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Psychometric assessment of mental health in tinnitus patients, depressive and healthy controls

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ABSTRACT

Tinnitus describes the perception of a sound without external source and is characterized by high comorbidity, e.g. depression. In many studies, tinnitus patients were compared to healthy controls while a comorbid psychiatric diagnosis was an exclusion criterion. Consequently, patients with severe tinnitus and psychiatric comorbidity were often neglected. In the current study, we tried to fill this gap and compared four groups including two control groups: (1) chronic tinnitus patients with mild tinnitus distress ($N = 37$), (2) chronic tinnitus patients with severe tinnitus distress ($N = 24$), (3) patients suffering from depression, but no tinnitus (major depressive disorder, MDD; $N = 23$) and (4) healthy controls ($N = 42$). We assessed their clinical profile with clinical questionnaires concerning anxiety, depression and somatoform symptoms. Data were analyzed with a canonical discriminant analysis resulting in two factors. Factor 1 was called *general psychopathology*, because most questionnaires loaded highly on it. Regarding this factor, patients with severe tinnitus distress and MDD controls were impaired equally strong. Patients with mild tinnitus distress were more strongly affected than healthy controls. Both tinnitus groups reached higher values than the two control groups with regard to factor 2, called *somatization*. These results stress the presence of significant general psychopathology even in mild tinnitus.

1. Introduction

Tinnitus describes the perception of a sound without the presence of an external noise. While on first sight this appears as a purely sensory phenomenon a lot of research evidenced that chronic tinnitus (lasting longer than 3 months) is accompanied by symptoms affecting cognition and attention (for reviews: Andersson and McKenna, 2006; Mohamad et al., 2016; Tegg-Quinn et al., 2016), as well as language perception (for review (Ivansic et al., 2017)). Most notably, there exists high comorbidity with depression, anxiety and somatoform disorders (e.g. Andersson, 2002; Hiller et al., 1997; McCormack et al., 2014, 2015; Pinto et al., 2014; Zöger et al., 2001, 2006). Reviewing the literature on comorbidity in tinnitus, Kratzsch and Goebel (2018) report that of the patients with decompensated tinnitus (severe tinnitus distress) 40–60% suffer from major depression, 15–60% from anxiety disorders and 20–50% from somatoform disorders. Only 7–11% of the patients do not suffer from any psychiatric disorder. In comparison, 73–86% of the patients with compensated tinnitus (mild tinnitus distress) do not suffer from any psychiatric disorder, only 15–30% from anxiety disorders, 7–15% from affective disorders and up to 30% from somatoform disorders, i.e. the presence of psychiatric disorder does not seem to be more likely in comparison to the general population. Further stressing the key role of depression, a recent study demonstrated that tinnitus handicap and anxiety are mediated by depressive symptomatology (Trevis et al., 2016). Additionally, subjective tinnitus loudness can be predicted by hearing loss and depression (Wallhausser-Franke et al., 2015). In a similar vein, some initial evidence was presented that antidepressant medication may alleviate tinnitus loudness along with depressive symptoms (Fornaro and Martino, 2010; Sullivan et al., 1993). Ooms et al. (2011) highlight the complexity of

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the relationship between depression and tinnitus and they propose the distinction between somatic symptoms as a consequence of tinnitus and somatic symptoms as indicators of depression.

Taken together, depressive and anxiety disorders are the most common psychiatric comorbid disorders among chronic tinnitus patients (Bhatt et al., 2017; Goebel and Hiller, 1992; Zirke et al., 2013) patients (Maes et al., 2013). According to the newest systematic review and meta-analysis of psychological functioning in chronic tinnitus, including 18 studies on anxiety and 19 studies on depression on 660 chronic tinnitus patients comparing them to 494 healthy controls, the relationship between tinnitus and psychiatric disorders seems to be correlated. That is, there are more depressive ($r = 0.51$) and anxiety ($r = 0.52$) symptoms in patients with severe tinnitus (Trevis et al., 2018). Despite the high rate for tinnitus coinciding with psychiatric disorders, especially depression and anxiety, a cause cannot be directly established. Severe tinnitus may cause psychological discomfort; alternatively, the presence of depression and anxiety may reduce an individual's tolerance of tinnitus, leading to exaggeration of the symptoms.

