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Reliability and usability of the Turkish Tinnitus Functional Index

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Abstract. *Objective***:** Standardized questionnaires are a tool to determine, compare, and investigate the severity of tinnitus. Although such questionnaires are designed for these purposes, they are also used to assess tinnitus-related changes. To solve this problem, a new survey called the tinnitus functional index (TFI) was published in 2012. This survey stated that changes related to treatment can also be monitored. The purpose of this study is to evaluate the usability and reliability of the Turkish version of the TFI.
Methods: This study included 100 patients who applied to our clinic and had been experiencing tinnitus for at least 6 months. First, each patient completed a TFI questionnaire and a tinnitus handicap index (THI). The TFI was administered again 1 week later. Internal consistency reliability (Cronbach's alpha coefficient) and test-retest correlations were used to test the reliability of the TFI. The validity of the TFI was determined by examining correlations between the TFI and the THI in the context of criterion-dependent validity. When testing for appropriateness for factor analysis, the Kaiser-Meyer-Olkin (KMO) test was used to determine sample adequacy and the Bartlett test was used to check the multivariate normal distribution fit of the data.
Results: The Turkish version of the TFI demonstrates a high level of reliability and a very high level of test-retest compatibility.
Conclusion: The Turkish version of the TFI is valid and reliable.

Introduction

Tinnitus is defined as the perception of a noise without any stimulus originating from any source outside the body. Various studies have reported that between 7% and 33% of the population suffer from this complaint.[1-3] It can present in childhood and incidence increases with age.[4]

Tinnitus can be objective or subjective. Objective tinnitus involves a sound that can be detected, originates from any part of the patient's body, and is particularly experienced as a result of turbulent blood flow or muscle contractions in the head and neck region. Subjective tinnitus is more common, and involves sounds that can only be heard by the patient. Objective tinnitus can be detected by a physical or radiological examination.[5] If no cause is determined, subjective tinnitus can be considered.

Tinnitus can seriously affect the quality of life, and can even lead to suicide in extreme cases.[6] This condition may be accompanied by complaints including anxiety,[7-8] depression,[9] and sleep disorders,[10] and should be distinguished from such issues. It has been demonstrated that tinnitus is closely related to hearing loss.[11]

Treatment approaches for tinnitus vary, and may include hearing aids, maskers, tinnitus instruments, or medical therapy. However, these treatments may not provide immediate and continuous relief, and so the patient's quality of life is further reduced. Therefore, standardized questionnaires are used to better understand the effect of tinnitus and to monitor the patients. The following surveys are in use worldwide: Tinnitus Handicap Inventory (THI), Tinnitus Severity Questionnaire (TSQ), Tinnitus Handicap Questionnaire (THQ), Tinnitus Reaction Questionnaire (TRQ), Tinnitus Severity Index (TSI), Tinnitus Questionnaire (TQ), and Tinnitus Handicap/Support Scale (TH/SS).[12] Currently, there is an insufficient number of standardized questionnaires for tinnitus assessment in Turkey.

Most of these surveys lack validity and reliability studies. The most commonly used questionnaire is the tinnitus handicap inventory (THI).[13] The

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THI was originally developed by the British Association of Otolaryngologists (BAO) as a 50-item questionnaire and was revised in 1996 by Newman et al.[14] in the United States as a more easily implemented, psychometrically sound, 25-item questionnaire. Aksoy et al.[13] stated that the Turkish language version of the THI, created in 2006, was highly reliable and consistent when measuring the symptoms of tinnitus patients. We decided that it was also necessary to test the validity and reliability of the Turkish version of the Tinnitus Functional Index (TFI) in Turkey.

Materials and methods

Participants

This was a prospective, non-invasive, observational study conducted in Turkey. This study included 100 patients who were admitted to our clinic between 2016 and 2017 complaining of tinnitus. The study was approved by the university's ethics committee. Patient criteria for inclusion in the study were: age ≥18 years, voluntary participation, and no problems reading and understanding the questionnaire. All participants provided written, informed consent before they completed the questionnaires.

Patients suffering from tinnitus for ≥1 month were included because they were able to fully differentiate the changes in their life. Each patient initially completed a TFI questionnaire and a THI. Then, the TFI was administered again 1 week later.

We contacted one of the researchers who developed the TFI and obtained permission for a Turkish version of the TFI from Oregon Health & Science University (OHSU).

