ORIGINAL ARTICLE

Factors Influencing Tinnitus Loudness and Annoyance

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Objective: To evaluate the 2 major components of tinnitus severity, loudness and annoyance, and their degree of dependence on characteristics of tinnitus manifestation, history, and etiology.

Design: Cross-sectional survey performed during the first months of 2004.

Setting: Nonclinical population.

Participants: A total of 4995 members of the German Tinnitus League.

Main Outcome Measures: Comprehensive screening questionnaire, including the Klockhoff and Lindblom loudness grading system and the miniversion of the Tinnitus Questionnaire.

Results: A moderate correlation of 0.45 was found between tinnitus loudness and annoyance. Both factors were generally higher in men, those older than 50 years, those with binaural and centrally perceived tinnitus, those with increased noise sensitivity, and those who had continuous tinnitus without interruptions. Tinnitus that lasted 12 months or less had a stronger influence on annoyance (odds ratio [OR], 1.96) than on loudness (OR, 0.45), whereas the contrary was found for tinnitus of more than 5 years' duration (ORs, 0.72 and 2.11, respectively). Loudness and annoyance were increased in subjects with coexisting hearing loss, vertigo, and hyperacusis. The impact of hyperacusis on annoyance was clearly stronger than on loudness (ORs, 21.91 vs 9.47).

Conclusions: Several clinical factors of tinnitus influence perceived loudness and annoyance. Both are distinguishable components of tinnitus severity.

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TINNITUS IS A COMMON BUT heterogeneous otologic symptom. Its widespread occurrence in the population was demonstrated by epidemiologic surveys.[1,2] A total of 10% to 15% of patients reported that they had experienced tinnitus that lasted longer than 5 minutes, and 1% to 5% had troublesome tinnitus that interfered with sleep or even led to disability and reduced quality of life. The clinical presentation of tinnitus as a symptom and disorder may depend on a variety of variables. Large individual differences exist with regard to audiologic, medical, and psychological characteristics.[3-6] For example, tinnitus can be localized unilaterally or bilaterally, acute or chronic, constant or intermittent, due to clear medical disease or of unknown origin, or associated with different patterns and levels of psychological distress.

One important variable to explain individual differences is the intensity of the tinnitus signal.[7,8] Some patients describe their tinnitus as very noisy or louder than most or even all environmental sounds. A high degree of signal intensity could explain why a subgroup expresses strong complaints or develops psychosocial disability. Many patients are convinced that the loudness of their tinnitus is a crucial factor in their quality of life. They argue that loud noises hinder habituation and acceptance, whereas they consider a relatively soft signal as easier to tolerate and integrate into normal life. Whether this perspective is supported by empirical evidence is debatable. Some authors have reported only small or moderate correlations between tinnitus loudness on one side and the severity of associated distress and handicap on the other side,[9-12] whereas others have found tinnitus loudness to be significantly predictive of perceived severity.[13]

Despite the apparent relevance of signal intensity as a clinical variable, no general consensus exists in the international literature of how it should be defined. One approach is psychoacoustic methods of loudness matching.[14] A set of tones across different frequencies and intensities is presented to an individual, who is asked to indicate which of these tones is perceived as having the same loudness as the

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tinnitus. A related method is to determine the level of acoustic stimulation needed to mask the tinnitus perception (minimal masking level). Although it had been hoped that psychoacoustic methods would measure tinnitus loudness in a precise and objective way, it remained ambiguous whether measurements should be performed ipsilaterally or contralaterally or at tinnitus frequency or normal-hearing frequency or whether loudness should be expressed as absolute loudness above hearing level or absolute loudness minus auditory threshold. All these variants led to different results, leaving unanswered how the true psychoacoustic intensity of a tinnitus sound can and should be quantified.

Another approach is represented by subjective ratings given by the patient. Different techniques exist, such as numeric rating scales (eg, the patient is asked to rate signal intensity between 0 [scarcely perceivable] and 10 [maximum loudness]) or visual analog scales. Previous studies[15-19] have consistently shown that the correlation between psychoacoustic and self-rated measures of tinnitus loudness is low to moderate. However, rating scales have the advantage of reflecting the patient's personal perception, and it was shown that they are sensitive to change when used in treatment studies.[20]

There is wide agreement that global tinnitus severity is not identical to signal intensity.[9] Perceived severity also refers to the degree of annoyance and associated disability. Although some patients do not report any unpleasant emotional and behavioral consequences of the tinnitus, others experience considerable distress or even develop serious mental disorders.[21-23] Typical psychological symptoms are concentration difficulties, decreased sleep quality, health-related worries and anxieties, low mood, and withdrawal from social activities. Several methods and instruments exist to assess the level of tinnitus-related distress, ranging from simple rating scales to psychometrically well-validated questionnaires.[8,24,25] A study by Kuk et al[11] compared psychoacoustic and subjective loudness measures with tinnitus-related distress assessed by a handicap questionnaire. The correlation between subjective loudness ratings and tinnitus handicap was 0.57 but only 0.27 between psychoacoustic loudness and disability.