The involvement of emotional factors in the generation and/or perpetuation of tinnitus was confirmed by imaging studies using resting state functional magnetic resonance imaging (fMRI), voxel based morphometry or diffusion tensor imaging (DTI). Several recent reviews (Husain, 2016; Husain and Schmidt, 2014; Leaver et al., 2016) agree that the limbic system (mainly amgygdala, parahippocampus, insula) plays a key role in tinnitus pathophysiology. Other structures involve the ventromedial prefrontal cortex and the nucleus accumbens which are directly connected to the amygdala (reviewed in Rauschecker et al., 2015). The interplay between sensory and non-sensory systems is captured in tinnitus models like the neurophysiological model by Jastreboff and Hazell (1993) and the central gating hypothesis (Rauschecker et al., 2010). Taking into consideration that the presence of a psychiatric disorder is usually an exclusion criterion for imaging studies and thus mostly only tinnitus patients with mild or moderate tinnitus are investigated, the actual influence of the limbic system could be even stronger in patients with decompensated tinnitus.

For research purposes the exclusion of patients with a diagnosed psychiatric disorder is a reasonable approach to avoid factors (i.e. the presence to two disorders) confounding the dependent variables. On the other hand, an exclusion based on a categorical classification (disorder yes/no) does not guarantee that symptoms are not present on a subclinical level. In order to assess this, the measurement of symptoms on a quantifiable scale is necessary. This is the case for standardized questionnaires.

As a result, the patients suffering most strongly from tinnitus and the ones searching for help most often, thereby producing the highest cost for the health care system, become neglected in research. One could go even further and ask if the results gained on the patients with low tinnitus distress are applicable to patients seeking help due to high tinnitus distress.

As a first approach to this problem, we investigated the psychiatric profile of tinnitus patients with mild (compensated) and severe tinnitus distress (decompensated) and compared them to two control groups without tinnitus, a group suffering from major depressive disorder (MDD) and a healthy group. The presence of a psychiatric diagnosis in all groups was assessed using a standardized clinical interview (SKID-I). We investigated how the psychiatric profile based on standardized questionnaires on depression, anxiety and somatoform symptoms differs between patients with mild or severe tinnitus distress, MDD patients and heathy controls. These results should demonstrate how tinnitus distress and psychiatric symptoms are confounded and how the selection of suitable control groups may help to deconfound these factors in future tinnitus-research.

2. Methods

2.1. Participants

The sample consisted of four groups, two groups suffering from chronic bilateral tinnitus for longer than three months ($N = 61$) and two control groups ($N = 65$): one suffering from MDD ($N = 23$) and one healthy control group without tinnitus or psychiatric disorders ($N = 42$). Exclusion criteria for all participants were major neurological and unmedicated internal medical conditions. The presence or absence of a psychiatric disorder in all four groups was diagnosed with the German version of Structured Clinical Interview for DSM-IV Axis I Disorders (SKID-I) (Lobbestael et al., 2011). The resulting DSM-IV diagnoses were confirmed by two different psychiatrists (B.B. and I.N.). Chronic tinnitus patients were recruited at the Tinnitus Centre of the Department for Otorhinolaryngology of the Jena University Hospital. 29.3% of the tinnitus patients suffered from hearing loss, defined as 4-frequency (500, 1000, 2000 and 4000 Hz) pure-tone average (4PTA) >25 dB in pure-tone audiogram. All participants completed the German version of Tinnitus questionnaire (TQ) to assess tinnitus distress: TQ values above 46 points are labelled as severe tinnitus distress (decompensated), otherwise as mild (compensated) tinnitus distress (Goebel and Hiller, 1994) decompensated tinnitus ($n = 24$), nine patients (37.5%) had no psychiatric disorder, twelve were diagnosed with major depression, one with agoraphobia with panic disorder, one with posttraumatic stress disorder and one with substance use disorder (ibuprofen). In the group with compensated tinnitus ($N = 37$), twenty persons (54.1%) had no psychiatric disorder, thirteen were diagnosed with major depression, two with anxiety disorder ($N = 1$: panic disorder; $N = 1$: agoraphobia with panic disorder) and two with substance use disorder (alcohol).

