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Prevalence and Characteristics of Patients with Severe Hyperacusis among Patients Seen in a Tinnitus and Hyperacusis Clinic

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Abstract

Purpose: The purpose was to assess the proportion of patients seeking help for tinnitus and/or hyperacusis who have severe hyperacusis and to examine factors associated with severe hyperacusis.

Research Design: This was a retrospective cross-sectional study based on 362 consecutive patients who attended a National Health Service audiology clinic for tinnitus and/or hyperacusis rehabilitation and for whom uncomfortable loudness levels (ULLs) had been measured. The criterion for severe hyperacusis was taken as a ULL of 30 dB HL or less for at least one of the measured frequencies for at least one ear.

Results: Thirteen patients had severe hyperacusis, and eight of those had normal hearing. The lowest average ULL across frequencies was 28 dB HL. The difference in average ULLs between ears was 5 dB or less for nine patients. The range of ULLs across frequencies was between 5 and 60 dB, ULLs often being lowest at 8 kHz. Eleven patients had tinnitus, eight had otological abnormalities, twelve had mental health problems, and six were taking antidepressants.

Conclusions: Severe hyperacusis is characterized by low ULLs for specific frequencies and no or mild hearing loss. Given the high incidence of tinnitus, otological abnormalities, and mental health problems, the management of patients with severe hyperacusis should involve otologists and psychiatrists in addition to audiologists.

Key Words: hyperacusis, psychological assessment, tinnitus, uncomfortable loudness levels

Abbreviations: HADS = Hospital Anxiety and Depression Scale; HQ = Hyperacusis questionnaire; ISI = Insomnia severity index; PTA = Pure-tone average; SD = Standard deviation; THI = Tinnitus Handicap Inventory; THTSC = Tinnitus and Hyperacusis Therapy Specialist Clinic; ULL = Uncomfortable Loudness Level; VAS = Visual Analog Scale

Hyperacusis is intolerance of everyday sounds that causes significant distress and impairment in social, occupational, recreational, and other day-to-day activities (Aazh et al, 2016). The sounds may be perceived as uncomfortably loud, unpleasant, frightening, or painful (Tyler et al, 2014). Audiologists often use uncomfortable loudness levels (ULLs) to determine the lowest sound level at which sounds are perceived to be "too loud." ULLs are also used to assess the severity of hyperacusis. For normal-hearing people, the average ULL is about 100 dB HL (Sherlock and Formby, 2005). People with hyperacusis often have lower than normal ULLs in one or both ears (Tyler et al, 2014). Anari et al (1999) measured ULLs at 0.5, 1, 2, 3, and 4 kHz for patients with hyperacusis and normal or near-normal hearing thresholds. They reported that, averaged across patients, ULLs were similar across frequency and the overall average was 75 dB HL, about 25 dB lower than for normal-hearing people without hyperacusis. Sheldrake et al (2015) assessed ULLs for 381 patients with hyperacusis. The mean ULL was 85 dB HL and it was almost independent of hearing thresholds. The ULLs tended to be lower at 8 kHz than at lower frequencies.

Sheldrake et al (2015) reported that in cases of severe hyperacusis, ULLs can be as low as 30 dB HL. However,

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they did not report the proportion and characteristics of such patients. More recently, Zaugg et al (2016) reported that 2/139 patients with tinnitus had remarkably low mean ULLs of 35 and 27 dB HL. They did not report the characteristics of these patients. It is important to explore the characteristics of patients with very low ULLs, 30 dB HL or below, because such patients can be expected to have very severe problems in everyday life. The average sound level of a whisper or the background noise in a quiet library is about 30 dB (SPL ASHA, 2015). For patients with ULLs close to 30 dB HL, almost all day-to-day environmental sounds might be perceived as uncomfortably loud. Therefore, it is not surprising that high levels of joblessness and psychological disorders, and diminished quality of life and relationship difficulties have been reported for some patients with hyperacusis (Hallberg et al, 2005; Baguley and Andersson, 2007; Jüris et al, 2013; Schröder et al, 2013; Schecklmann et al, 2014; Paulin et al, 2016). Although severe hyperacusis is rare, it can cause substantial discomfort, inability to access public services, health and education, suicidal ideations, and violence toward people or animals, as has been highlighted in internet forums for hyperacusis sufferers based in the United Kingdom and United States (MISOPHONIA UK, 2013; The Hyperacusis Network, 2013; Hyperacusis Sufferers, 2013).