Because the University of Oregon has a Turkish form of the TFI, it was not necessary to translate the TFI into Turkish again; however, the University of Oregon version cannot be used in Turkey because there has been no research about the reliability and usability of the Turkish language version in Turkey. That is why we planned this study. We received permission from OHSU to use this survey for our research.

For control purposes, a questionnaire was administered to 30 independent subjects from the study group to assess the comprehensibility of the language before applying the survey to our patient group.

The Tinnitus Functional Index

This survey was developed by Meike et al. in 2012 to evaluate tinnitus with an emphasis on tinnitus severity, and is an accurate measurement of changes in tinnitus severity.[15] The TFI can be used as a standard tool in both clinical and research settings to measure response to treatment, the extent of the effects of tinnitus, and other psychometric properties. The researcher used factor analysis and described the domains as eight distinct subscales: intrusiveness, control, cognition, sleep, hearing, relaxation, emotional distress, and quality of life;[15] the first seven domains are each measured using three items, and quality of life is measured using four items, for a total of 25 items divided into eight subscales that cover different aspects of tinnitus severity. A 10-point scale is used in TFI, with scores recorded in the 0-10 or 0-100% range. Scores are calculated for the total scale and all subscales (range 0-100). Exceptions to this are items 1 and 3, because they are expressed in terms of percentages ranging from 0% to 100%. These answers must be converted to a scale of 0-10 before any calculations can be made. The overall TFI score is calculated by multiplying the average of all answered questions by 10. At least 19 questions must be answered to calculate a valid general TFI score. As a result, the general TFI score varies from 0 to 100 regardless of the number of questions answered.[15]

Statistical analysis

Statistical analysis of the data obtained in the study was conducted using version 15.0 of the Statistical Package for Social Sciences (SPSS) package program. Internal consistency reliability (Cronbach's alpha coefficient) and test-retest correlations were used in addition to descriptive statistical methods (mean, standard deviation, etc.) to determine the reliability of the TFI. The validity of the TFI was determined by examining the correlations between the TFI and the THI in the context of criterion-dependent validity. When testing for appropriateness for factor analysis, the Kaiser-Meyer-Olkin (KMO) test was used to determine sample adequacy, and the Bartlett test was used to check the multivariate normal distribution fit of the data. To investigate the factor structure of the TFI, the principal components were subjected to factor analysis with skew rotation.

Table 1
Tinnitus Functional Index Test-Retest Values

	Test			Re-test		
	mean	**ss**	**median**	**mean**	**ss**	**median**
Intrusiveness	73.80	24.28	78.33	73.60	23.59	78.33
Sense of control	70.73	25.94	75.00	70.47	25.79	75.00
Cognition	54.23	29.38	56.67	54.23	29.33	53.33
Sleep	50.77	32.00	50.00	51.23	32.33	50.00
Audition	45.27	28.58	40.00	45.33	28.48	40.00
Relaxation	59.57	31.26	65.00	59.43	31.10	65.00
Quality of life	48.62	30.03	48.75	48.95	29.87	48.75
Emotional distress	52.17	31.69	50.00	52.97	31.22	50.00
TOTAL SCORE	56.56	23.38	60.60	56.70	23.22	60.20

For the results, $p<0.05$ was accepted as indicating statistical significance.

Results

A total of 100 patients (65 women and 35 men) were included in the study. The mean age of patients was 38.3 years (range, 25-65 years). Regarding education level, 60% of patients were university graduates, 30% were high school graduates, and 10% had a primary and secondary school education only. The reliability analysis of the TFI test-retest mean values is given in Table 1, according to the eight subscale and total scores.

Cronbach's alpha for internal consistency in the reliability analysis was 0.970. When the findings of test-retest reliability were examined, a statistically significant correlation was observed among all the scores of both surveys at a high level (Table 2). These results show that the Turkish version of the TFI is homogeneous and very reliable. Statistically significant correlations were observed ($p = 0.0001$) when the total correlations of the items were examined (e.g., 0.98 for the first item and 0.99 for the second item). When the correlations of the items are considered, the correlation values of the items are 0.45 (i.e., when one item was removed from the total, the correlation for total items also deteriorated).