The MDD control group ($N = 23$) was recruited at the wards for patients suffering from depression or anxiety disorders at the Department of Psychiatry and Psychotherapy of the Jena University Hospital. These inpatients suffered from MDD, but neither from chronic tinnitus assessed by the TQ nor hearing impairment determined by pure tone audiograms (4PTA <25 dB).

Three more patients were assessed, but later excluded because only patients with a diagnosis for major depression went into the analysis. This was done to keep the group as homogeneous as possible.

No patient suffered from auditory hallucinations or psychotic symptoms.

The second control group ($N = 42$) consisted of healthy persons recruited via press releases. They had neither currently nor in the past a DSM-IV axis I disorder nor first-degree relatives with a psychiatric disorder, as determined by careful phone screening. They also did not experience tinnitus lasting longer than several seconds and had no hearing impairment of more than 25 dB (4-PTA) as measured by pure tone audiograms.

An overview of demographic, audiometric and psychometric characteristics of all four groups is given in Table 1.

2.2. Further assessment of psychiatric profiles

All participants completed the MWT-B, a German language inventory similar to the NART (Antretter et al., 2013), to estimate IQ and the Edinburgh Handedness Inventory (Oldfield, 1971).

For assessment of psychological symptoms all participants also completed well established self- and assessor-assessment instruments. Depressive symptoms were measured with Beck´s depression inventory (BDI-2) (Beck and Steer, 1984), the Hospital anxiety and depression scale (HADS-D) (Hinz and Brahler, 2011) and the Hamilton depression scale (HAM-D) (Bailey and Coppen, 1976; Schwab et al., 1967; Worboys, 2013). Symptoms of anxiety were measured with the Hospital anxiety and depression scale (Hinz and Brahler, 2011) (HADS-A) and the Hamilton anxiety scale (Gjerris et al., 1983) (HAM-A). Somatoform

Table 1
Mean (± SD) of demographic, audiometric and psychometric characteristics of all subjects.

	Compensated tinnitus (N = 37)	Decompensated tinnitus (N = 24)	Healthy controls (N = 42)	MDD controls (N = 23)
Gender	15 f, 22 m	13 f, 11 m	21 f, 21 m	15 f, 8 m
Age,years	49.4 (± 12.5)	53.1 (± 12.4)	46.0 (± 17.4)	44.0 (± 11.8)
IQ	112.5 (± 15.8)	107.9 (± 15.0)	117.6 (± 16.7)	110.3 (± 14.6)
Handedness	0.8 (± 0.2)	0.8 (± 0.2)	0.8 (± 0.2)	0.84 (± 0.2)
TQ	32.3 (± 10.6)	58.5 (± 7.0)	n.a.	n.a.
4PTA left side, dB	23.0 (± 11.5)	30.4 (± 12.8)	12.8 (± 6.7)	12.78 (± 5.7)
4PTA right side,dB	21.1 (± 10.2)	28.6 (± 13.1)	10.8 (± 5.8)	12.28 (± 6.1)

4PTA = 4-frequency pure-tone average; f = female, m = male; n.a. = not applicable.

symptoms were assessed using the SOMS-2 Screening for somatoform symptoms (Rief et al., 2001; Rief and Hiller, 1999) . For general screening of minor psychopathological symptoms we also applied the Symptom Checklist 90 revised (SCL-90-R), which is divided into ten subscales (Derogatis et al., 1974; Schmitz et al., 2000).

