

# Psychosocial consequences of the loudness of tinnitus

Henk M Koning\*

## ABSTRACT

**Introduction:** Tinnitus distress is associated with the perceived loudness of the tinnitus.

**Objectives:** To evaluate the psychosocial problems in tinnitus patients and to explore any relation with the tinnitus loudness.

**Design:** From all patients who were treated in our clinic from January 2017 to September 2019 for their tinnitus, patients chart and a questionnaire with the psychosocial variables were studied retrospectively.

**Results:** Almost half of the tinnitus patients could not withstand their tinnitus and they were faced with disturbed concentration and feeling depressed. Psychosocial problems were related to the maximal loudness of the tinnitus. If the perceived maximal loudness of the tinnitus was above 73 millimetre on the visual analogue scale the prevalence of psychosocial problems raised. If it was above 83 millimetre the majority of these patients had psychosocial problems.

**Conclusion:** Psychosocial problems were related to the maximal loudness of the tinnitus. We recommend patients suffering from severe tinnitus distress that therapy should be aimed at a reduction of the maximal loudness of tinnitus to less than 73 mm on the visual analogue scale.

**Keywords:** Tinnitus, tinnitus distress, tinnitus loudness, visual analog scale, psychological disorder.

Department of Pain Therapy and Pain Clinic de bilt, Netherlands

\*Send correspondence to:

Henk M Koning

Department of Pain therapy and Pain clinic de bilt, Netherlands, Email: [hmkoning@pijnkliniekdebilt.nl](mailto:hmkoning@pijnkliniekdebilt.nl) Phone: +0031302040753

Paper submitted to the ITJ-EM (Editorial Manager System) on November 06, 2019; and accepted on November 20, 2019.

## INTRODUCTION

Tinnitus can cause distress, sleep problems, and reduced quality of life<sup>1-3</sup>. A minority of the tinnitus patients are subjected to serious psychosocial consequences of their tinnitus<sup>4</sup>. Tinnitus distress is associated with the perceived tinnitus loudness and further research is warranted<sup>2-4</sup>. This study was performed to evaluate the psychosocial problems in tinnitus patients and to explore any relation with tinnitus loudness.

## MATERIALS AND METHODS

Following approval of the Medical research Ethics Committees United (Nieuwegein, the Netherlands), all patients who were treated in our clinic in the period from January 2017 to September 2019 for their tinnitus were retrospectively studied. Information obtained was medical data and the psychosocial survey. The survey had the following items (“Are your tinnitus acceptable?”, “Is your concentration disturbed?”, “Are you capable to resist your tinnitus?”, “Are you feeling depressed?”, “Are you having fear”, and “Are you having anger?”). The response for each question could be “none”, “slight”, “moderate”, or “always”.

### Data assessment

The data obtained from each patient were age, sex, the perceived tinnitus loudness measured by the visual analogue scale (VAS), and the outcome of the psychosocial survey. VAS of tinnitus loudness are 10 cm lines between “no tinnitus” and “unbearable loud”. The tinnitus patient is requested to indicate on the line the mean, minimal and maximal loudness of their tinnitus. The distance (millimetre) on the 10 cm line is the score. The items of the survey for the psychosocial consequences of tinnitus can be answered “none” (0), “slight” (1), “moderate” (2), or “good” (3). A score of 2 or more indicated for the acceptance of tinnitus and for the capability to resist their tinnitus as normal. A score of 2 or more for concentration, depression, fear and anger was considered as disturbed. Data from the audiogram at the dominant side of the tinnitus was used for analysis. In cases of bilateral tinnitus with equal intensity, the mean of the audiogram was computed and used.

### Statistical methods

For statistical analysis, we used Minitab 16 (Minitab Inc., State College, PA, USA). Multivariate statistical analysis was performed for the correlation of tinnitus loudness with the results of the psychosocial survey. A value of  $p < 0.05$  was considered statistically significant.

