



CROATIAN VERSION OF TINNITUS HANDICAP INVENTORY – THI-HR

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SUMMARY – In this study, we translated the Tinnitus Handicap Inventory questionnaire into Croatian language, and determined the reliability and validity of the Croatian adaptation (THI-HR). Tinnitus sufferers (N=130) underwent audiometry and completed the THI-HR, the Depression Anxiety Stress Scale (DASS), and the Eysenck Personality Questionnaire Revised/Short Scale (EPQ R/S). Sociodemographic data on the patients and descriptive data on tinnitus were collected. The THI-HR internal consistency, construct validity, factor structure and repeatability were evaluated. The Cronbach's alpha coefficients for the THI-HR Total, Functional, Emotional, and Catastrophic subscales were 0.96, 0.76, 0.78, and 0.76, respectively. Moderate correlations of the THI-HR total and subscales with the three DASS subscales ($r_s=0.42$ to $r_s=0.61$) and the EPQ R/S-Neuroticism subscale ($r_s=0.56$ to $r_s=0.64$) were observed. The THI-HR factor analysis revealed that the original THI three-factor solution was a good fit to the data. Three factors explained 48.7% of the total variance. The test-retest reliability was high ($r_p=0.89$ to $r_p=0.93$). It was established that the THI-HR had high internal consistency reliability and good construct validity. The THI-HR is a valid and reliable measure of tinnitus complaint that can be used for assessment of the impact of tinnitus symptoms in daily life in the adult Croatian population.

Key words: *Tinnitus; Handicap; Questionnaires; Outcome assessment; Health measurement scales*

Introduction

Tinnitus is perception of sound or noise produced unwillingly within the head in the absence of any external acoustic stimulus. This phenomenon can be categorized into tinnitus generated by para-auditory structures (vascular and muscle structures near the

ear and auditory pathways) and tinnitus generated by the sensorineural auditory system (alterations in the ear, auditory pathways and auditory cortex)¹. It may be the first or the most prominent symptom of different pathological conditions that threaten the patient's physical health and well-being. Many tinnitus sufferers believe that they have a serious medical problem¹.

Patients suffering from tinnitus experience a spectrum of distressing symptoms that include emotional components such as sleep impairment, anxiety, depression, irritation, and concentration difficulties. The quality of life can be worsened severely by the psychological effects of tinnitus directly on the patient and

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indirectly on the family involved². One of the complaints among patients with hearing loss is difficulty in cognitive performance, but association of tinnitus with cognitive decline was not found³. It is important to assess the effect of tinnitus on a patient's daily life. There have been multiple efforts to create subjective instruments that measure the wide-ranging functional and emotional effects of tinnitus. Questionnaires have been developed and validated for this purpose. One of the most widely established and commonly used is the Tinnitus Handicap Inventory (THI), created in the United States of America by Newman *et al.*^{4,5}.

There is not a satisfying number of tinnitus research studies in our country and neighborhood. One of the reasons might be a lack of tinnitus-specific questionnaire and measurement scale adapted to language and cultural specificities and therefore usable in the population in our region. Hence, in our subjective, experience-based opinion, the handicap of our patients with tinnitus is underestimated.

The aim of this single-center prospective cross-sectional study was to provide the THI in Croatian language (THI-HR), which would be reliable and valid for the adult population in Croatian-speaking territories.

Materials and Methods

Translation procedure

Permission for adaptation of the THI in English (THI-US) into Croatian language was obtained from Dr. Craig W. Newman, author of the original questionnaire. The THI-US was translated into Croatian language by three independent translators (one informed translator and two naïve translators). These three versions in Croatian were then compared and merged into a single forward translation which was back-translated independently by another three naïve translators. There was a congruence among the original English and back-translated (English) versions. The intelligibility of the prefinal reconciled version in Croatian was rated by 15 patients (mean age 62.5±14.84, age range 23-73 years; 9 males; formal educational level: primary 1, secondary 11, college 2, and university 1). A 5-point scale (from 1=completely unintelligible to

5=completely intelligible) was used. After completing the questionnaire, the respondents were interviewed. After a review of the debriefing results and finalization, proofreading was done by a university Croatian language lecturer. The final version of THI in Croatian (THI-HR) is given in the Appendix.

Patients and procedures

The study group was comprised of consecutive patients suffering from tinnitus for at least four months. From February 2015 to January 2018, these patients were referred to our clinic with a primary complaint of tinnitus. The patient exclusion criteria were age under 18 years, duration of tinnitus less than four months, previous tinnitus treatment, vertigo, mental illness, otologic disease, and neurological disease. The institutional Ethics Committee approval was obtained.