All participants gave written informed consent to the study which was approved by the local Ethics Committee of Jena University Hospital (4729-03/16).

2.3. Data analysis

We employed a canonical discriminant analysis (implemented in R, R Core Team, 2017) to find one or more linear combinations of variables (i.e. one or more discriminant factors) in order to separate the four groups. Predictors were all assessment instruments (subscales if available) including IQ. Individual diagnoses were not used as predictors, because they served to classify the group. After establishing the factors, the individual factor scores were used in a one factorial ANOVA and subsequent Welch t-tests to find out which groups differed with regard to the established factors.

3. Results

Two factors of the possible three factors allowed to explain 90% of the variance of the original predictors and were chosen for further analysis (see Tables 2 and 3).

Table 2
Correlations with psychiatric measures, Eigenvalue and variance explained of factor 1.

Discriminant Factor 1		
Correlation	Hospital Anxiety and Depression Scale (Anxiety Scale)	0.81
	Hamilton Anxiety Rating Scale	0.9
	Symptom Checklist 90-R (Anxiety Scale)	0.58
	Symptom Checklist 90-R (Phobic Anxiety Scale)	0.35
	Mean of correlations with anxiety scales	**0.66**
	Hospital Anxiety and Depression Scale (Depression Scale)	0.71
	Beck's Depression Inventory II	0.81
	Hamilton Depression Rating Scale 24	0.84
	Symptom Checklist 90-R (Depression Scale)	0.72
	Mean of correlations with depression scales	**0.77**
	Mehrfachwahl-Wortschatz-Intelligenztest (IQ)	−0.28
	Screening for Somatoform Symptoms (Somatization Index)	0.69
	Screening for Somatoform Symptoms (Grievance Index)	0.71
	Symptom Checklist 90-R (Somatization Scale)	0.6
	Symptom Checklist 90-R (Obsessive Compulsion Scale)	0.7
	Symptom Checklist 90-R (Interpersonal Sensitivity Scale)	0.61
	Symptom Checklist 90-R (Hostility Scale)	0.52
	Symptom Checklist 90-R (Paranoid Ideation Scale)	0.57
	Symptom Checklist 90-R (Psychoticism Scale)	0.54
	Symptom Checklist 90-R (Unspecific Symptoms Scale)	0.79
	Mean of correlation with other scales	**0.54**
Eigenvalue		1.82
% of variance explained		58.43
Squared canonical correlation		0.64

Table 3
Correlations with psychiatric measures, Eigenvalue and variance explained of factor 2.

Discriminant factor 2		
Correlation	Screening For Somatoform Symptoms (Somatization Index)	0.07
	Screening For Somatoform Symptoms (Grievance Index)	0.11
	Symptom Checklist 90-R (Somatization Scale)	0.08
	Hamilton Anxiety Rating Scale	0.04
	Mean of correlations with somatization scales	**0.08**
	Hospital Anxiety and Depression Scale (Anxiety Scale)	−0.24
	Symptom Checklist 90-R (Anxiety Scale)	−0.43
	Symptom Checklist 90-R (Phobic Anxiety Scale)	−0.35
	Hamilton Anxiety Rating Scale	0.04
	Mean of correlations with anxiety scales	**−0.25**
	Hospital Anxiety and Depression Scale (Depression Scale)	−0.48
	Beck's Depression Inventory II	−0.36
	Hamilton Depression Rating Scale 24	−0.28
	Symptom Checklist 90-R (Depression Scale)	−0.4
	Mean of correlations with depression scales	**−0.38**
	Mehrfachwahl-Wortschatz-Intelligenztest (IQ)	−0.03
	Symptom Checklist 90-R (Obsessive Compulsion Scale)	−0.24
	Symptom Checklist 90-R (Interpersonal Sensitivity Scale)	−0.17
	Symptom Checklist 90-R (Hostility Scale)	0.05
	Symptom Checklist 90-R (Paranoid Ideation Scale)	−0.13
	Symptom Checklist 90-R (Psychoticism Scale)	−0.21
	Symptom Checklist 90-R (Unspecific Symptoms Scale)	−0.03
	Mean of correlations with other scales	**−0.11**
Eigenvalue		0.97
% of variance explained		31.13
Squared canonical correlation		0.49

