicap Questionnaire.

p=0.001, Chi-square/df=1.397, RMSEA= 0.044. HHQ: Hyperacusis Handicap Questionnaire; RMSEA: Root mean square error of approximation.

The path diagram obtained after CFA is shown in Figure 2, demonstrating that the factor loadings of the items in the scale varied between 0.41 and 0.73.

Table 4 shows the results of the CFA. When the fit indices were examined, the following values were found: chi-square=255.657, χ^2/sd=1.397, RMSEA=0.044, RMR=0.063, NFI=0.867, RFI=0.850, CFI=0.958, IFI=0.958, GFI=0.899, and AGFI=0.873. These values indicate that the model had a perfect and acceptable fit.

Looking at the reliability coefficients, the Cronbach's alpha coefficient for the whole scale was 0.92. Factor one had a Cronbach's alpha coefficients of the first, second, and third factors were 0.84, 0.85, and 0.80, respectively.

The scores of all items in the questionnaire were summed. As a result, the total scores of the participants were calculated. From these total scores, the cutoff value for patients and healthy individuals was 35.

Table 4
Confirmatory factor analysis fit values of the HHQ

Index of fit	Value
Chi-square (χ^2)	255.657
p	<0.001
Degree of freedom	210
Chi-square (df (χ^2/sd)	1.397
RMSEA	0.044
Root mean square residual	0.063
Normed fit index	0.867
Relative fit index	0.850
Comparative fit index	0.958
Incremental fit index	0.958
Goodness-of-fit index	0.899
Adjusted goodness-of-fit index	0.873

HHQ: Hyperacusis Handicap Questionnaire; RMSEA: Root mean square error of approximation.

DISCUSSION

This study assessed whether this scale accurately measures hyperacusis and provides consistent results, establishing the HHQ as a reliable tool in clinical practice and research. The results indicate that a valid and reliable Turkish version of the questionnaire was created. The HHQ was found to be successful in terms of construct and criterion validity, demonstrating that the scale can be used by clinicians in individuals with hyperacusis.

Cronbach's alpha should be calculated separately for each subscale, as each subscale should be able to express the main concept related to the subject.[18] In the KHQ validity and reliability study conducted by Oishi et al.,[19] the scores of participants with and without hyperacusis were compared. In this study, it was reported that Cronbach's alpha coefficients ranged from 0.77 to 0.92 for the total score. Furthermore, Cronbach's internal consistency coefficients were quite high (0.92) for the total score and also had high values for the attention (0.85), social (0.84), and emotional (0.77) dimensions. Another study reported a Cronbach's alpha coefficient of 0.89.[13] The Geräuschüberempfindlichkeits-Fragebogen (GÜF; German Questionnaire on Hypersensitivity to Sound) exhibited a reliability coefficient of 0.92, with minimal variation observed across its subscales.[20] The GÜF recorded a score of 0.82 for actional/somatic behavior, 0.83 for emotional reaction to external noises, and 0.81 for cognitive reactions to hyperacusis. The HHQ demonstrated similar reliability scores. In their investigation of the HHQ for individuals experiencing tinnitus, Prabhu and Nagaraj[2] determined that Cronbach's alpha coefficient for the scale was 0.85. In our study, Cronbach's alpha coefficient was 0.92 for the whole scale, 0.84 for the first factor, 0.85 for the second factor, and 0.80 for the third factor. These values are considered high and satisfactory. The similarity of Cronbach's alpha in different studies suggests that the scale may have intercultural validity. The scores of all the items of the questionnaire were summed, and as a result, the total scores of the participants were calculated. From these total scores, the cutoff value for patients and healthy subjects was determined to be 35. It can be concluded that individuals with a scale score exceeding 35 exhibited findings that supported the presence of hyperacusis.

Although hyperacusis is a common condition, it is difficult to reach patient groups with this diagnosis.[8,11] Therefore, it is thought that a more accurate approach may be to measure sensitivity to sound in general and interpret the results according to the distribution of the total score by applying this measurement to the whole population. The normal distribution of the total score shows that the scale is sensitive in distinguishing the individuals participating in the survey from the general population. The results of EFA indicated that the scale accounted for 52.51% of the overall variance. A 50% explanatory power is considered relatively modest in terms of scale validity. The original developers of the HHQ for the tinnitus population did not disclose total variance figures in their research; nevertheless, various language adaptations of the KHQ have reported total variance ranging from 46 to 63%.[8,11] It is posited that the variance observed in our investigation may stem from the exclusive reliance on self-reported measures to assess hyperacusis, coupled with the multitude of factors that can affect hyperacusis due to its intricate nature.

In this study, we analyzed 210 participants who completed both the HHQ and the KHQ. The KHQ validation study conducted in 2022 showed that the value of χ^2 was 125.334, and this was significant.[12] Moreover, GFI and RMSEA, which was 0.04 in the current study, was accepted since it was statistically significant, indicating that the research model was approved. Other indices such as Tucker-Lewis index, NFI, IFI, and CFI also confirmed the acceptability of the first and second order model. In another study, the results of the first-order CFA to assess the validity of the three-factor structure of the KHQ showed that the high loading factors of the items were statistically significant, and the fit indices of the measurement model (χ^2/df) and RMSEA were equal to 1.74 and 0.04, respectively, demonstrating the overall adequacy of the measurement model.[12] We found similar results in our study when the fit index values were analyzed based on the results of the CFA: χ^2=255.657, χ^2/sd=1.397, RMSEA=0.044, RMR=0.063, NFI=0.867, RFI=0.850, CFI=0.958, IFI=0.958, GFI=0.899 and AGFI=0.873. These results showed that the three-factor structure of the questionnaire had the best overall fit, even without modification. This finding is in line with the results of previous studies. These fit index values indicate that the model had an excellent and acceptable fit.

Many patients are unaware that their problem is hyperacusis or do not understand the meaning of hyperacusis. Hyperacusis can lead to social isolation, anxiety, depression, and poor quality of life.[6,21] Appropriate treatment requires a multidisciplinary approach involving a general practitioner, neurologist, otolaryngologist, and psychologist. The HHQ is used as a screening tool to assess subjective distress associated with hypersensitivity to sound and to guide treatment/therapy outcomes.

The limitation of this study was that the HHQ was assessed only in a group of healthy individuals.

In conclusion, the factorial structure of the Turkish version of the HHQ was confirmed in this study. The results underline the importance of the concept of acceptance for patients with hyperacusis. We believe that it will be an important assessment parameter for both the patient and the clinician in the evaluation of individuals with hyperacusis in clinical practice and in treatments to be implemented. Therefore, it will be necessary to use acceptance questionnaires such as the HHQ in the assessment or treatment of hyperacusis.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Design/idea, critical interpretation, data collection: Z.A., N.Ö.Ö., S.K., K.B.B.; Literature review: Z.A., N.Ö.Ö.; Supervision/kontrol, data analysis and article writing: Z.A.; Language editing and article editing: S.K., N.Ö.Ö.

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