The patients had undergone an otologic medical examination and pure-tone audiometry but had not received any specific tinnitus therapy or counseling at the time of completion of the questionnaires. After informed consent was obtained, patients completed the THI, the Depression Anxiety Stress Scale (DASS) and the Eysenck Personality Questionnaire Revised/Short Scale (EPQ R/S). Sociodemographic data on the patients (age, gender, formal educational level, length of history) and descriptive data on tinnitus were collected. The patients included in the establishment of repeatability were asked by their family doctor to complete the questionnaires at their home under repeatability conditions. The retest of the THI-HR was taken at home on day 15 after the first completion.

Measures

Tinnitus Handicap Inventory. The THI quantifies the impact of tinnitus on daily living. The THI is a 25-item self-report measure comprised of three subscales: the Functional subscale (11 items), the Emotional subscale (9 items), and the Catastrophic subscale (5 items) that measure the functional, emotional, and catastrophic impact of tinnitus, respectively. Each of 25 items is rated on a 3-point scale: "yes" (4 points), "sometimes" (2 points), and "no" (0 points). The mean total score reflects the sum of all responses with a global score of 100 indicating greatest impact on everyday function^{4,5}. Scores are interpreted using the following categories: slight problem (0-16), mild (18-36),

moderate (38–56), severe (58–76), and catastrophic (78–100)⁶.

Depression Anxiety Stress Scale. The DASS is a 42-item self-report instrument designed by S. H. Lovibond and P. F. Lovibond to measure the three related negative emotional states of depression, anxiety and tension/stress⁷. We used an adapted Croatian version. Its internal consistency, computed as Cronbach's α , was quite high, i.e., 0.87 for depressive symptoms, 0.91 for anxiety symptoms, and 0.82 for stress symptoms⁸. The DASS-Depression (14 items) focuses on reports of low mood, motivation, and self-esteem, DASS-Anxiety (14 items) on physiological arousal, perceived panic, and fear, and DASS-Stress (14 items) on tension and irritability. A participant indicates on a 4-point scale the extent to which each of 42 statements applied over the past week (from 0=did not apply to me at all to 3=applied to me very much, or most of the time). Higher scores on each subscale indicate increasing severity of depression, anxiety, or stress⁷.

Eysenck Personality Questionnaire Revised/ Short Scale. The EPQ R/S is a self-reported questionnaire

developed by Eysenck, Eysenck and Barrett. It includes 48 items and four subscales: Extraversion (12 items), Neuroticism (12 items), Psychoticism (12 items), and Lie (12 items). The Lie subscale is a control scale in which the whole scale is tested for social desirability bias. Each question has a binary response, "yes" or "no". Each dichotomous item was scored 1 or 0, and each scale had a maximum possible score of 12 and minimum of zero⁹.

Perceived tinnitus pitch and loudness. A subjective judgment of the overall pitch and loudness of tinnitus using a 4-point scale was done by each patient. For pitch scaling, a 1 response represented a very low-pitched foghorn, and 4 represented a very high-pitched whistle. For loudness scaling, a 1 response represented very faint tinnitus and 4 represented very loud tinnitus.

Statistical analysis

The normality of distribution was tested by the Kolmogorov-Smirnov test. Relationships of perceived tinnitus handicap with age, gender, hearing impairment, and formal education were examined using the

Table 1. Sociodemographic and clinical characteristics of study patients suffering from tinnitus (N=130)

Characteristic	
Age (yrs, mean \pm SD)	50.53 \pm 12.26
Age range (yrs, min-max)	19-78
Gender (male/female)	74/56
Educational level: primary/secondary/college/university (n)	10/82/11/27
Duration of tinnitus (months, mean \pm SD)	52.31 \pm 76.23
Duration of tinnitus (months, min-max)	4-420
Pure tone (mean \pm SD)*	29.30 \pm 14.45
Normal hearing/impaired hearing (n)†	14/116
Tinnitus location: right ear/left ear/both ears/inside the head/cannot make out (n)	29/37/46/8/10
Tinnitus manifestation: intermittent/constant (n)	29/101
Tinnitus loudness (subjective): very faint/silent/moderate/very loud (n)	2/24/81/23
Tinnitus pitch (subjective): low/high/cannot make out (n)	27/41/62
Tinnitus severity according to THI: slight or no handicap/mild/moderate/severe/catastrophic (n)	46/41/15/16/12
Depression: median [IQR], min-max‡	2 [7], 0-36
Anxiety: median [IQR], min-max‡	6 [7], 0-39
Stress: median [IQR], min-max‡	9 [10], 0-42

*Pure-tone audiometry: average of eight air-conduction thresholds (both ears at 0.5 kHz, 1 kHz, 2 kHz, 4 kHz); †normal hearing: hearing threshold of up to 25 dB in frequency range of 0.5 kHz to 8 kHz; ‡measured by the Depression Anxiety Stress Scale; n = number of patients

Pearson's product-moment correlations for normally distributed variables and the Spearman's rank correlation coefficient for data that did not follow normal distribution. Comparison of the central location of two independent variables was done using Student's *t*-test for variables not showing statistically significant deviation from Gaussian distribution on the Kolmogorov-Smirnov test and using the Mann-Whitney *U* test for data where deviation from Gaussian distribution was statistically significant. Cronbach's alpha and the item-total correlations were calculated to assess internal consistency reliability of the THI-HR. Correlations between scores on the THI-HR and other assessment measures (DASS, EPQR/S, subjective tinnitus ratings) were examined using the Pearson's product moment correlations for normally distributed variables and the Spearman's rank correlation coefficient for data that did not follow normal distribution. Exploratory data analysis was performed using a principal component factor analysis with varimax rotation. The level of statistical significance was set at $p < 0.05$. All statistical analyses were performed using SPSS for Windows (Version 13.0; SPSS Inc., Chicago, IL, USA).