We called Factor 1 "*general psychopathology*", because most questionnaires loaded highly on this factor and consequently the general nature of this factor should be described. Note that positive values on this scale and positive correlations indicate the presence of symptoms such as depression or anxiety symptoms. This factor explains 58.4% of the total variance, the mean correlation with predictors measuring depression was 0.77, the mean correlation with predictors measuring anxiety was 0.66, and others 0.54 (as an example the somatization Index correlated 0.69).

Factor 2 can be characterized as "*somatization without depression and anxiety*" (from now called "*somatization*") as indicated by a positive correlation with somatization and a negative correlation with depression and anxiety. It explained 31.1% of the total variance, the mean correlation with predictors measuring depression was −0.38, with predictors measuring anxiety −0.25, with predictors measuring somatization 0.08 and with others −0.11. Note, that a negative value on this scale indexes the absence of symptoms, as for depression and anxiety, while a positive value indicates the presence, as for somatization. The Hamilton anxiety scale (HAM-A) was included for both anxiety and somatization correlation means, as this scale measures a considerable amount of somatic anxiety and somatic symptoms (Hamilton, 1960).

The one-way ANOVA on factor 1 was significant ($F(3, 122) = 73.84$; $p < 0.0001$). See Fig. 1 for the boxplots separated by groups. For repeated post-hoc testing we used Bonferroni correction,

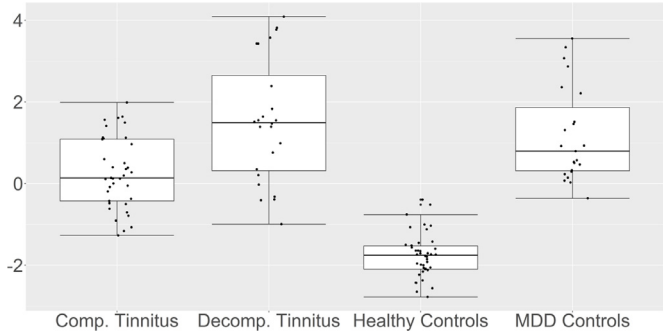

Fig. 1. Scores on factor 1 divided by group (individual data appear as datapoints).

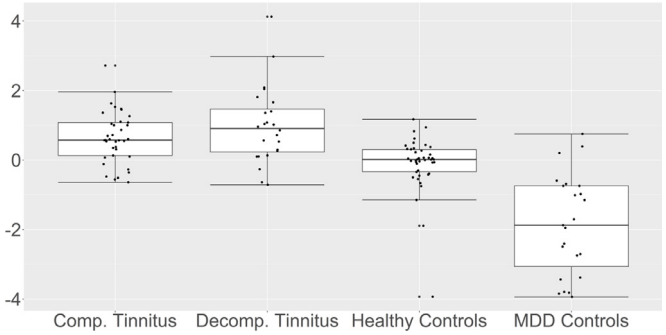

Fig. 2. Scores on factor 2 divided by group (individual data appear as datapoints).

the significance level was therefore set on $p = 0.008$. Follow-up Welch *t*-tests showed that all groups differed, but patients with decompensated tinnitus do not differ from MDD controls (see Table 4 for comparison of groups).

Similarly, the one-way ANOVA on factor 2 was also significant ($F(3, 122) = 29.5$; $p < 0.0001$). See Fig. 2 for the boxplots separated by groups. Follow-up Welch *t*-tests showed that all groups differed, but not the two groups with tinnitus (see Table 4 for comparison of groups).