Many questions that concern the relationship between tinnitus loudness and annoyance are still open. The statistical results of only partial overlap correspond with the observation that not all persons with weak tinnitus cope well, just as persons with severe tinnitus do not necessarily develop severe distress. Thus, loudness and annoyance may be influenced by different factors. Evidence exists that variables such as continuous tinnitus without intervals, hearing loss, hyperacusis, and diagnosed etiologies seem to be of prognostic value,[5] but it is not known whether such prognoses refer to tinnitus loudness, personal distress, or both.

In this article, we present data differentiating between tinnitus loudness and annoyance. We conducted a large survey among members of a national tinnitus association in Germany to investigate how audiologic, medical, and psychological properties of tinnitus were distributed in this population and whether associations with tinnitus severity existed. Because of the large membership in the organization, we were able to collect data from almost 5000 persons. A sample of this size allows analysis of the contribution of variables even if they are rare. We operationalized tinnitus loudness using the grading system of Klockhoff and Lindblom.[26] Tinnitus-related distress was assessed with the miniversion of the Tinnitus Questionnaire (Mini-TQ).[25]

Our main hypothesis was that loudness and annoyance are related but not interchangeable. We expected that binaural and permanent tinnitus are positively correlated with perceived tinnitus intensity, whereas comorbid otologic conditions, such as hearing loss, vertigo, and hyperacusis, are likely to influence annoyance more than loudness. Since we did not have definite expectations concerning the impact of specific etiologic factors on tinnitus severity, an exploratory analysis was conducted.

METHODS

DATA COLLECTION AND SAMPLE

A large mail survey was performed among the approximately 20 000 members of the German Tinnitus League (Deutsche Tinnitus Liga, or DTL), which is a registered charity that provides information, support, and advice about tinnitus, thereby aiming to raise awareness about the condition and funding research. During the first months of 2004, we distributed a newly developed screening questionnaire to all registered members. They were asked to support the DTL's work by providing information that could be used to generate a statistical overview about typical characteristics of tinnitus and associated problems. A total of 4995 questionnaires with sufficient and valid data were returned. The age range of the sample was 16 to 95 years (mean [SD], 56.5 [12.2] years), and the overall female proportion was 42.2%. Data were analyzed in cooperation with the Psychological Institute of the University of Mainz and the Roseneck Center of Behavioral Medicine in Prien, Germany.

THE SCREENING QUESTIONNAIRE

The study questionnaire was developed according to current scientific standards. A total of 34 items were obtained from the Structured Tinnitus Interview and the TQ, both well-established psychometric instruments designed to assess medical and psychological characteristics of tinnitus.[5,27-30] Almost all items were multiple choice. The questionnaire was kept short to achieve as much compliance and cooperation as possible. It was divided into the following 5 sections.

Tinnitus Manifestation and History

The tinnitus manifestation and history items assessed tinnitus localization (right, left, binaural, or centrally perceived), subjective description of the type of sound, time since onset, type of onset (suddenly vs slowly developed over time), development of tinnitus loudness since onset, maskability, effects of loud external noise on the tinnitus, and constancy of the tinnitus (continuously, interruptions <1 hour, interruptions >1 hour, or sometimes entire day without tinnitus).

Tinnitus-Related Otologic Conditions

We included items to assess whether coexisting hearing loss, dizziness or vertigo, or hyperacusis were present. Hyperacusis was operationalized through the following 3 questions: (1) "Do you experience slight or everyday noises (eg, turning newspaper pages, humming of a computer, own laughter, or buzzing

The purpose of this questionnaire is to find out whether the noises in your ears/head have had any effect on your mood, habits, or attitudes. Please tick the answer that applies to you for each statement.

1. I am aware of the noises from the moment I get up to the moment I sleep
2. Because of the noises, I worry that there is something seriously wrong with my body
3. If the noises continue, my life will not be worth living
4. I am more irritable with my family and friends because of the noises
5. I worry that the noises might damage my physical health
6. I find it harder to relax because of the noises
7. My noises are often so bad that I cannot ignore them
8. It takes me longer to get to sleep because of the noises
9. I am more liable to feel low because of the noises
10. I often think about whether the noises will ever go away
11. I am a victim of my noises
12. The noises have affected my concentration

[Note: the response alternatives for each item are true, partly true, and not true.]

Figure 1. The miniversion of the Tinnitus Questionnaire.[25]

of refrigerator) as uncomfortable or painful?"; (2) "Is it true that your oversensitivity to noise not only pertains to certain noises (eg, a child crying or music) but is also generalized to different types of noises and multiple situations?"; and (3) "Did the oversensitivity to noise lead to considerable impairment in your daily routines?" Each item could be answered as yes, sometimes, or no. We categorized a respondent as having hyperacusis if all 3 questions were answered yes. If all 3 questions were affirmed but at least 1 item was answered as sometimes instead of yes, hyperacusis was considered subclinical.