The aim of this study was to assess the proportion and characteristics of patients seeking treatment for tinnitus and hyperacusis under the UK National Health Service who have ULLs of 30 dB HL or below.

METHODS

Study Design and Patients

This was a retrospective cross-sectional study conducted at the Tinnitus and Hyperacusis Therapy Specialist Clinic (THTSC), Royal Surrey County Hospital, Guildford, United Kingdom. The data for consecutive patients who attended the THTSC in 2012–13 were included (n = 362). The average age of the patients was 56 yr (standard deviation, SD = 16 yr). Forty-eight percent (174/362) were male.

Demographic data for the patients and the outcomes of their latest audiological investigations and their routine self-report questionnaires were imported from records held at the Audiology department. These comprised:

- Pure tone audiogram measured using the procedure described by the British Society of Audiology (BSA, 2004). The severity of hearing loss was categorized based on the pure-tone average (PTA) across the frequencies 0.25, 0.5, 1, 2, and 4 kHz, as recommended by the British Society of Audiology (BSA, 2004): mild (20–40 dB HL), moderate (41–70 dB HL), severe (71–95 dB HL), and profound (over 95 dB HL).
- ULLs measured following the BSA recommended procedure (BSA, 2011).
- The following self-report questionnaires: the Tinnitus Handicap Inventory (THI; Newman et al, 1996), the Visual Analog Scale (VAS; Maxwell, 1978) of tinnitus loudness, the Hyperacusis Questionnaire (HQ; Khalfa et al, 2002), the Hospital Anxiety and Depression Scale (HADS; Zigmond and Snaith, 1983), and the Insomnia Severity Index (ISI; Bastien et al, 2001). These questionnaires are routinely given to all patients attending the THTSC for tinnitus or hyperacusis therapy, and they are described briefly in the following section.
- Age and gender.

Questionnaires

The THI has 25 items and the response choices are "no" (0 points), "sometimes" (2 points) and "yes" (4 points). The overall score ranges from 0 to 100. Scores from 0 to 16 indicate no handicap, scores from 18 to 36 indicate mild handicap, scores from 38 to 56 indicate moderate handicap, and scores from 58 to 100 indicate severe handicap (Newman et al, 1996). It should be noted that the validity and sensitivity of the THI have been questioned (Tyler et al, 2007).

The VAS is a procedure that uses ratings on a scale from 0 to 10 to measure subjective attributes, here tinnitus loudness (Adamchic et al, 2012). The loudness of tinnitus was assessed by asking the patient to rate the loudness of tinnitus during their waking hours over the last month (It was explained that 0 corresponds to no tinnitus being heard and 10 is the loudest sound that they can imagine).

The HQ comprises 14 items and the response choices are "no" (0 points), "yes, a little" (1 points), "yes, quite a lot" (2 points), and "yes, a lot" (3 points). The overall score ranges from 0 to 42. Scores above 26 indicate strong auditory hypersensitivity (Meeus et al, 2010).

The HADS consists of 14 items, each rated from 0 to 3 according to the severity of difficulty experienced. Eight items require reversed scoring, after which anxiety (HADS-A) and depression (HADS-D) subscale totals are calculated. Total scores for each subscale range from 0 to 21. Scores from 0 to 7 are classified as normal, scores from 8 to 10 are classified as borderline abnormal, and scores from 11 to 21 are classified as abnormal (Zigmond and Snaith, 1983).

The ISI comprises seven items that assess the severity of sleep difficulties and their effect on the patient's life. Each item is rated on a scale from 0 to 4, and the total score ranges from 0 to 28. Scores from 0 to 7 indicate no clinically significant insomnia, scores from 8 to 14 indicate minimal insomnia, scores from 15 to 21 indicate moderate insomnia, and scores from 22 to 28 indicate severe insomnia (Bastien et al, 2001).