Comparisons with the THI

According to the THI, Grade 1 tinnitus was detected in 1%, Grade 2 in 11%, Grade 3 in 16%, Grade 4 in 28%, and Grade 5 tinnitus in 44% of the 100 patients. Significant correlations were observed between the THI total score and the scores for items 1, 2, and 3 in the "Intrusive" TFI subscale in a moderate, positive direction. A significant positive

Table 2
Tinnitus Functional Index Test-ReTest Correlation

	r	**p***	**Corrected item-total correlation**
Item 1	0.980	0.0001	0.451
Item 2	0.996	0.0001	0.585
Item 3	0995	0.0001	0.662
Item 4	0.999	0.0001	0.673
Item 5	0.997	0.0001	0.716
Item 6	0.997	0.0001	0.692
Item 7	0.998	0.0001	0.806
Item 8	0.997	0.0001	0.720
Item 9	0.997	0.0001	0.751
Item 10	0.998	0.0001	0.731
Item 11	0.960	0.0001	0.722
Item 12	0.997	0.0001	0.746
Item 13	0.999	0.0001	0.577
Item 14	1.000	0.0001	0.654
Item 15	0.999	0.0001	0.687
Item 16	0.998	0.0001	0.816
Item 17	0.999	0.0001	0.838
Item 18	1.000	0.0001	0.840
Item 19	1.000	0.0001	0.814
Item 20	1.000	0.0001	0.832
Item 21	0.997	0.0001	0.821
Item 22	0.994	0.0001	0.786
Item 23	0.997	0.0001	0.807
Item 24	0.994	0.0001	0.832
Item 25	0.995	0.0001	0.817
TOTAL	0.999	0.0001	
Intrusiveness	0.995	0.0001	
Sense of control	0.999	0.0001	
Cognition	0.999	0.0001	
Sleep	0.993	0.0001	
Audition	1.000	0.0001	
Relaxation	1.000	0.0001	
Quality of life	0.999	0.0001	
Emotional distress	0.997	0.0001	

*p<0.001 for all items.

Table 3

Relationship between Tinnitus Handicap Inventory Total Score and Grade and Tinnitus Functional Index Scores

	THI Total		THI Grade	
	r	p	r	p
Item 1	0.538	0.0001***	0.520	0.0001***
Item 2	0.509	0.0001***	0.495	0.0001***
Item 3	0.616	0.0001***	0.595	0.0001***
Item 4	0.430	0.0001***	0.437	0.0001***
Item 5	0.450	0.0001***	0.454	0.0001***
Item 6	0.330	0.001**	0.356	0.0001***
Item 7	0.451	0.0001***	0.499	0.0001***
Item 8	0.290	0.003**	0.346	0.0001***
Item 9	0.348	0.0001***	0.400	0.0001***
Item 10	0.249	0.012*	0.259	0.009**
Item 11	0.314	0.001**	0.333	0.001**
Item 12	0.322	0.001**	0.339	0.001**
Item 13	0.247	0.013*	0.259	0.009**
Item 14	0.208	0.038*	0.203	0.043*
Item 15	0.200	0.046*	0.230	0.021*
Item 16	0.275	0.006**	0.315	0.001**
Item 17	0.380	0.0001***	0.407	0.0001***
Item 18	0.284	0.004**	0.321	0.001**
Item 19	0.349	0.0001***	0.374	0.0001***
Item 20	0.341	0.001**	0.385	0.0001***
Item 21	0.346	0.0001***	0.368	0.0001***
Item 22	0.372	0.0001***	0.383	0.0001***
Item 23	0.227	0.023*	0.269	0.007**
Item 24	0.294	0.003**	0.327	0.001**
Item 25	0.251	0.012*	0.293	0.003**
TFI TOTAL	0.445	0.0001***	0.475	0.0001***
Intrusiveness	0.606	0.0001***	0.586	0.0001***
Sense of control	0.429	0.0001***	0.443	0.0001***
Cognition	0.376	0.0001***	0.431	0.0001***
Sleep	0.307	0.002**	0.324	0.001**
Audition	0.232	0.020*	0.245	0.014*
Relaxation	0.319	0.001**	0.354	0.0001***
Quality of life	0.375	0.0001***	0.402	0.0001***
Emotional distress	0.263	0.008**	0.304	0.002**

TFI, Tinnitus functional index; THI, tinnitus handicap inventory. *p<0.05; **p<0.01; ***p<0.001

correlation was observed between the THI total score and other TFI scores and the TFI grade score (Table 3).