Tinnitus Etiology

Respondents were asked whether there existed a medical diagnosis related to the cause of their tinnitus. The following etiologic conditions were to be rated as predefined categories: inner ear dysfunction, conductive hearing loss (eg, otosclerosis), sudden hearing loss, vascular dysfunction, cervical spine dysfunction, craniomandibular dysfunction, acoustic trauma or noise exposure, Ménière disease, severe head injury, acoustic neuroma, neurologic disease, ototoxic substance intake, and known family history of hearing disorder. All items were obtained from the Structured Tinnitus Interview, in which their assessment had been successfully evaluated. Since etiologies do not exclude each other, multiple choices could be made.

Psychological Complaints

The 12 items of the Mini-TQ were included to yield a quantitative measure of tinnitus-related annoyance. The Mini-TQ represents an abridged version of the TQ.[29,31] It defines a general dimension of distress that has a high degree of correlation ($r>0.90$) with the full TQ. The test-retest reliability of the Mini-TQ was 0.89.[25] The items of the Mini-TQ are listed in **Figure 1**.

DEFINITION OF TINNITUS LOUDNESS AND ANNOYANCE

The Klockhoff and Lindblom system[26] was used to define tinnitus loudness. Subjects had to rate how loud their tinnitus was compared with external noise. Three grades are differentiated: grade I (weak) indicates that tinnitus is audible only in silent environments, grade II (moderate) represents tinnitus that is audible in ordinary acoustic environments but masked by loud environmental sounds, and grade III (severe) is when tinnitus is audible in all acoustic environments (ie, tinnitus is louder than all external sounds).

Table 1. Association Between Tinnitus Loudness and Annoyance*

Degree of Annoyance (From Mini-TQ)	Degree of Tinnitus Loudness, No. (%)		
	Weak (Grade I)	Medium (Grade II)	Strong (Grade III)
Mild (scores 0-7)	334 (6.7)	1378 (27.8)	233 (4.7)
Moderate (scores 8-12)	43 (0.9)	788 (15.9)	354 (7.1)
Severe (scores 13-18)	20 (0.4)	613 (12.4)	561 (11.3)
Very severe (scores 19-24)	8 (0.2)	180 (3.6)	446 (9.0)

Abbreviation: Mini-TQ, miniversion of the Tinnitus Questionnaire.
*N = 4958 (because of missing data on single items).

The Klockhoff and Lindblom system is recommended by the British Association of Otolaryngologists, Head and Neck Surgeons.[8] To avoid confounding with tinnitus annoyance, we followed the recommendations of Scott et al[32] and slightly modified the grading system by omitting aspects of sleep and quality of life from the definitions of grades II and III. The Klockhoff and Lindblom system had previously been incorporated into the interview approach of the Structured Tinnitus Interview, which had high test-retest reliabilities with κ coefficients of 0.78 for grade I, 0.66 for grade II, and 0.72 for grade III.[5] Andersson et al[33] found good interrater reliability ($r=0.80$) in patients from a Swedish audiologic clinic.

Tinnitus annoyance was quantified using the Mini-TQ distress scale, for which scores from 0 (no distress) to 24 (maximum distress) can be computed. According to normative data,[25] subjects were classified according to the following 4 quartiles: (1) no to mild distress (scores 0-7), (2) moderate distress (scores 8-12), (3) severe distress (scores 13-18), and (4) very severe distress (scores 19-24).

STATISTICAL ANALYSIS

To facilitate data analysis and interpretation, groups with weak vs strong loudness and with weak vs strong annoyance were compared. We report base rates of all categorical variables for the entire sample and the subgroups. Since tests of statistical significance lead to significant results in nearly every case when sample sizes are as large as in our study, these results are not reported. Instead, we computed odds ratios (ORs), which indicate the degree of practical significance when differences between 2 proportions are found. Unlike χ^2 tests, ORs are independent of the overall sample size. An OR of 3, for example, indicates that a specific characteristic is 3 times as frequent in group A as in comparison group B. Whenever t tests are used to analyze mean differences, we additionally report the Cohen d as an effect size independent of sample size.