## RESULTS

In the period from January 2017 to September 2019, there were 202 tinnitus patients treated in our clinic. The description of the patients is given in Table 1. Almost half of the patients were incapable to resist their tinnitus. Their

concentration was disturbed and felt depressed. Fear or anger was reported by only a minority of the tinnitus patients. In Table 2, the items of the psychosocial survey were compared with the tinnitus loudness. The maximal tinnitus loudness was statistical significant correlated to all items of the psychosocial questionnaire, in contrast to the minimal tinnitus loudness. The mean loudness of tinnitus showed only a significant correlation with the “acceptance of tinnitus” and to the “capability to resist their tinnitus”. The variation between minimal and maximal loudness was statistical significant related to “disturbed concentration”, “capability to resist their tinnitus”, “feeling depressed”, and “having fear”. Multivariate statistical analysis conducted to see which levels of the maximal loudness and which levels of variation between minimal and maximal loudness of tinnitus are associated with changes in the acceptance of tinnitus (Table 3). If the maximal loudness of the tinnitus increased above 73 millimetre on the visual analogue scale the prevalence of psychosocial problems raised. If it was above 83 millimetre the majority of the patients had psychosocial problems. The difference between minimal and maximal loudness of tinnitus associated with a change in the groups are presented in Table 4. If the variation between the minimal and maximal loudness of tinnitus was above 41 millimetres the vast majority of patients had disturbed concentration and were feeling depressed.

**Table 1:** Clinical characteristics of the patients with tinnitus.

Contents	Prevalence	Median	Q1 – Q3
Age (year)	-	57	50.0- 64.3
Gender (male)	57%	-	-
<b>Hearing loss (dB) at:</b>			
250 Hz	-	15	8.0 – 25.0
500 Hz	-	15	5.0 – 25.0
1 KHz	-	15	10.0 – 30.0
2 KHz	-	20	10.0 – 35.0
4 KHz	-	40	20.0 – 55.0
8 KHz	-	50	29.0 – 66.5
<b>Loudness tinnitus (VAS; mm):</b>			
Mean		68	50.0 – 81.0
Minimal		42	20.0 – 62.0
Maximal		84	69.8 – 95.0
Tinnitus not acceptabel	53%	-	-
Concentration disturbed	60%	-	-
Tinnitus not to resist	46%	-	-
Feeling depressed	42%	-	-
Having fear	32%	-	-
Having anger	18%	-	-

dB: decibel; Hz: Hertz; KHz: Kilohertz; Q1 – Q3: Inter-Quartile Range; VAS: Visual Analogue Scale; mm: millimetre

**Table 2:** The results of the comparison of the results of the survey for the psychosocial consequences of tinnitus with the parameters of the loudness of tinnitus.

<b>Tinnitus Acceptable</b>		No (n=65)		Yes (n=57)		
Loudness tinnitus (VAS; mm)	Mean	SEM	Mean	SEM	P-value	
Mean	68.8	3.4	57	3.4	0.016	Sign.
Minimal	45.5	4.3	41.7	3.5	0.493	
Maximal	84.3	3.1	73	2.9	0.004	Sign.
Difference Maximal and Minimal	32.7	3.3	40.2	4.1	0.155	
<b>Concentration Disturbed</b>		Yes (n=75)		No (n=49)		
Loudness tinnitus (VAS; mm)	Mean	SEM	Mean	SEM	P-value	
Mean	65.3	3.6	59.2	3.8	0.224	
Minimal	42.5	3.6	44.2	4.3	0.765	
Maximal	83.6	2.3	71.3	3.3	0.003	Sign.
Difference Maximal and Minimal	43.3	3.5	27.4	3.6	0.002	Sign.
<b>Can resist their tinnitus</b>		No (n=54)		Yes (n=63)		
Loudness tinnitus (VAS; mm)	Mean	SEM	Mean	SEM	P-value	
Mean	69.3	3.6	56.4	3.3	0.010	Sign.
Minimal	45.7	4.4	40.2	3.5	0.332	
Maximal	88.2	1.5	70.5	3.1	0.000	Sign.
Difference Maximal and Minimal	44	4.1	31.3	3.4	0.020	Sign.
<b>Feeling Depressed</b>		Yes (n=51)		No (n=71)		
Loudness tinnitus (VAS; mm)	Mean	SEM	Mean	SEM	P-value	
Mean	65	3.7	60.7	3.3	0.39	
Minimal	39.0	4.0	45.4	3.7	0.243	
Maximal	85.0	2.4	73.8	2.9	0.003	Sign.
Difference Maximal and Minimal	48.5	3.9	28.7	3.2	0.000	Sign.
<b>Having Fear</b>		Yes (n=39)		No (n=84)		
Loudness tinnitus (VAS; mm)	Mean	SEM	Mean	SEM	P-value	
Mean	63	4.3	62.8	3	0.964	
Minimal	37.3	4.4	45.9	3.4	0.128	
Maximal	85.3	2.9	75.7	2.5	0.014	Sign.
Difference Maximal and Minimal	47.8	4.7	31.7	3	0.005	Sign.
<b>Having Anger</b>		Yes (n=22)		No (n=101)		
Loudness tinnitus (VAS; mm)	Mean	SEM	Mean	SEM	P-value	
Mean	68.8	6.6	61.6	2.7	0.322	
Minimal	44.4	8.5	43.4	2.9	0.907	
Maximal	87.4	2.6	76.8	2.3	0.004	Sign.
Difference Maximal and Minimal	41.6	7.2	35.3	2.8	0.425	