Table 4

Basic Component Analysis

	Factor				
	1	2	3	4	5
Item 23	**0.952**	-0.120	-0.038	0.068	-0.035
Item 25	**0.951**	-0.094	0.002	0.045	0.000
Item 21	**0.878**	0.079	0.211	-0.119	0.018
Item 22	**0.856**	0.208	0.006	-0.093	0.118
Item 24	**0.842**	-0.083	0.016	0.149	-0.038
Item 20	**0.839**	-0.028	0.112	0.051	-0.076
Item 19	**0.814**	0.110	0.133	-0.054	-0.066
Item 1	-0.046	**0.989**	0.044	-0.119	0.136
Item 2	-0.081	**0.890**	0.139	0.030	-0.124
Item 3	0.063	**0.808**	0.011	0.099	-0.147
Item 13	0.023	0.142	**0.864**	0.077	-0.008
Item 14	0.195	0.018	**0.823**	0.110	0.062
Item 15	0.162	0.053	**0.657**	0.246	0.035
Item 12	-0.082	0.005	0.092	**0.920**	0.025
Item 11	-0.036	-0.017	0.014	**0.911**	0.042
Item 10	-0.047	-0.076	0.171	**0.852**	-0.131
Item 18	0.165	0.005	0.119	**0.721**	-0.134
Item 17	0.104	0.138	0.119	**0.677**	-0.168
Item 16	0.139	0.051	0.161	**0.666**	-0.141
Item 9	0.307	0.153	-0.081	**0.600**	0.455
Item 8	0.277	0.124	-0.050	**0.598**	0.432
Item 7	0.303	0.344	-0.145	**0.522**	0.265
Item 4	0.287	0.321	-0.206	0.285	**-0.531**
Item 6	0.368	0.209	-0.019	0.210	**-0.474**
Item 5	0.326	0.291	-0.149	0.295	**-0.455**

Scope validity and factor analysis

Validity studies

The Bartlett Sphericity Test was statistically significant ($\chi 2 = 3591.823$ p = 0.0001). The Kaiser-Meyer-Olkin (KMO) value was very high at 0.893, above the acceptable limit. In the graph distribution of the eigenvalues, it was observed that the sharpest break occurred after the first factor and that there were five factors above the eigenvalue. In order to apply the factor analysis, the test value of KMO should be >0.5 In this study, like 0.893, a very close value of 1 has emerged and this sample is sufficient. We conducted these two tests to see if the scale was suitable for factor analysis.

Scope validity and factor analysis

Five factors were above eigenvalue 1 and the total variance was 83.697% (eigenvalues: 14.570, 2.054, 1.619, 1.501, and 1.181; variance: 58.281%, 8.216%, 6.475%, 6.003%, and 4.723% respectively). Items 19-25 were in Factor 1, items

Table 5
Eight Factor Analysis of Basic Components

	Factor							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Item 23	**0.864**	-0.040	0.035	0.002	0.072	-0.091	-0.019	-0.037
Item 25	**0.842**	-0.006	0.063	0.011	0.071	-0.040	-0.011	-0.075
Item 24	**0.787**	0.016	0.042	0.064	0.020	-0.015	-0.126	-0.049
Item 22	**0.497***	0.266	-0.017	0.144	0.092	0.052	0.125	**-0.400***
Item 1	0.012	**0.969**	0.000	-0.057	0.106	0.114	0.014	-0.017
Item 2	0.001	**0.845**	0.105	0.013	-0.083	-0.099	-0.123	0.032
Item 3	-0.031	**0.699**	0.027	0.140	0.027	-0.298	0.046	-0.075
Item 13	-0.057	0.105	**0.943**	0.019	-0.091	0.033	-0.036	-0.029
Item 14	0.032	-0.019	**0.928**	0.051	0.017	0.032	0.030	-0.079
Item 15	0.092	-0.035	**0.820**	-0.034	0.170	-0.102	-0.029	0.100
Item 11	-0.005	-0.007	-0.026	**0.940**	0.109	-0.036	0.043	-0.041
Item 12	-0.075	0.002	0.043	**0.899**	0.095	-0.030	-0.035	-0.058
Item 10	0.196	0.010	0.099	**0.749**	-0.154	0.025	-0.245	0.125
Item 8	0.098	-0.025	0.107	0.020	**0.869**	-0.010	-0.059	0.083
Item 9	0.011	0.011	0.027	0.149	**0.846**	0.024	-0.024	-0.081
Item 7	0.041	0.184	-0.060	-0.005	**0.713**	-0.110	-0.194	-0.044
Item 5	0.091	0.062	0.026	0.136	0.076	**-0.848**	0.098	0.006
Item 6	-0.086	-0.048	0.115	-0.019	0.054	**-0.816**	-0.090	-0.191
Item 4	0.222	0.157	-0.098	-0.002	-0.055	**-0.743**	-0.178	0.116
Item 16	-0.001	0.017	0.053	0.035	0.084	0.000	**-0.855**	-0.092
Item 17	-0.014	0.084	0.031	0.085	0.089	-0.077	**-0.772**	-0.063
Item 18	0.126	-0.009	0.042	0.118	0.092	-0.018	**-0.759**	0.005
Item 19	0.121	0.089	0.033	0.047	-0.014	-0.067	-0.227	**-0.696**
Item 21	0.228	0.070	0.169	0.058	0.037	-0.040	-0.035	**-0.637**
Item 20	0.176	-0.094	0.099	0.018	0.109	-0.199	-0.172	**-0.567**