RESULTS

BASE RATES OF LOUDNESS AND ANNOYANCE

A total of 4971 subjects gave valid ratings on the Klockhoff and Lindblom grading system. Of these subjects, 407 (8.2%) rated their condition as grade I, 2964 (59.6%) as grade II, and 1600 (32.2%) as grade III. Scores on the Mini-TQ were available for 4982 subjects. Of these, 1957 (39.2%) were categorized as mildly, 1189 (23.9%) as moderately, 1199 (24.0%) as severely, and 637 (12.8%) as most severely distressed. The exact relationship between tinnitus loudness and annoyance is indicated in **Table 1**. Although most subjects with grade I conditions reported mild tinnitus

Table 2. Influence of Tinnitus Characteristics on Loudness and Annoyance

Characteristic	Total (N = 4995)	Degree of Tinnitus Loudness: Weak (Grade I) (n = 407)	Degree of Tinnitus Loudness: Strong (Grade III) (n = 1600)	Degree of Tinnitus Loudness: OR (95% CI)	Degree of Tinnitus Annoyance: Weak (Quartile I) (n = 1957)	Degree of Tinnitus Annoyance: Strong (Quartile IV) (n = 637)	Degree of Tinnitus Annoyance: OR (95% CI)
Female, %	42.2	50.4	39.4	0.64 (0.51-0.80)	42.0	35.4	0.76 (0.63-0.91)
Age, mean (SD), y	56.4 (12.2)	53.2 (15.4)	58.0 (10.2)		55.8 (13.0)	57.1 (11.1)	
>50 y, %	67.8	52.1	75.7	2.86 (2.29-3.59)	62.4	73.3	1.66 (1.36-2.02)
Familial status, %							
Married	71.6	64.0	75.1	1.69 (1.34-2.13)	69.3	73.7	1.24 (1.02-1.52)
Divorced	4.5	3.7	5.3	1.45 (0.83-2.54)	4.6	4.9	1.07 (0.71-1.63)
Localization of tinnitus, %*							
Right	20.0	22.9	17.1	0.70 (0.54-0.91)	23.0	14.9	0.59 (0.46-0.75)
Left	29.1	35.6	25.9	0.63 (0.50-0.80)	30.7	28.9	0.92 (0.75-1.12)
Binaural	44.9	34.9	49.8	1.85 (1.48-2.32)	39.8	49.3	1.47 (1.23-1.76)
Centrally perceived	23.7	16.2	32.2	2.45 (1.85-3.26)	16.6	35.2	2.73 (2.23-3.34)
Time since onset of tinnitus, %							
≤12 mo	2.7	4.4	2.1	0.45 (0.25-0.82)	1.7	3.3	1.96 (1.11-3.46)
>12 mo and ≤5 y	17.3	24.5	14.2	0.51 (0.39-0.67)	17.3	21.3	1.30 (1.03-1.64)
>5 y	80.0	71.0	83.8	2.11 (1.62-2.73)	81.0	75.3	0.72 (0.58-0.89)
Type of tinnitus onset, %							
Suddenly	49.2	55.8	47.1	0.71 (0.57-0.88)	49.7	48.4	0.95 (0.79-1.13)
Slowly progressive	38.5	35.4	37.7	1.10 (0.88-1.39)	40.7	35.6	0.81 (0.67-0.97)
Development of tinnitus loudness, %†							
Has increased	35.0	10.1	53.1	12.61 (8.97-17.7)	19.2	62.6	9.34 (7.54-11.6)
Has decreased	12.3	43.2	3.1	0.04 (0.03-0.06)	21.4	2.5	0.10 (0.06-0.16)
Unchanged	43.0	41.3	32.3	0.74 (0.59-0.93)	52.4	23.2	0.28 (0.22-0.34)
Effects of loud external noise, %							
Tinnitus increases	48.4	39.3	54.2	1.83 (1.46-2.29)	41.9	54.2	1.65 (1.37-1.97)
Tinnitus decreases	5.0	9.5	3.3	0.32 (0.21-0.50)	5.4	3.1	0.57 (0.35-0.92)
No change	46.6	51.2	42.5	0.70 (0.56-0.88)	52.7	42.6	0.67 (0.56-0.80)
Constancy of tinnitus, %							
Permanent	81.9	57.3	90.6	7.16 (5.52-9.28)	75.2	93.2	4.56 (3.29-6.31)
Tinnitus-free intervals of <1 h	5.0	3.5	4.3	1.24 (0.69-2.23)	4.0	4.2	1.08 (0.69-1.68)
Tinnitus-free intervals of >1 h	6.9	14.3	2.2	0.13 (0.09-0.21)	10.8	1.4	0.12 (0.06-0.23)
Sometime entire days without tinnitus	6.1	25.0	2.9	0.09 (0.06-0.13)	10.0	1.1	0.10 (0.05-0.21)
Associated otologic conditions, %							
Subjective hearing loss	79.6	62.7	88.4	4.55 (3.51-5.91)	72.9	88.2	2.79 (2.14-3.64)
Dizziness or vertigo	36.9	25.9	48.5	2.70 (2.12-3.44)	27.4	53.9	3.09 (2.57-3.72)
Hyperacusis	7.3	1.7	14.4	9.47 (4.43-20.3)	1.3	23.0	21.91 (14.3-33.7)
Subclinical	27.7	12.7	37.7	5.30 (3.88-7.25)	13.5	38.3	6.25 (5.01-7.80)

Abbreviations: CI, confidence interval; OR, odds ratio.