Results

Out of 195 consecutive patients who met the study criteria, 65 of them did not agree to participate in the study. One hundred and thirty tinnitus sufferers were included in this study. The sociodemographic and clinical characteristics of study patients are shown in Table 1.

In order to determine whether there was an association between patient age and perceived tinnitus handicap, we calculated correlations between age and THI-HR scores. There was no statistically significant relationship between age and total THI-HR (Spearman's $r_s = 0.066$, $p > 0.05$), functional (Spearman's $r_s = 0.074$, $p > 0.05$), emotional (Spearman's $r_s = 0.090$, $p > 0.05$), and catastrophic (Pearson's $r_p = 0.019$, $p > 0.05$) subscales. Additionally, we made scatterplots in order to visualize the relationship between age and perceived tinnitus handicap. The scatter diagram with age as an independent variable (*x*-axis) and with THI-HR scores as a dependent variable (*y*-axis) showed a lack of correlation between the two variables.

Differences between males and females in total THI-HR (Mann-Whitney *U* test: $Z = -0.536$; $p = 0.592$), functional (Mann-Whitney *U* test: $Z = -0.863$; $p = 0.388$), emotional (Mann-Whitney *U* test: $Z = -0.77$; $p = 0.48$), and catastrophic (Student's *t*-test: $t = 0.381$; $p = 0.725$) subscales were statistically nonsignificant.

Correlations between the pure tone average (an average of eight air conduction thresholds, both ears at 0.5 kHz, 1 kHz, 2 kHz, 4 kHz) and THI-HR scores were calculated in order to determine whether there was an association between hearing impairment and perceived tinnitus handicap. Results showed a statistically significant positive weak relationship between hearing impairment and total THI-HR (Spearman's $r_s = 0.23$, $p < 0.05$), functional (Spearman's $r_s = 0.26$, $p < 0.05$), emotional (Spearman's $r_s = 0.241$, $p < 0.05$), and catastrophic (Pearson's $r_p = 0.27$, $p < 0.05$) subscales.

Correlations between years of formal education and THI-HR scores were calculated in order to determine whether there was an association between formal educational level and perceived tinnitus handicap. Results did not show a statistically significant relationship of education with total THI-HR (Spearman's $r_s = -0.192$, $p > 0.05$) and catastrophic subscale (Pearson's $r_p = -0.18$, $p > 0.05$). There was a statistically significant negative weak relationship of education with the functional subscale (Spearman's $r_s = -0.22$, $p < 0.05$) and emotional subscale (Spearman's $r_s = -0.235$, $p < 0.05$). The higher formal educational level was associated with lower perceived tinnitus handicap.

Out of 130 study patients, 62 of them had difficulties ("cannot make out") in tinnitus pitch rating. Therefore, pitch ratings were not included in further statistical analysis.

Means and standard deviations for each of the items in the THI-HR are presented in Table 2. The proportions of "yes", "sometimes", and "no" responses to individual questions were analyzed. It is believed that items with high endorsement rates for one of the response options are a little discriminating and insensitive. The endorsement rates of the THI-HR for a "Yes" response ranged from 6% to 56%, for a "Sometimes" response ranged from 9% to 45%, and for a "No" response ranged from 28% to 82%. The THI-US score ranges were 8%–63% for a "Yes", 18%–49% for a "Sometimes", and 19%–64% for a "No" response⁴. The THI-US and THI-HR showed comparable ranges for

a “Yes” and for a “Sometimes” response. The endorsement rates for each of the 25 items for the adapted THI-HR and the original THI-US are presented in Table 2.

Mean and range values for the THI-HR are presented in Table 3. The means of the original THI-US total (25.4 ± 20.5) and subscale (11.0 ± 9.7 ; 8.2 ± 8.4 ; 6.1 ± 4.5) scores were lower than the means of the THI-HR scores⁴. The high values of standard deviations

demonstrated great variations in perceived tinnitus handicap in our study sample. Interestingly, one patient checked „No“ and one patient checked „Yes“ for each of the 25 items. We should take in consideration a response bias of these two participants.

The Spearman's rank correlation coefficients between the total THI and subscale scores were calculated. There were significant strong positive correlations ($p < 0.05$), ranging from $r_s = 0.71$ to $r_s = 0.94$ (Table 4).