Diagnosis of Severe Hyperacusis

There are no widely agreed diagnostic criteria for hyperacusis. Hyperacusis may be present if the average ULL across the frequencies 0.25, 0.5, 1, 2, 4, and 8 kHz in the ear with the lowest ULLs is below 80 dB HL (Khalfa et al, 2002; Sherlock and Formby, 2005). Scores above 26 on the HQ are often taken to indicate the presence of hyperacusis handicap (Meeus et al, 2010). However, the validity of both the ULL criteria for diagnosis of hyperacusis and the HQ has been questioned by several authors (Baguley and Andersson, 2007; Meeus et al, 2010; Fackrell et al, 2015). In this study, the criterion for diagnosing severe hyperacusis was taken as a ULL of 30 dB HL or less for at least one of the measured frequencies: 0.25, 0.5, 1, 2, 3, 4, 6, and 8 kHz for at least one ear.

Ethical Approval

This study was approved by the South-West Cornwall and Plymouth Research Ethics Committee and the Research and Development department at the Royal Surrey County Hospital.

Data Analysis

The data were anonymized before statistical analysis. Descriptive statistics (means and SDs) for the characteristics of the patients and scores for the self-report questionnaires were calculated. Because the data for the subgroup with severe hyperacusis were not normally distributed, the nonparametric Mann–Whitney test was used to compare the mean differences in questionnaire responses and audiological measures between patients with severe hyperacusis and the remainder of the sample. Two-tailed tests were used. The Spearman rank correlation coefficient, r_s, was used to assess the relationship between ULLs and HQ scores. Some of the patients did not complete all of the questionnaires or audiological examinations. The analyses were restricted to responders with complete data on all variables required for a particular analysis. The number of patients included in each analysis (n) is reported. The STATA program (version 13) was used for statistical analyses.

RESULTS

Thirteen of 362 (3.6%) patients were diagnosed as having severe hyperacusis based on a ULL of 30 dB HL or less for at least one ear and one frequency. Their mean age was 40 yr (SD = 17), 16 yr younger than for the remainder of the study population ($p = 0.0007$). The scores on the THI, VAS, HQ, HADS, and ISI for these 13 patients and for the remainder of the study population are given in Table 1. Table 2 shows the audiological characteristics of the patients diagnosed with severe hyperacusis, and Table 3 shows the means and SDs of hearing thresholds and ULLs for each ear and each frequency for the remainder of the study population.

For the patients with severe hyperacusis the mean PTA was 16 dB HL (SD = 16) for the right ears and 17 dB HL (SD = 14) for left ears. These values are slightly lower (better) than the corresponding values for the remainder of the study population, which were 23 dB HL (SD = 16) for both right and left ears, but the difference was not significant ($p = 0.12$).

Among all patients in the study population for whom ULLs had been measured for both ears at all frequencies, the average ULL across frequencies was below 55 dB HL for 6% (19/326) of the patients for at least one ear. For the group with severe hyperacusis, the grand mean of the ULLs (averaged across frequencies, ears and patients) was 47.5 dB HL (SD across patients = 9.3). This is 38 dB lower than for the remainder of the study population, which was 85.5 dB HL (SD across patients = 12.6). The difference between groups was significant ($p < 0.001$).

As shown in Table 2, 8/13 patients had PTA values within the normal range. The remaining five had a mild hearing impairment in their worse ear with a maximum PTA of 34 dB HL. The means and SDs of the scores of the patients diagnosed with severe hyperacusis for the questionnaires are given in columns 5 and 6 of Table 1. Compared with the remainder of the study population, the patients with severe hyperacusis had higher HQ scores (more sound sensitivity) and this difference was significant ($p < 0.001$). However, only 6/13 of those diagnosed as having severe hyperacusis had scores above 26 on the HQ. A score above 26 is usually taken as indicating hyperacusis handicap (Meeus et al, 2010). To assess the relationship between the HQ scores and the ULLs, we calculated the grand mean ULL across frequencies and ears for each patient. The grand mean ULLs calculated in this way were significantly correlated with the HQ scores both for the patients diagnosed with severe hyperacusis ($r_s = -0.6, p = 0.03$) and for the remainder of the population ($r_s = -0.4$, $p < 0.001$).