*The column sum exceeds 100% because subjects had the option to code multiple categories, mainly if they identified 2 or more distinguishable types of their tinnitus (eg, buzzing binaurally plus ringing tone unilaterally).

†Only subjects who were unequivocally assignable to 1 of the categories are considered. Subjects with binaural tinnitus who reported a different situation for either ear were dropped from this analysis. Therefore, the percentages do not sum to 100.

distress, subjects with grade II conditions were split, with substantial proportions in the mild, moderate, and severe annoyance categories. Almost two thirds of those with grade III conditions were found to have either severe or very severe distress. The Spearman rank correlation between loudness and annoyance was 0.45. This medium correlation confirms that although there is considerable overlap, loudness and annoyance as experienced by the subjects are not congruent. Therefore, both variables need to be analyzed separately.

BASE RATES OF TINNITUS CHARACTERISTICS AND ETIOLOGIES

The sample base rates for the demographic variables, tinnitus history characteristics, and etiologic factors are presented in **Tables 2** and **3**. Most of the sample was male, older than 50 years, and married. Location of the tinnitus was more often binaural than unilateral, and the left ear was more frequently affected than the right ear. Only 2.7% had tinnitus duration of less than 1 year, whereas chronic tinnitus for longer than 5 years was reported by 4 of 5 subjects. Mean (SD) tinnitus duration in the entire sample was 11.9 (9.1) years for the right ear and 11.4 (8.6) years for the left ear. Sudden onset of tinnitus was reported more often than slowly progressive development. More than 40% had not noticed a change in loudness over the course of time, but an impressively large proportion of 35% had experienced increased loudness. Continuous tinnitus without intervals was present in 81.9% compared with only 6.1% who sometimes had entire days without tinnitus. A proportion of almost 50% reported noise sensitivity with exacerbation of tinnitus after exposure to loud external noise.

Table 3. Influence of Tinnitus Causes on Loudness and Annoyance*

Cause	Total (N = 4995)	Degree of Tinnitus Loudness: Weak (Grade I)	Degree of Tinnitus Loudness: Strong (Grade III)	Degree of Tinnitus Loudness: OR (95% CI)	Degree of Tinnitus Annoyance: Weak (Quartile I)	Degree of Tinnitus Annoyance: Strong (Quartile IV)	Degree of Tinnitus Annoyance: OR (95% CI)
Inner ear dysfunction	23.7	14.3	32.7	2.92 (2.17-3.93)	17.8	33.4	2.31 (1.89-2.83)
Conductive hearing loss (eg, otosclerosis)	4.6	1.5	7.3	5.27 (2.30-12.1)	2.7	7.2	2.85 (1.90-4.29)
Sudden hearing loss	34.2	29.0	39.4	1.59 (1.26-2.01)	31.2	37.8	1.34 (1.11-1.62)
Disturbance of blood circulation	28.1	25.6	28.8	1.18 (0.92-1.51)	24.6	33.8	1.56 (1.29-1.90)
Cervical spine dysfunction	31.7	30.7	35.0	1.21 (0.96-1.54)	26.9	39.6	1.78 (1.48-2.15)
Craniomandibular dysfunction	13.2	15.0	13.9	0.91 (0.67-1.24)	12.1	14.9	1.27 (0.98-1.64)
Acoustic trauma or noise exposure	18.0	11.5	21.8	2.13 (1.54-2.95)	14.2	24.2	1.93 (1.55-2.41)
Ménière disease	9.7	6.9	12.8	1.98 (1.31-2.98)	7.7	14.1	1.97 (1.49-2.60)
Severe head injury	2.3	0.7	3.2	4.43 (1.38-14.3)	1.5	2.7	1.82 (0.99-3.34)
Acoustic neuroma	1.0	0.7	1.4	1.88 (0.56-6.30)	0.6	1.1	1.80 (0.71-4.59)
Neurologic disease	5.1	3.9	7.6	2.00 (1.17-3.41)	2.4	10.4	4.80 (3.26-7.08)
Ototoxic substance intake	4.6	3.4	6.4	1.91 (1.08-3.38)	3.0	6.3	2.16 (1.43-3.25)
Family history of hearing disorder	20.1	15.0	20.2	1.43 (1.06-1.93)	19.2	19.5	1.02 (0.81-1.27)

Abbreviations: CI, confidence interval; OR, odds ratio.
*Data are presented as percentages unless otherwise indicated.

The most common associated otologic condition was subjective hearing loss, followed by vertigo or dizziness and hyperacusis. Hyperacusis according to strict criteria was present in 7.3%. The most prevalent etiologic factors, with rates of approximately 30%, were sudden hearing loss, cervical spine dysfunction, and disturbance of blood circulation. Rare conditions with rates less than 5% were conductive hearing loss, tinnitus due to ototoxic substance, severe head injury, and acoustic neuroma. It should be considered, however, that even the smallest group of 1% with acoustic neuroma included 50 subjects.