Table 2. Means, standard deviations, endorsement rates and item-total correlations of the Croatian adaptation (THI-HR) and the original version of the Tinnitus Handicap Inventory (THI-US)

THI item*	Mean \pm SD for THI-HR	Endorsement rate (%)			Item-total correlation†
		Yes	Sometimes	No	
1F	1.68 \pm 1.45	20 (24)	45 (49)	35 (27)	0.70 (0.70)
2F	1.55 \pm 1.62	24 (35)	30 (35)	46 (30)	0.61 (0.22)
3E	1.80 \pm 1.53	24 (20)	41 (38)	35 (42)	0.72 (0.54)
4F	1.71 \pm 1.67	28 (18)	29 (25)	43 (57)	0.61 (0.64)
5C	1.02 \pm 1.46	14 (17)	23 (25)	63 (58)	0.71 (0.54)
6E	1.88 \pm 1.60	29 (17)	36 (26)	35 (57)	0.70 (0.63)
7F	1.45 \pm 1.52	19 (24)	35 (38)	46 (38)	0.62 (0.48)
8C	2.25 \pm 1.76	45 (60)	22 (20)	33 (20)	0.58 (0.55)
9F	1.11 \pm 1.65	22 (8)	12 (29)	66 (63)	0.81 (0.61)
10E	1.43 \pm 1.66	24 (29)	24 (37)	52 (34)	0.76 (0.77)
11C	0.57 \pm 1.15	6 (14)	16 (23)	78 (63)	0.59 (0.48)
12F	0.95 \pm 1.48	15 (12)	18 (26)	67 (62)	0.81 (0.69)
13F	0.83 \pm 1.36	11 (10)	20 (32)	69 (58)	0.68 (0.56)
14E	1.42 \pm 1.56	20 (22)	31 (32)	49 (46)	0.80 (0.69)
15F	1.06 \pm 1.52	16 (20)	21 (29)	63 (51)	0.54 (0.48)
16E	1.29 \pm 1.59	20 (25)	25 (38)	55 (37)	0.83 (0.76)
17E	0.55 \pm 1.25	9 (26)	9 (20)	82 (54)	0.68 (0.53)
18F	0.86 \pm 1.32	9 (15)	25 (42)	66 (43)	0.62 (0.69)
19C	2.57 \pm 1.75	56 (63)	16 (18)	28 (19)	0.44 (0.48)
20F	1.11 \pm 1.56	18 (18)	20 (23)	62 (59)	0.75 (0.58)
21E	1.06 \pm 1.56	18 (18)	18 (26)	64 (56)	0.84 (0.63)
22E	1.28 \pm 1.61	21 (25)	22 (28)	57 (49)	0.77 (0.54)
23C	1.00 \pm 1.50	16 (11)	19 (40)	65 (49)	0.76 (0.59)
24F	1.66 \pm 1.73	30 (43)	23 (25)	47 (32)	0.57 (0.49)
25E	0.97 \pm 1.50	15 (16)	18 (20)	67 (64)	0.76 (0.47)

*F = item contained on the functional subscale; E = item contained on the emotional subscale; C = item contained on the catastrophic subscale; †values of the THI-US version are listed in parentheses⁴

Table 3. Mean and range values of the Croatian adaptation of the Tinnitus Handicap Inventory (N=130)

	Croatian adaptation of the Tinnitus Handicap Inventory			
	Total*	Functional†	Emotional‡	Catastrophic§
Mean ± SD	33.02±27.30	14.05±12.28	11.60±11.34	7.46±5.49
Median [IQR]	24.00 [41.00]	12.00 [19.00]	8.00 [16.00]	6.00 [8.00]
Range	0-100	0-44	0-36	0-20

*Maximal score 100; †maximal score 44; ‡maximal score 36; §maximal score 20

Table 4. Spearman's rank correlation coefficients between total scale and subscales of the Croatian adaptation of the Tinnitus Handicap Inventory (N=130)

	Total score r	Functional r	Emotional r	Catastrophic r
Total score	-	0.94*	0.92*	0.86*
Functional	0.94*	-	0.80*	0.71*
Emotional	0.92*	0.80*	-	0.76*
Catastrophic	0.86*	0.71*	0.76*	-

*Statistically significant (p<0.05)

Internal consistency reliability

The item-total correlations and the internal consistency reliability coefficients (Cronbach's alpha) were calculated for the THI-HR Total scale. For the whole THI-HR, Cronbach's alpha of $\alpha=0.96$ was obtained, indicating excellent internal consistency reliability (Table 5). The item total correlations ranged from 0.44 to 0.84, reflecting a homogeneous sample of items. The lowest item-total correlation (0.44) was observed for item 19 („Do you feel that you have no control over your tinnitus?“). Items having high item-total correlations are considered more representative of the scale content than items demonstrating low item-total correlations. On the other hand, having high item-total correlations for all items can, for some issues, suggest that the measure is too long. Having said that, this does not seem to be the case here as the alpha coefficients were not extremely high. The item-total correlations for each of the 25 items for the adapted THI-HR and the original THI-US are presented in Table 2.