4. Discussion

We set out to investigate the psychiatric profile in two groups of chronic tinnitus patients with either severe or mild tinnitus distress. Confirming earlier research, patients with severe tinnitus distress suffered more often from a psychiatric disorder than the patients with mild tinnitus distress, with depression being most prevalent. The two groups with chronic tinnitus were compared to two control groups without tinnitus: a MDD control group as well as a healthy group. Summarizing the results briefly, several findings are striking: (1) regarding general psychopathology, patients with severe tinnitus distress suffer as much as patients with MDD (2) even patients with compensated tinnitus suffer more from general psychopathology than healthy controls (3) tinnitus patients can be characterized by elevated somatization in comparison to both control groups. We will discuss each of these aspects in turn.

We were able to replicate earlier studies that the severity of tinnitus distress is associated with the presence of psychiatric comorbidity based on a categorical diagnosis from a clinical interview. 62% of the group with severe tinnitus distress suffered from at least one psychiatric disorder, mostly major depression, whereby only 45% of patients with mild tinnitus distress suffered from at least one psychiatric disorder. This is in line with the prevalence presented in the review by Kratzsch and Goebel (2018) and stresses the crucial influence of depression on the "vicious circle" of chronic tinnitus and in maintenance of chronic tinnitus (Trevis et al., 2016).

In order to avoid problems with multiple comparisons by comparing several groups on several measures, we performed first a discriminant factor analysis which revealed that two factors allow distinguishing the four groups which explained 90% of the variance of the original predictors. Factor 1 was labelled "*general psychopathology*", because most questionnaires and scales loaded positively on this factor with positive factor values indicating the presence of general psychopathology. Factor 2 explained the remaining variance between groups after considering factor 1 *general psychopathology* and thus informs about the more subtle differences of tinnitus and MDD control patients. It was called "*somatization*" (more specifically "somatization without depression and anxiety)", because measures on somatic symptoms loaded positively, while measures for depression and anxiety loaded negatively on it. In other words, high somatization values lead to positive scores and high values on depression and anxiety at the same time to negative scores. Patients with tinnitus reached positive values due to their somatization in this factor, but this was not the case for MDD controls. The latter ones score low on somatization, but at the same time high on depression and anxiety, which is why they receive negative values on this factor.

Accordingly, the healthy control group reached negative values in factor 1, indicating the absence of general psychopathology, and scored around zero in factor 2, i.e. neither showing symptoms for somatization nor for depression and anxiety. In a second step, we compared the groups within the established two factors.

Importantly, standardized questionnaires assessing affective disorders on a continuous scale do not distinguish decompensated tinnitus patients from patients diagnosed with MDD regarding *general psychopathology* (factor 1). And even patients with compensated tinnitus score higher than healthy controls on this factor. Both from a methodological and clinical viewpoint this makes the comparison of patients with compensated tinnitus and healthy controls questionable. On one hand, it underestimates the contribution of general psychopathology in patients with severe tinnitus distress and on the other hand our results show how tinnitus and emotional distress are confounded even in patients with compensated tinnitus. Thus, the involvement of the limbic systems suggested by many imaging studies (Husain, 2016; Husain and Schmidt, 2014; Leaver et al., 2016; Rauschecker et al., 2015) could be much stronger than postulated. This implies that affective symptoms in particular should be taken into account even if compensated tinnitus with no psychiatric comorbidity is investigated. From a clinical

Table 4
Comparison of groups for factor 1 and 2.