dB: decibel; Hz: Hertz; KHz Kilohertz; SEM: Standard Error of the Mean; Sign: Significant; Prev: Prevalence; VAS: Visual Analogue Scale; mm: millimetre

**Table 3:** The levels of the maximal loudness of the tinnitus and the results of the survey for the psychosocial consequences of tinnitus.

Maximal loudness tinnitus (VAS; mm)	Less than 73	73 -77	78 - 83	More than 83	P-value	
Not acceptable	31%	60%	33%	65%	0.009	Sign.
Concentration disturbed	34%	60%	60%	77%	0.001	Sign.
Feeling depressed	28%	40%	27%	58%	0.026	Sign.
Cannot resist their tinnitus	16%	40%	40%	64%	0.000	Sign.
Having Fear	19%	40%	20%	43%	0.070	
Having Anger	6%	20%	20%	23%	-	

**Table 4:** The levels of the gap between maximal and minimal loudness of the tinnitus and the results of the survey for the psychosocial consequences of tinnitus.

Maximal - Minimal loudness tinnitus (VAS; mm)	Less than 31	31-36	37-41	More than 41	P-value	
Not acceptable	43%	50%	25%	61%	0.209	
Concentration disturbed	46%	50%	50%	79%	0.011	Sign.
Feeling depressed	27%	33%	38%	64%	0.006	Sign.
Cannot resist their tinnitus	33%	33%	38%	59%	0.106	
Having Fear	24%	33%	25%	44%	0.269	
Having Anger	13%	0%	13%	24%	-	

## DISCUSSION

In this group of tinnitus sufferers, almost half of the patients had no capability to resist their tinnitus and found their tinnitus not acceptable. Their concentration was hampered and they felt depressed. These psychosocial problems were related to the maximal loudness of the tinnitus. If the perceived maximal loudness of the tinnitus increased above 73 millimetre on the visual analogue scale the prevalence of psychosocial problems raised. If it was above 83 millimetre the majority of the patients had psychosocial problems.

It has been suggested that at least two distinct brain networks are involved in tinnitus<sup>5</sup>. One network is associated with the distress caused by tinnitus, and the other network reflects tinnitus loudness<sup>6</sup>. The anterior cingulate/insula, parahippocampus, and auditory cortex are functioning within the loudness network<sup>7</sup>. The inadequate coping in tinnitus patients is thought to be related to the left dorsolateral prefrontal cortex<sup>8</sup>. In normal conditions, there is no intercommunication between distress and loudness networks. Only in distressed patients, there is interaction between both networks<sup>5</sup>. It is possible that the interaction between those two networks depends on the level of the maximal tinnitus loudness. In our study, a maximal loudness of tinnitus of 73 mm on the VAS and/or variation between maximal and minimal loudness above 41 mm on the VAS was found to induce tinnitus distress in considerably more patients.

Exposure to intense sound can raise the activity of central auditory neurons for a longer period<sup>9</sup>. Overstimulation induce neural plasticity not only in the auditory nervous system but also in other parts of the central nervous system<sup>10</sup>. It may be possible that if perceived maximal loudness of tinnitus exceeds a certain threshold also neural plasticity in the tinnitus distress network will occur.