Item-total correlations and the internal consistency reliability coefficients (Cronbach's alpha) were calculated separately for the three subscales of the THI-HR. Cronbach's alpha coefficients for the functional, emotional, and catastrophic scale were 0.76, 0.78, and 0.76, respectively (Table 5). The item total correlations

for the functional scale ranged from 0.54 to 0.81, for the emotional scale from 0.68 to 0.84, and for the catastrophic scale from 0.44 to 0.76. The most representative items with the highest correlations within each subscale were item 9 („Does your tinnitus interfere with your ability to enjoy social activities (such as going out to dinner or to the cinema)?“) and item 12 („Does your tinnitus make it difficult to enjoy life?“) for the functional (0.81), item 21 („Because of your tinnitus, do you feel depressed?“) for the emotional (0.84), and item 23 („Do you feel you can no longer cope with your tinnitus?“) for the catastrophic scale (0.76) (Table 2).

Table 5. Item-total correlations and reliability coefficients (Cronbach's alpha) of total scale and three subscales of the Croatian adaptation of the Tinnitus Handicap Inventory (THI-HR)

THI-HR Scale	Cronbach's alpha	Item-total correlation
Total (25 items)	0.96	0.510
Functional (11 items)	0.76	0.508
Emotional (9 items)	0.78	0.671
Catastrophic (5 items)	0.76	0.549

Construct validity

Correlations among scores of the THI-HR, DASS, EPQ R/S, and subjective tinnitus ratings are presented in Table 6. There was a statistically significant positive weak relationship between tinnitus loudness and THI-HR scores, total and subscale. Results showed a statistically significant positive moderate relationship of the three DASS subscales and the EPQ R/S-Neuroticism subscale with total THI-HR and its three subscales.

Repeatability

Test-retest reliability was evaluated in 32 patients (mean age 46.72±13.26, age range 22-68 years, 21 males). The correlation coefficients, standard error of measurement, and 95% confidence intervals are shown in Table 7.

Exploratory data analysis

An exploratory data analysis was conducted to test whether the data could confirm latent variables represented by the Functional, Emotional, and Catastrophic subscales of the original version of THI. Data were analyzed using a principal component analysis with varimax rotation. Three-factor solution was examined to test whether the results were comparable to the subscales proposed by Newman *et al.*^{4,5}. An additional factor analysis using eigenvalues >1 as criterion yielded three factors as the original scale consists of, with the first extracted factor (functional) explaining 28.4%, second (emotional) 10.6%, and third (catastrophic) 9.7% of the variance. Three factors explained 48.7% of total variance. The factors and factor loads are presented in Table 8.

When forming the factors, the issues we considered were coding of the original study factor loads in the

Table 6. Correlations between scores of the Croatian adaptation of the Tinnitus Handicap Inventory (THI-HR), Depression Anxiety Stress Scale (DASS), Eysenck Personality Questionnaire Revised/Short Scale (EPQ R/S), and subjective tinnitus ratings (N=130)

	THI-HR Total r	Functional r	Emotional r	Catastrophic r
Duration of tinnitus (months)	0.04†	0.07†	0.02†	0.03‡
Tinnitus loudness	0.37†,*	0.35†,*	0.29†,*	0.33‡,*
DASS (Depression)	0.47†,*	0.42†,*	0.49†,*	0.43†,*
DASS (Anxiety)	0.53†,*	0.48†,*	0.43†,*	0.44†,*
DASS (Stress)	0.57†,*	0.61†,*	0.59†,*	0.52†,*
EPQ R/S (Extraversion)	-0.18†	-0.10†	-0.21†	-0.12‡
EPQ R/S (Neuroticism)	0.64†,*	0.56†,*	0.62†,*	0.59‡,*
EPQ R/S (Psychoticism)	0.08†	0.03†	0.06†	0.22†
EPQ R/S (Lie)	-0.09†	-0.08†	-0.10†	-0.04‡

*Statistically significant ($p < 0.05$); †Spearman's rank correlation coefficient; ‡Pearson's product

Table 7. Test-retest administration of the Croatian adaptation of the Tinnitus Handicap Inventory (N=32)

	Croatian adaptation of the Tinnitus Handicap Inventory			
	Total	Functional	Emotional	Catastrophic
Test-retest correlation coefficient*	0.926	0.928	0.890	0.899
Standard error	2.1	2.4	3.1	1.9
95% Confidence interval	18.7	7.6	9.1	4.8

*Pearson's product moment correlations

Table 8. Factor structure of the Croatian adaptation of the Tinnitus Handicap Inventory (THI-HR)*

THI-HR Item†	Factor		
	1	2	3
1F	0.66		
2F	0.67		
3E		0.32	
4F	0.70		
5C			0.47
6E		0.40	
7F	0.41		
8C			0.72
9F	0.70		
10E		0.44	
11C			0.72
12F	0.58		
13F	0.49		
14E		0.43	
15F	0.41		
16E		0.54	
17E		0.74	
18F	0.37		
19C			0.81
20F	0.73		
21E		0.61	
22E		0.63	
23C			0.43
24F	0.64		
25E		0.62	

*Loadings >0.30 are presented; †F = item contained on the functional subscale; E = item contained on the emotional subscale; C = item contained on the catastrophic subscale

present study, and the criterion that high scores in one dimension showed a tendency toward that dimension. As the criteria for factor loads, we used those with loads >0.30. Table 8 shows that three factors represent items of the original three subscales.