Pair of groups compared	Factor 1 *t*-value (*df*)	*p*-value	Factor 2 *t*-value (*df*)	*p*-value
Comp. vs. decomp.	−3.75 (*33.10*)	<0.001	−1.3 (*36.49*)	0.202
Comp. vs. healthy Controls	12.16 (*58.14*)	<0.0001	4.28 (*76.78*)	<0.0001
Comp. vs. MDD Controls	−3.25 (*37.41*)	<0.01	7.64 (*29.37*)	<0.0001
Decomp. vs. MDD Controls	0.91 (*43.01*)	0.364	7.48 (*41.22*)	<0.0001
Decomp. vs. healthy Controls	10.31 (*26.35*)	<0.0001	4.19 (*37.04*)	<0.001
Healthy Controls vs. MDD Controls	−11.46 (*27.22*)	<0.0001	5.33 (*29.61*)	<0.0001

Comp. = compensated Tinnitus; decomp. = decompensated Tinnitus.

viewpoint our results suggest that in chronic tinnitus patients in addition to measuring tinnitus distress, an assessment of general psychopathology via standardized questionnaires is as important as a categorical clinical diagnosis by an experienced clinician. Currently, the *Multidisciplinary European Guideline for Tinnitus: Diagnostics, Assessment and Treatment* (Cima et al., 2019) acknowledge the assessment of affective symptoms as one of essential topics to assess in tinnitus diagnosis and recommend using the Hospital Anxiety and Depression Scale (HADS) to assess negative affect coinciding with or reactionary to the tinnitus. This guideline recommends tinnitus-specific psychological and comorbidity assessment for all tinnitus patients with TQ-score >30 or THI- score >36 (Tinnitus Handicap Inventory; Newman et al., 1996). Our suggestion for practitioners is to use standardized questionnaires, because they can also be used without specific training. If a specified cut-off value is reached, a trained clinician should be involved for further diagnostics.

While factor 1 "*general psychopathology*" separates all groups, but not MDD controls from patients with decompensated tinnitus, this can be done with factor 2 "*somatization*". Here, all groups can be separated, but not the two tinnitus groups. Even though somatoform disorders are less often recognized as comorbid disorders (Hiller et al., 1997; Kratzsch and Goebel, 2018; Sahin et al., 2016; Zirke et al., 2013), chronic tinnitus has been associated with greater somatisation tendencies and perceived pain, as well as increased hypochondriasis and illness attitudes (e.g., Trevis et al., 2016; Wallhausser-Franke et al., 2012). People with chronic tinnitus were investigated on their body image perceptions and they were neither overly insecure nor concerned about their body, but still reported reduced pleasure and self-confidence in their body as well as a reduced sense of vitality. Patients with severe tinnitus distress had more concerns and insecurity about their bodies, and perceived themselves as less healthy than patients with mild distress (Stuerz et al., 2009). Hiller et al. (1997) even suggested that tinnitus should be considered as somatoform symptom on its own and that tinnitus and somatisation may be linked through a common mechanism of arousal and somatic anxiety.

Newman et al. (1997) examined a sample of 51 outpatients with tinnitus on self-focused attention (attention directed toward one's own thoughts and feelings) and somatic attention (an individual's awareness of bodily sensations). Two subgroups of patients emerged following a cluster analysis of the attentional tasks. One group scored lower on both self-focus and somatic attention measures ("low self -attenders"), whereas a second group was more internally directed and scored higher on the attention measures ("high self-attenders"). Between-group comparisons revealed that high self-attenders displayed a stronger tinnitus handicap and distress associated with tinnitus and depression.

Thus, assessing the level of self-focused and somatic attention in patients with chronic tinnitus recommends itself and might have important implications for interventions.

In conclusion, our results stress the impact of tinnitus on general psychopathology. In patients with decompensated tinnitus, they are equally strongly affected as in MDD patients. Even though less strongly expressed, patients with mild tinnitus suffer from general psychopathology more than healthy persons, too. Thus, measures to assess such symptoms should be taken into account by psychometric measures or by selecting suitable control groups. In line with some earlier research findings, we found that tinnitus patients differ from MDD patients with regard to the amount of somatization. Consequently, somatization should be systematically assessed and taken into account in theories on the development of chronic tinnitus as well as treatment.

Declaration of Competing Interest

None.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2019.112582.

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