As shown in Table 2, the difference in PTA across ears for the group with severe hyperacusis was 5 dB or less for all but one patient. For this group, the lowest average ULL was 28 dB HL and the lowest ULL at a single frequency was 10 dB HL, which was recorded at 6 and 8 kHz for one patient. A ULL of 15 dB HL was recorded at 2 kHz for another patient. The difference in average ULLs between ears was 5 dB or less for nine patients. The maximum between-ears difference in average ULL was 12.5 dB. The number of frequencies for which the ULL was 30 dB HL or less varied across patients. Eight patients had only one frequency for which the ULL was 30 dB HL or below and five had between two and five

Table 1. Columns 3 and 4 Show Means and SDs of Scores of the Study Population (Excluding the 13 Patients Diagnosed with Severe Hyperacusis) on the THI, the VAS for Tinnitus Loudness, the HQ, the HADS, and the ISI

	Study Population (Excluding those with Severe Hyperacusis)			Group with Severe Hyperacusis		
Questionnaire	n	Mean	SD	Mean	SD	*p*-value
THI	325	44 (out of 100)	23.5	57	31	0.09
VAS (tinnitus loudness)	306	6 (out of 10)	1.9	5.4	3	0.79
HQ	315	17.7 (out of 42)	9.3	27	8	**0.001**
HADS (anxiety)	332	8.3 (out of 21)	4.6	10.5	3	0.054
HADS (depression)	332	6 (out of 21)	4.5	5.5	4	0.81
ISI	279	12.5 (out of 28)	7.2	12	7	0.74

Notes: The number of patients included in each analysis is indicated by n. Columns 5 and 6 show corresponding scores for the patients diagnosed with severe hyperacusis. For all questionnaires, higher scores indicate greater problems. The *p*-values for the significance of the mean differences between the patients with severe hyperacusis and the remainder of the study population are given. The only significant value is in bold font.

frequencies. The most common frequency for which the ULL was 30 dB HL or less was 8 kHz. This occurred for nine patients. The ULL values within a given ear varied across frequency by as little as 5 dB and as much as 60 dB. The most common pattern was a rather large range of ULL values. There were 11 patients for whom the ULL values varied across frequency by 30 dB or more for at least one ear. Overall, the results indicate that most of the patients with severe hyperacusis were especially sensitive to one or a few frequencies, usually high frequencies, but sometimes middle or low frequencies.

Table 4 gives the age, gender, score on the HQ, and otological, mental health, and medical history for each of the patients with severe hyperacusis. Only one of the patients was aged over 56 yr. Seven patients were male. Scores on the HQ ranged from 17 to 42, where 42 is the maximum possible (worst) score. Eleven patients had tinnitus, eight had a history of otological abnormalities, twelve had a history of mental health problems, and six were taking antidepressants.

DISCUSSION

Severe hyperacusis in this study was defined by a ULL of 30 dB HL or less for at least one of the measured frequencies, 0.25, 0.5, 1, 2, 3, 4, 6, and 8 kHz, and at least one ear. We found 13 patients with severe hyperacusis among 362 patients who had sought help with regard to their tinnitus and/or hyperacusis, that is, about 4%. This proportion may not be representative of the general population of people with tinnitus and/or hyperacusis, because such people often do not seek help. Nevertheless our data are relevant to audiology services that offer rehabilitative interventions for patients with troublesome tinnitus or hyperacusis who seek professional help.

Although only 6/13 of patients with severe hyperacusis had HQ scores above 26, the value that is usually used as an indicator of hyperacusis handicap, all patients reported that they were severely affected by their intolerance to sound. Their hyperacusis led to significant disability and was associated with a high prevalence of emotional disorders (12/13 had mental health problems). It seems that the HQ did not capture the full extent of hyperacusis handicap for many of the patients with severe hyperacusis. This is consistent with a previous report questioning the validity and reliability of the HQ in the assessment of hyperacusis handicap in the UK population (Fackrell et al, 2015). Recently an HQ score of 22 and above has been recommended as one criterion for diagnosing hyperacusis handicap (Aazh and Moore, 2017). Using this criterion, nine of the 13 patients with one or more ULLs below 30 dB HL would also have hyperacusis handicap.