Discussion

Symptom severity and quality of life impairment drive most tinnitus sufferers to seek medical treatment. Since the evaluation of symptoms and decrease of tinnitus handicap are the primary goals of tinnitus management, there has been a growing interest in patient rated outcome measures. Besides the audiologist-developed THI, the Tinnitus Questionnaire (TQ), developed by a psychologist Hallam *et al.*, and the Tinnitus Handicap Questionnaire (THQ), developed by an audiologist Kuk *et al.*, are also in widespread use^{10,11}. Until now, there is no measurement tool for tinnitus handicap developed or validated in Croatian language. We chose the THI for adaptation because this validated instrument has been shown to be robust and credible^{4,5,12}. The THI is comprised of only 25 questions that makes it practical and useful for both clinical and research application. Our aim was to translate and cross-culturally adapt the original THI into Croatian and to investigate its validity and reliability in adult tinnitus sufferers. There is a high prevalence of hearing impairment in tinnitus sufferers. Therefore, we did not restrict our study to patients with tinnitus only (i.e., no hearing loss). Further, item 14 belongs to the emotional subscale of the THI-US. In Table 1 in the original article describing the THI-US⁴ and in the Appendix of the verification article⁵, item 14 is mislabeled as a functional subscale item¹³. Consequently, this labeling error can be found in some translated versions^{14,15}. In the THI-HR, item 14 is ascribed to the emotional subscale. Therefore, in this study, statistical analysis was conducted with item 14 constituting an emotional subscale item.

As was the case with the original THI-US, the THI-HR total and subscale scores were not affected by age and gender. Newman *et al.* report no significant difference in the THI-US scores between subjects with normal hearing and those with hearing loss⁴. Unlike the THI-US, we found a statistically significant positive weak relationship between hearing impairment (as measured by the mean threshold) and THI-HR scores. A significant positive moderate relationship ($r=0.52$) between the THQ scores and the mean hearing threshold has been reported by Kuk *et al.*¹¹. Relationship between formal educational level and perceived tinnitus handicap for the original THI-US was not

investigated. We found a statistically significant negative weak relationship of education with the THI-HR functional and emotional subscale scores. The subjects with higher formal educational level had lower perceived tinnitus handicap related to weaker functional and emotional response reactions to tinnitus. We assume that higher educated subjects had more information about tinnitus, which might have resulted in more effective coping strategies. This suggests that patient education to understand tinnitus may be a useful part of tinnitus treatment.

In order to evaluate reliability of the THI-HR, we measured its internal consistency. Item-total correlation coefficients for each item and Cronbach's alpha were calculated. Single item showing low item-total correlations does not measure the same construct as the others. The THI-HR items showed to be homogeneous. All items correlated with the total scale to a good degree and had item-total correlations above 0.40, which is encouraging. These results indicated that each THI-HR item is measuring the same construct measured by the other items included. Arguably, it may be an indication that the questionnaire is overlong with too many items that are too similar to each other. The item-total correlations for the THI-US ranged from 0.22 to 0.77⁴. The lowest item-total correlation coefficient observed in our study was 0.44. This suggests that there may be an issue about the items having become more similar to each other in translation than they were in the English version. It was shown that the THI-HR had excellent internal consistency reliability for total scale ($\alpha=0.96$) and good internal consistency reliability for functional ($\alpha=0.76$), emotional ($\alpha=0.78$), and catastrophic ($\alpha=0.76$) subscales. The THI-HR has been shown to be a reliable indicator of handicap related to tinnitus. The Cronbach's alpha values for the original THI-US were 0.93, 0.86, 0.87, and 0.68, respectively⁴.

Significant moderate to strong intercorrelations ($r_p=0.65$ to $r_p=0.93$) between total THI-US and subscale scores were found by Newman *et al.*⁴. Our results were comparable to the THI-US. The intercorrelations for the THI-HR were high and ranged from $r_s=0.71$ to $r_s=0.94$. These high intercorrelations imply that three factors do not measure three distinct constructs.