Therapy of tinnitus should be focused on a reduction of the tinnitus loudness, commonly assessed with a numeric rating scale<sup>11</sup>. Also, our study indicate that the lowering the maximal tinnitus loudness will have a direct impact on the improvement in patient's wellbeing. When the maximal tinnitus loudness from above 83 mm is diminished to less than 73 mm, the incapability to resist their tinnitus decreased from 64% to 16% and feeling depressed from 58% to 28%.

Consequently, physicians can use perceived tinnitus

loudness to identify the ones at risk for tinnitus distress<sup>12</sup>. Also, the use of perceived tinnitus loudness during therapy can be used as an indication to see whether the measures taken are effective. The perceived tinnitus loudness are simple and easy to measure and the results are easy to interpret. Therefore, we conclude that the three tinnitus self-rating scales (mean, minimal and maximal) are a valuable additive for the patient's current tinnitus status.

Our retrospective study has limitations. A prospective follow-up study is a logic sequel to confirm these results and endorse the conclusions. Also, we used a simple questionnaire to reflect the use of these questions in clinical practice. In a follow-up study, more extensive questionnaires could eventually give more extensive information of the psychosocial consequences of tinnitus.

## CONCLUSION

Psychosocial problems were related to the maximal loudness of the tinnitus. We recommend patients suffering from severe tinnitus distress that therapy should be aimed at a reduction of the maximal loudness of tinnitus to less than 73 mm on the visual analogue scale.

## CONFLICT OF INTEREST

The author declares no conflict of interest.

## REFERENCES

1. Drexler D, Lopez-Paullier M, Rodio S, González M, Geisinger D, Pedemonte M. Impact of reduction of tinnitus intensity on patients' quality of life. *Int J Audiol.* 2016;55:1-9.
2. Meikle MB, Vernon J, Johnsom RM. The perceived severity of tinnitus. Some observations concerning a large population of tinnitus clinic patients. *Otolaryngol Head Neck Surg.* 1984;92:689-96.
3. Rizzardo R, Savastano M, Maron MB, Mangialaio M, Salvadori L. Psychological distress in patients with tinnitus. *J Otolaryngol.* 1998;27:21-5.
4. Hoekstra CE, Wesdorp FM, van Zanten GA. Socio-demographic, health, and tinnitus related variables affecting tinnitus severity. *Ear Hear.* 2014;35:544-54.
5. Vanneste S, Congedo M, De Ridder D. Pinpointing a highly specific pathological functional connection that turns phantom sound into distress. *Cereb Cortex.* 2014;24:2268-82.
6. Ueyama T, Donishi T, Ukai S, Ikeda Y, Hotomi M, Yamanaka N, et al. Brain regions responsible for tinnitus distress and loudness: a resting-state FMRI study. *PLoS One.* 2013;8:e67778.

- 
7. De Ridder D, Congedo M, Vanneste S. The neural correlates of subjectively perceived and passively matched loudness perception in auditory phantom perception. *Brain Behav.* 2015;5:e00331.
  8. Vanneste S, Joos K, Languth B, To WT, De Ridder D. Neuronal correlates of maladaptive coping: an EEG-study in tinnitus patients. *PLoS One.* 2014;9:e88253.
  9. Kaltenbach JA, McCaslin DL. Increases in Spontaneous Activity in the Dorsal Cochlear Nucleus Following Exposure to High Intensity Sound: A Possible Neural Correlate of Tinnitus. *Audit Neurosci.* 1996;3:57-78.
  10. De Deus JL, Cunha AOS, Terzian AL, Resstel LB, Elias LLK, Antunes-Rodrigues J, et al. A single episode of high intensity sound inhibits long-term potentiation in the hippocampus of rats. *Sci Rep.* 2017;7:14094.
  11. Manning C, Grush L, Thielman E, Roberts L, Henry JA. Comparison of Tinnitus Loudness Measures: Matching, Rating, and Scaling. *Am J Audiol.* 2019;28:137-143.
  12. Weidt S, Delsignore A, Meyer M, Rufer M, Peter N, Drabe N, et al. Which tinnitus-related characteristics affect current health-related quality of life and depression? A cross-sectional cohort study. *Psychiatry Res.* 2016;237:114-21.