For our data there were significant correlations between the grand mean ULLs for each patient and the scores on the HQ. The correlation coefficients were −0.6 for the patients with severe hyperacusis and −0.4 for the remainder of the population. The moderately high correlation found for the patients with severe hyperacusis needs to be interpreted with caution because of the small sample size. Further research is needed to explore the relationship between ULLs and HQ scores and the way that each of these is related to the impact of hyperacusis on the patient's life.

Most of the patients diagnosed with severe hyperacusis had very low ULLs only over a limited frequency range, most commonly at high frequencies. For 11 patients, the difference between the maximum and minimum ULL across the frequency range in each ear was 30 dB or more. Past studies have typically shown that ULLs averaged across participants did not change markedly across the frequency range (Formby et al, 2007; Meeus et al, 2010; Sheldrake et al, 2015), but the authors did not report the ULL threshold variations across frequency for individual patients. Our data suggest that severe hyperacusis may typically be characterized by strong across-frequency variations in ULL, but data from a larger sample of patients with severe hyperacusis are required to test this further.

Table 2. Audiological Characteristics of the 13 Patients with Severe Hyperacusis

Hearing Loss Category (PTA, dB HL)		Interaural Difference in PTA (dB)	Mean ULL (dB HL), Lowest ULL (dB HL)		Interaural Difference in Mean ULL (dB)	Number of Frequencies with ULL below 30 dB HL (Values of the Frequencies, kHz)		Range of ULL Values (Frequency at the Minimum and Maximum, kHz)	
Right	Left		Right	Left		Right	Left	Right	Left
Normal (7)	Normal (10)	3	28, 20	31, 30	2.5	5 (0.25, 1, 2, 4, 8)	5 (0.25, 0.5, 1, 4, 8)	15 (8, 0.5)	5 (0.25/0.5/1/4/6/8, 2)
Mild (24)	Mild (22)	2	55, 30	51, 35	4.2	1 (8)	0	40 (8, 3)	25 (8, 4/3/1)
Normal (6)	Normal (4)	2	58, 50	53, 30	5.0	0	1 (8)	15 (0.25, 1/3/4)	40 (8, 0.5)
Normal (14)	Normal (17)	3	30, 30	32, 30	1.6	1 (1)	1 (1)	40 (1, 4)	35 (1, 4)
Mild (20)	Mild (24)	4	45, 30	52, 55	7.0	1 (8)	0	35 (6, 1)	15 (0.25, 2)
Normal (8)	Normal (6)	2	34, 20	47, 20	12.4	3 (2, 6, 8)	1 (8)	20 (6, 4/1/0.5)	35 (8, 2/1/0.5)
Normal (10)	Normal (6)	4	47, 40	39, 30	7.4	0	1 (2)	15 (6/2/0.5, 1)	20 (4, 8)
Mild (21)	Mild (26)	5	58, 40	51, 25	7.5	0	1 (2)	35 (6, 0.25)	40 (2, 5)
Normal (9)	Normal (14)	5	48, 25	50, 40	1.7	2 (6, 8)	0	45 (8, 1)	15 (8/6, 2/1/0.25)
Normal (18)	Mild (34)	16	57, 30	53, 40	3.3	1 (8)	0	40 (8, 5)	25 (8/6, 5)
Normal (6)	Normal (5)	1	53, 30	53, 35	0.0	1 (8)	0	30 (8, 1/0.5/0.25)	25 (8, 0.25)
Normal (19)	Mild (24)	5	29, 15	33, 20	4.1	4 (0.25, 1, 2, 4)	4 (1, 2, 6, 4)	40 (2, 6)	40 (2, 8)
Normal (3)	Normal (8)	5	53, 10	48, 15	5.0	2 (6, 8)	2 (4, 8)	60 (6/8, 0.25/5)	60 (8, 0.25/0.5)

Notes: The table shows, from left to right, the hearing loss category for each ear with the PTA value in parentheses, the interaural difference in PTA, the mean ULL and lowest ULL for each ear, the interaural difference in mean ULL, the number of frequencies for each ear with ULL below 30 dB HL, and the values of the frequencies where that occurred, and the range of ULL values for each ear with the frequencies of the maximum and minimum values in parentheses.