In the original study, non-significant weak correlations between the THI-US scores and subjectively

rated tinnitus loudness ($p>0.05$; $r_p=0.20$ to $r_p=0.24$) were observed⁴. Our results showed a statistically significant positive weak relationship between the subjectively rated loudness and THI-HR scores, total and subscale ($r_s=0.29$ to $r_s=0.37$). Hallam *et al.* report an association between tinnitus loudness and emotional distress as measured by the TQ. They propose a single-case study approach to investigate whether distress or annoyance influences the perceived intensity of the noise, or tinnitus loudness causes distress or annoyance¹⁰.

Kuk *et al.* report a significant positive moderate relationship ($r=0.63$) between THQ scores and depression as measured by the Zung Self-Rating Depression Scale¹¹. We found a statistically significant positive moderate relationship ($r_s=0.42$ to $r_s=0.61$) of total THI-HR and its three subscales with depression, anxiety, and tension/stress as measured by DASS. These correlations may be seen as suggesting that THI scores may be highly contaminated with depression, anxiety, stress and neuroticism and that, provided that someone has tinnitus, the strongest predictors of impact are those psychological state variables. The original study results by Newman *et al.*⁴ showed a statistically significant positive weak correlation ($r_p=0.22$ to $r_p=0.38$) of total THI-US, functional and emotional subscales with depression as measured by the Beck Depression Inventory (BDI). Unlike our study sample, tinnitus was not necessarily a primary complaint in the Newman's patient sample. The Croatian patients had higher mean THI-Total scores (33.02 ± 27.30) compared with the US sample (25.4 ± 20.5)⁴. These two studies used two different depression measuring instruments (DASS and BDI). Therefore, we were not able to determine whether our patient sample was composed of more significantly depressed subjects. Zachariae *et al.* used BDI and observed significant moderate to strong correlations ($r_p=0.60$ to $r_p=0.73$) between depression and the Danish adaptation of THI scores¹⁴. Danish patients had higher depression scores compared with the original US sample^{4,14}. Further, similar statistically significant positive moderate relationships of the EPQ R/S-Neuroticism subscale with both the Danish ($r_p=0.40$ to $r_p=0.56$) and our Croatian ($r_s=0.56$ to $r_s=0.64$) adaptation of the THI were found. Neuroticism as a personality trait including anger, depression and anxiety as components is

related to frequent expression of negative emotions, physiological reaction, and psychosomatic reaction. Those who are more neurotic feel and express more suffer caused by tinnitus. Both the Danish and Croatian adaptation showed no significant correlation with the Extraversion, Psychoticism, and Lie subscale¹⁴. The low and nonsignificant correlations with the EPQ Extraversion, Psychoticism, and Lie subscale scores are reassuring evidence of divergent validity.

In order to determine whether the THI-HR produces consistent results, test-retest reliability was evaluated. An analysis of the test-retest administration of the THI-HR revealed good and excellent correlations between the test and retest scores ($r_p=0.890$ to $r_p=0.928$) which were comparable to the correlations reported in the original article ($r=0.84$ to $r=0.94$)⁵. These results suggest that the THI-HR is a tool that can be used with confidence to evaluate the impact of tinnitus treatment on patient performance.

We performed an exploratory factor analysis to test whether our data could confirm the latent variables represented by the Functional, Emotional, and Catastrophic subscales of the original version of the THI. Our results were comparable to the subscales proposed by Newman *et al.*^{4,5}. The first extracted factor (functional) explained 28.4%, second (emotional) 10.6% and third factor (catastrophic) explained 9.7% of variance. Three factors explained 48.7% of total variance. The THI-HR factor analysis revealed that the original THI three-factor solution was a good fit to the data. The original three-factor structure of the THI-US was confirmed.

The factor structure of the THI-HR differed from the THI-US factor structure reported by Baguley and Andersson¹⁶. Their study yielded unifactorial structure of the original scale with a majority of items loading on the first factor. They recommended use of total score in clinical practice and research. The Danish adaptation by Zachariae *et al.*¹⁴ and the Italian adaptation by Monzani *et al.*¹⁵ only partially represented items of the original three subscales. They also used eigen values greater than 1 as criterion, as we did, but the Danish adaptation yielded seven factors.

Conclusion

The property testing of the THI in Croatian language was performed in a otorhinolaryngology clinic adult population with a primary complaint of tinnitus. The results of this single-center prospective cross-sectional study demonstrated that the THI-HR had high internal consistency reliability and good construct validity. The THI-HR is a valid and reliable measure of tinnitus complaint that can be used for assessment of the impact of tinnitus symptoms in daily life in the adult Croatian population.