INFLUENCE OF DEMOGRAPHIC AND TINNITUS-RELATED CHARACTERISTICS

Table 2 also indicates how the sample characteristics were distributed within the different categories of loudness and annoyance. When loudness grades I and III were compared, strong tinnitus loudness was more prevalent in men, among older adults, in binaural or centrally perceived tinnitus, in persons with tinnitus duration longer than 5 years, when tinnitus had increased over time, in cases in which external noise led to tinnitus deterioration, in persons with continuously present tinnitus, and in those with additional hearing loss, vertigo or dizziness, or hyperacusis. This profile was similar in subjects in the upper quartile of tinnitus annoyance. One surprising exception was found for tinnitus duration. Although there was a larger proportion with weak loudness among subjects with short tinnitus duration and a larger proportion with strong loudness among those with long duration, the contrary was found for annoyance. This finding shows that annoyance does not increase as much as loudness does over time. A parallel finding is that increasing or decreasing tinnitus loudness over time had a somewhat stronger effect on loudness (ORs, 12.61 and 0.04, respectively) than on annoyance (ORs, 9.34 and 0.10, respectively).

An inspection of all ORs given in Table 2 reveals that the strongest influences on both loudness and annoyance come from tinnitus that is continuously present (without tinnitus-free intervals) and from hyperacusis.

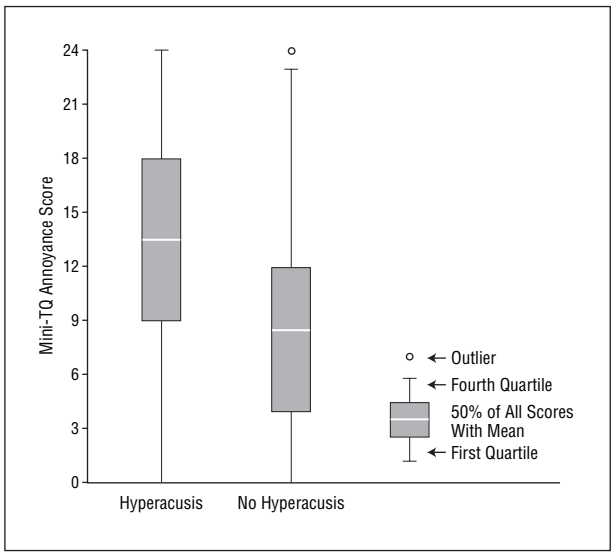

Figure 2. Annoyance scores of subjects who reported tinnitus with and without concurrent hyperacusis.

Permanent tinnitus had stronger effects on loudness (OR, 7.16) than on annoyance (OR, 4.06). On the contrary, the impact of hyperacusis is stronger on annoyance than on loudness, especially for strictly defined hyperacusis (ORs, 21.91 vs 9.47). The impressive relevance of hyperacusis for tinnitus annoyance is additionally demonstrated in **Figure 2**. Subjects with hyperacusis had significantly higher Mini-TQ distress scores (mean [SD], 13.73 [5.75]) than those without hyperacusis (mean [SD], 8.46 [5.88]; Cohen d=0.91).

INFLUENCE OF ETIOLOGIC FACTORS

The relevance of the different etiologic factors for tinnitus loudness and annoyance is indicated in Table 3. All etiologies were more frequently found in subjects with loudness grade III (except for craniomandibular dysfunction) and in those with the highest degree of annoyance. When the loudness- and annoyance-related ORs

Table 4. Relationship Between Psychological Complaints and Tinnitus Loudness and Annoyance*

Mini-TQ Item	Loudness	Annoyance
I am aware of the noises from the moment I get up to the moment I sleep	0.18	0.44
Because of the noises, I worry that there is something seriously wrong with my body	0.05	0.63
If the noises continue, my life will not be worth living	0.12	0.76
I am more irritable with my family and friends because of the noises	0.11	0.59
I worry that the noises might damage my physical health	0.08	0.75
I find it harder to relax because of the noises	0.14	0.57
My noises are often so bad that I cannot ignore them	0.25	0.57
It takes me longer to get to sleep because of the noises	0.10	0.59
I am more liable to feel low because of the noises	0.13	0.72
I often think about whether the noises will ever go away	0.04	0.56
I am a victim of my noises	0.14	0.85
The noises have affected my concentration	0.15	0.58

Abbreviation: Mini-TQ, miniversion of the Tinnitus Questionnaire.
*Values are squared Pearson correlations between items scores (2 = true, 1 = partly or sometimes true, and 0 = not true) and the Klockhoff and Lindblom grading system (loudness) quartiles of the Mini-TQ distress score (annoyance).

of each etiologic factor were compared, conductive hearing loss (5.27 vs 2.85) and severe head injury (4.43 vs 1.82) had a stronger influence on loudness than on annoyance, whereas neurologic disease (4.80 vs 2.00) was more closely associated with annoyance than with loudness. Other etiologies, such as inner ear dysfunction, acoustic trauma or noise exposure, Ménière disease, acoustic neuroma, and ototoxic substance intake, also had ORs of approximately 2 or higher. Many subjects reported more than 1 etiology. The range was 0 to 9, and the mean (SD) number of etiologies reported was 1.96 (1.69). Subjects with loudness grade III had significantly more etiologies than those with grade I (mean [SD], 2.30 [1.82] vs 1.58 [1.52]; Cohen d=0.44), and those with annoyance quartile IV had more etiologies than those with quartile I (mean [SD], 2.46 [1.84] vs 1.63 [1.52]; Cohen d=0.50).