All items except item 22 were distributed appropriately; item 22 was loaded more on Factor 1 than Factor 8.

1–3 were in Factor 2, items 13-15 were in Factor 3, items 7-12 and 16-18 were in Factor 4, and items 4–6 were collected in Factor 5; all factor loads were >0.4 (Table 4).

When analyzed according to the 8 factors, all items except item 22 were distributed appropriately; item 22 was loaded more on Factor 1 than Factor 8 (Table 5). Factor analysis, criterion-related validity, and item-total test correlations suggest that the TFI is sufficient to be used as a valid measurement tool.

Discussion

The primary aim of this study was to demonstrate the reliability and validity of the Turkish version of the TFI questionnaire. The TFI survey is satisfactory with respect to structure and criterion validity. Turkish researchers who are interested in ear diseases can also use this survey. Furthermore, the TFI is a good psychometric tool and may be accepted as a questionnaire that can determine changes related to treatment.[16] This study shows the validity of the Turkish form of the TFI used to determine the degree of tinnitus. We believe that this may be more appropriate for conducting research or clinical use, if necessary.

Reliability analysis of scale results refers to the ability of the scale to accurately describe concepts and the ability to perform measurements with the same sample at different locations at the same time.

Commonly used methods are item analysis, internal consistency, and time invariance (test-retest). In this study, internal consistency (Cronbach's alpha reliability coefficient) and test-retest correlations were used to test the reliability of the TFI.

Cronbach's alpha reliability coefficient is the most commonly used method to evaluate internal consistency. If Cronbach's alpha coefficient is <0.40, it is not reliable. It is reliable between 0.40-0.59, very reliable between 0.60-0.79, and highly reliable between 0.80-1.00. In this study, the Cronbach's alpha reliability coefficient for internal consistency was 0.970 in the reliability analysis. The same values were obtained in the German version completed in Switzerland, and in the United Kingdom.[17-18]

In the test-retest method, the results of two applications are evaluated using correlation analysis. The closer the correlation coefficient is to 1, the better the test's time invariance. When the findings of test-retest reliability are examined, there is a statistically significant correlation between all the items of the TFI administered at different times (Table 2). These results show that the Turkish version of the TFI is homogeneous and very reliable.

Different methods are used to evaluate the validity of a scale, along with factor analysis and scope (content) validity. The validity of the TFI in our study was determined by examining the correlations between the TFI and the THI in the context of criterion-dependent validity.

Significant correlations were observed between the THI total score and the TFI subscales in a positive direction among the scores for items 1, 2, and 3 for the Intrusive score (correlation coefficient >0.5). A significant positive correlation was observed between the THI total score and other TFI scores and the TFI total score.

The TFI has recently been translated into several languages and is routinely used by scholars in Switzerland,[17] the United Kingdom,[18] Poland,[19] the Netherlands,[20] and Sweden.[21]

Overall, the results of this study are similar to those of other studies validating the TFI in different languages. In a recent study in the United Kingdom, it was stated that tinnitus covers multiple symptom areas and that it satisfies a set of psychometric requirements for good clinical criteria including excellent safety, sensitivity to individual differences in stability, and tinnitus over time. However, a seven-factor scale is recommended.[22]

This study is the first to show reliability and usability of the Turkish version of the TFI in Turkey. When we examine the reliability studies conducted in other countries, we can see that the number of patients is similar to the present study and there was a balanced distribution of tinnitus severity according to the TFI categories.

This study has demonstrated that the Turkish version of the TFI can be used to follow patients with tinnitus in Turkey.

Conclusion

In conclusion, the usability and reliability of the Turkish version of the TFI were high in Turkey. The fact that Cronbach's alpha for internal consistency was high in the reliability analysis and the statistically significant correlation among all scores of the two applications regarding test-retest reliability revealed that the Turkish version of the TFI was homogeneous and very reliable.

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