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Sažetak

THI-HR: HRVATSKA VERZIJA UPITNIKA *TINNITUS HANDICAP INVENTORY*

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U ovome radu preveli smo upitnik *Tinnitus Handicap Inventory* na hrvatski jezik i ispitali pouzdanost i valjanost hrvatske adaptacije (THI-HR). Nakon provedene audiološke obrade bolesnici s tinitusom (N=130) ispunili su upitnike THI-HR, Ljestvica depresivnosti, anksioznosti i stresa (DASS) i Eysenckova ljestvica ličnosti R/S (EPQ R/S). Prikupljeni su sociodemografski podatci o bolesnicima i deskriptivni podatci o tinitusu. Utvrđene su unutarnja konzistencija, konstruktna valjanost, faktorska struktura i pouzdanost upitnika putem *test-retest* primjene upitnika. Cronbachovi alfa koeficijenti (α) za cijelu THI-HR ljestvicu, Funkcionalnu, Emocionalnu i Katastrofičnu podljestvicu bili su redom 0,96, 0,76, 0,78 i 0,76. Utvrđene su umjerene korelacije cijele THI-HR i triju podljestvica s tri DASS podljestvice ($r_s=0,42$ do $r_s=0,61$) i EPQ R/S-podljestvicom neuroticizma ($r_s=0,56$ do $r_s=0,64$). Faktorska analiza upitnika pokazala je trofaktorsku strukturu upitnika kao i u originalnome upitniku te prikladno trofaktorsko pristajanje dobivenim podacima. Tri faktora objasnila su 48,7% ukupne varijance. Koeficijenti pouzdanosti putem *test-retest* primjene upitnika bili su visoki ($r_p=0,89$ do $r_p=0,93$). Na kraju, utvrđeno je da THI-HR ima visoku pouzdanost tipa unutarnje konzistencije i dobru konstruktnu valjanost. Upitnik THI-HR je valjan i pouzdan mjerni instrument za utvrđivanje smetnja povezanih s tinitusom te se može rabiti za ispitivanje utjecaja simptoma tinitusa na svakodnevno funkcioniranje odrasle hrvatske populacije.

Ključne riječi: *Tinitus; Šum u uhu; Hendikep; Upitnik; Mjerila stanja zdravlja*

APPENDIX

Croatian version of the Tinnitus Handicap Inventory (THI-HR).

Svrha ovoga upitnika je identificirati problem koji Vam Vaš tinitus može prouzročiti. Obilježite „Da“ ili „Ponekad“ ili „Ne“ za svako pitanje. Molimo Vas da odgovorite na sva pitanja.

1F Je li Vam otežana koncentracija zbog Vašega tinitusa?	DA	PONEKAD	NE
2F Je li Vam teško čuti druge ljude zbog glasnoće Vašega tinitusa?	DA	PONEKAD	NE
3E Jeste li ljuti zbog Vašega tinitusa?	DA	PONEKAD	NE
4F Jeste li zbunjeni zbog Vašega tinitusa?	DA	PONEKAD	NE
5C Jeste li očajni zbog Vašega tinitusa?	DA	PONEKAD	NE
6E Žalite li se često zbog tinitusa?	DA	PONEKAD	NE
7F Je li Vam teško zaspati noću zbog Vašega tinitusa?	DA	PONEKAD	NE
8C Osjećate li se kao da ne možete pobjeći od svoga tinitusa?	DA	PONEKAD	NE
9F Ometa li Vas Vaš tinitus da uživate u društvenim aktivnostima (kao odlazak na večeru ili kino)?	DA	PONEKAD	NE
10E Osjećate li se nezadovoljno (frustrirano) zbog Vašega tinitusa?	DA	PONEKAD	NE
11C Mislite li da bolujete od teške bolesti zbog Vašega tinitusa?	DA	PONEKAD	NE
12F Otežava li Vam Vaš tinitus da uživate u životu?	DA	PONEKAD	NE
13F Ometa li Vas tinitus u obavljanju svoga posla ili kućanskih poslova?	DA	PONEKAD	NE
14E Jeste li često nervozni (razdražljivi) zbog Vašega tinitusa?	DA	PONEKAD	NE
15F Ometa li Vam Vaš tinitus čitanje?	DA	PONEKAD	NE
16E Osjećate li se uzrujano zbog Vašega tinitusa?	DA	PONEKAD	NE
17E Mislite li da Vam je narušen odnos s Vašom obitelji i prijateljima zbog tinitusa?	DA	PONEKAD	NE
18F Je li Vam teško usmjeriti pozornost na neke druge stvari koje nisu povezane s Vašim tinitusom?	DA	PONEKAD	NE
19C Mislite li da nemate kontrolu nad Vašim tinitusom?	DA	PONEKAD	NE
20F Osjećate li se često umornima zbog Vašega tinitusa?	DA	PONEKAD	NE
21E Osjećate li se tužno (depresivno) zbog Vašega tinitusa?	DA	PONEKAD	NE
22E Osjećate li tjeskobu (uznemirenost) zbog Vašega tinitusa?	DA	PONEKAD	NE
23C Osjećate li da se više ne možete nositi s problemom tinitusa?	DA	PONEKAD	NE
24F Pogoršava li se Vaš tinitus kada ste pod stresom (pritiskom)?	DA	PONEKAD	NE
25E Jeste li nesigurni zbog Vašega tinitusa?	DA	PONEKAD	NE