INFLUENCE OF SPECIFIC PSYCHOLOGICAL COMPLAINTS

To analyze the role of single psychological complaints, we correlated the mean item score of each of the 12 Mini-TQ items with both loudness and annoyance. **Table 4** indicates the results expressed as squared correlations, which indicate the amount of common variance between the correlated variables (if Spearman rank correlations are computed instead of the Pearson correlations given in Table 4, results are practically identical). Not unexpectedly, all items were generally related more to annoyance than to loudness. The strongest influences on loudness came from items 7 (hard to ignore the noises), 1 (aware of the noises all day), and 12 (concentration affected), all of which explained 15% or more of the loudness grading variance. The prominent role of these items suggests that the experience of the tinnitus as being continuously present and its interference with cognitive functioning seem to be crucial not only to annoyance but also to perceived loudness.

COMMENT

Tinnitus research sometimes ignores that there may be large intersubject variability with regard to the clinical picture presented by this group of patients. Approximately a dozen or more major characteristics can be listed that should be taken into account when patients' conditions are diagnosed and treated. Various aspects of tinnitus severity seem to be important. Many patients consider the intensity of their tinnitus signal as responsible for the extent of distress and impairment. Although it has been shown that personal distress due to tinnitus is to some degree dependent on primarily psychological factors such as cognitive appraisal or differences in coping behavior,[28] the role of physical, audiologic, and medical properties of tinnitus should not be underestimated. There has been little research until now addressing these issues. We need studies that investigate the determinants of tinnitus loudness and annoyance to understand more deeply how patients react to their tinnitus and which factors contribute to the long-term maintenance of distress.

The present investigation was supported by the DTL, one of the largest charities worldwide providing advice, support, and information for people with tinnitus. Its interest was to obtain more detailed information about the tinnitus characteristics of its members, especially concerning the different forms and courses of the tinnitus, underlying etiologies, and types and levels of tinnitus-related psychological distress. A screening questionnaire was developed especially for the purpose of this study, adopting items from existing instruments that have proved reliable and valid. Almost 5000 questionnaires with complete or nearly complete data were returned. One advantage of this large sample size is that even rare attributes and subgroups can be analyzed with sufficient numbers of cases. It can also be assumed that statistical measures such as proportions, means, and correlations are considerably more stable than in typical clinical samples with case numbers usually between 50 and 200.

Despite differences in the sampling procedures, the base rates of many tinnitus characteristics found in our study were similar to those reported by other researchers. The prevailing proportion of men and the more frequent occurrence of tinnitus in the left ear are common findings.[4,33,34] The high rate of subjective hearing loss in our sample (80%) is comparable to results reported by Andersson et al[33] (almost 90%) and Stouffer and Tyler[4] (only

18% with hearing levels ≤25 dB). The proportion of subjects who experienced an increase in tinnitus loudness since onset was 35% in our study and 28% in a study by Stouffer et al.[35] As in the present data, these authors observed no clear linear increase in tinnitus annoyance as a function of years since onset. An increase in loudness, however, was found by both Stouffer et al[35] and Scott et al.[32] In the latter study, 24% of the subjects had experienced strong tinnitus when their tinnitus had begun compared with 40% at the time of investigation. Subjects with binaural tinnitus had higher degrees of both loudness and annoyance in our study. Erlandsson et al[36] reported a related finding, with binaural patients having significantly more sleeping disturbances than those with tinnitus in only 1 ear.

One major finding of the present study is that tinnitus loudness and annoyance are associated but not identical. We consider both variables to constitute tinnitus severity. Almost 10% of our subjects rated their tinnitus loudness as weak in the Klockhoff and Lindblom system, whereas approximately one third were assigned to grade III, with tinnitus perceived louder than all external noise. Tinnitus annoyance was generally somewhat less severe than loudness. Approximately one third of the subjects were categorized as mildly distressed, and only 16% belonged to the subgroup with the highest distress level. The correlation between loudness and annoyance was 0.45 and thus moderate. The obvious overlap between both variables corresponds to our finding that several tinnitus parameters had comparable influence on both loudness and annoyance. In particular, higher levels of severity were found for men, older adults, binaural and centrally perceived tinnitus, increase in tinnitus intensity since onset, sensitivity to loud external noise, continuous tinnitus (as opposed to intermittent tinnitus), and the coexistence of hearing loss, vertigo, and hyperacusis. These attributes can therefore be considered risk factors for the development of loud and annoying tinnitus.

Despite these similarities, other variables had inconsistent influence on loudness and annoyance. The most striking result was found for time since onset of the tinnitus. Tinnitus duration of less than 12 months was associated with higher annoyance but lower loudness, whereas the reverse was the case for duration of more than 5 years. This means that annoyance tends to be more crucial during the first year of the tinnitus and is less predictable in the long term. From a theoretical perspective, it is assumed that habituation and acceptance tend to increase over time, which is likely to lead to reduced annoyance.[37]

Distinguishable effects on loudness and annoyance were also found for permanent (interval-free) tinnitus and coexisting hyperacusis. Both variables, whenever present, were associated with increased severity. The effect of continuous tinnitus was greater on loudness (OR, 7.16) than on annoyance (OR, 4.56), whereas hyperacusis influenced annoyance (OR, 21.91) more than loudness (OR, 9.47). The extraordinary high OR for the relationship between hyperacusis and annoyance emphasizes the high relevance of hyperacusis to tinnitus perception. An increasing number of studies have described more distress, a higher loss of quality of life, and more complicated treatments in patients with tinnitus who have coexisting hyperacusis.[38] Recent work by Sindhusake et al[39] has additionally suggested that hearing loss and dizziness are further risk factors for severe tinnitus. Since tinnitus, hearing loss, and hyperacusis are considered as a triad with common pathophysiologic mechanisms,[40] the consequences of these conditions on tinnitus perception are likely to be interrelated.

This study has also provided evidence that some of the various etiologies of tinnitus seem to be related to tinnitus severity. We found substantially higher rates of loudness and annoyance in subjects whose tinnitus was due to conductive hearing loss, severe head injury, or neurologic disease. Our results, however, are based on self-reported data and not on direct medical examination. On the other hand, many subjects are well informed about the diagnoses made by their physicians, and the DTL provides broad information for their members to enhance understanding of medical procedures and diagnostic findings. There has been little research until now about how specific etiologies influence the ways patients interpret and react to their tinnitus. Stouffer and Tyler[4] observed increased levels of loudness and annoyance in patients with Ménière disease. In a previous study, we identified sudden hearing loss and associated craniomandibular disorder to be of some relevance for tinnitus distress.[5] However, the etiologic pathways related to tinnitus severity are less well studied than for hearing loss, and more systematic research is needed in this field.

This study has some limitations that should be mentioned. First, our sample was not representative. Participation was voluntary, and it can be assumed that the questionnaires were returned primarily by cooperative individuals interested in some form of active discussion about their tinnitus. Exact judgement of possible bias due to these selections is difficult. To our surprise, the sex and age distributions were highly similar to those of the population of all DTL members, in whichthe female-male ratio is 42% to 58% and the mean age is 56 years. We know, however, that our sample had a larger male proportion and was somewhat older compared with the average German population, in which approximately 48% are male and the mean population age is approximately 47 years. Several years ago, Pilgramm et al[2] conducted a tinnitus survey in a representative German sample and published data derived from 3049 respondents. A total of 37% of their sample had grade I on the Klockhoff and Lindblom system, 44% had grade II, and 17% had grade III. On a scale similar to the Mini-TQ, 24% were classified as quartile IV and 20% as quartile III. It can therefore be concluded that the sample presented herein is characterized by a higher proportion of subjects with loud and annoying tinnitus. However, this does not necessarily imply that results will be biased when the relationship among different variables is analyzed.

A second limitation is that the loudness data in our study are based on self-report and not psychoacoustic measurement. Although it is equivocal which method yields data of higher validity, it would be desirable to investigate whether the loudness-related findings presented herein could be replicated using psychoacoustic methods. Some evidence in the literature indicates that the minimal masking level may be linked to psychological distress.[32,33] Independent of such associations, the question of whether self-

reported loudness or audiometrically measured match intensity is more valid seems to be misleading when both approaches are considered as basically different.

The strengths of the present study are its large sample size, making it possible to analyze even rare conditions, and the use of items with established psychometric validity. In addition, all levels of loudness and annoyance are represented in our sample, with a sufficiently large number of subjects in each category. This is usually not the case in samples recruited in audiologic clinics, where loudness grades II or III are overrepresented.[33] Grade I of the Klockhoff and Lindblom system is relatively frequent in the population, with rates of approximately one third among all individuals who reported tinnitus.[2]

In conclusion, the results of our study highlight the importance of tinnitus loudness and annoyance as major components of tinnitus severity. As a matter of course, both components are to be considered thoroughly in the clinical examination of patients with tinnitus. Adequate treatment decisions cannot be made without taking tinnitus severity into account. Moreover, loudness and annoyance represent outcome variables that should be considered central for treatment studies.

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