The most common frequency associated with ULLs of 30 dB HL or below was 8 kHz; this occurred for nine patients. This is consistent with the finding of Sheldrake et al (2015) that the mean ULL at 8 kHz for patients with hyperacusis was about 7 dB lower than the average ULL at 0.25, 5, 1, 2, 3, 4, and 6 kHz. Our finding is also consistent with the results of de Klaver et al (2007), who assessed ULLs for 15 patients with regional pain syndrome and hyperacusis; the mean ULLs across patients were 45, 55, 55, 50, 55, and 45 dB HL at 0.25, 0.5, 1, 2, 4, and 8 kHz, respectively. Thus, for these patients, the mean ULLs were lower at 0.25 and 8 kHz than at other frequencies. The ULLs for our study population excluding the population with severe hyperacusis (Table 3) showed a similar trend, but the variation across frequency was less pronounced, possibly because our study population included people whose primary complaint was tinnitus rather than hyperacusis.

Meeus et al (2010) assessed ULLs for 46 patients with tinnitus, with or without hyperacusis, most of whom had mild high-frequency hearing loss. The mean ULLs for the right ears were 105, 109, 110, 110, 111, 112, 110, and 104 dB HL at 0.25, 0.5, 1, 2, 3, 4, 6, and 8 kHz, respectively. The mean ULLs for the left ears were 104, 109, 110, 110, 111, 109, 108, and 102 dB HL at 0.25, 0.5, 1, 2, 3, 4, 6, and 8 kHz, respectively. These ULLs are markedly higher than the ULLs reported in the current study, perhaps because of differences in the measurement method or the instructions to the patients (the authors did not specify the exact method used to measure the ULLs). However, the results of Meeus et al (2010) again show lower ULLs at 8 kHz than at lower frequencies. Meeus et al (2010) did not report ULLs separately for those with hyperacusis plus tinnitus and those with tinnitus only. Formby et al (2007) did report ULLs separately for tinnitus patients with hyperacusis as their main complaint (135 ears, 68 patients) and patients with tinnitus only (140 ears, 70 patients). For the hyperacusis group, the mean ULLs were approximately 90 dB HL at 1, 2, and 4 kHz and 95 dB HL at 8 kHz; ULLs at 8 kHz were not lower than for other frequencies. This may have been a consequence of the fact that the audiometric thresholds of their patients at high frequencies were higher (worse) than those of Meeus et al (2010) and of our study population or the 13 patients with severe hyperacusis.

To sum up, it appears that for patients with hyperacusis and normal hearing or mild hearing loss at high frequencies, ULLs are often lower at 8 kHz than at lower frequencies. Thus, hypersensitivity to sounds with strong high-frequency components may be the primary problem. Such sounds include the noise produced by high-speed hand-driers in toilet facilities and the sound of frying bacon (although we do not know whether the patients in our sample actually found these sounds to be aversive). However, for people with moderate or severe hearing loss at

Table 3. Means (SDs) of the Audiometric Thresholds and ULLs in dB HL of the Study Population (Excluding the 13 Patients Diagnosed with Severe Hyperacusis), Given Separately for Each Frequency and Each Ear

	Frequency, kHz							
	0.25	0.5	1	2	3	4	6	8
Threshold right	19 (15.6) n = 345	19 (15.4) n = 348	20 (17) n = 348	22 (19) n = 348	28 (20) n = 305	33 (22.5) n = 348	38 (25) n = 310	41 (28) n = 343
Threshold left	18 (17) n = 345	19 (17) n = 346	19 (17) n = 346	22 (19.6) n = 346	29.5 (21) n = 306	35 (22.5) n = 346	40 (24) n = 307	42 (27) n = 344
ULL right	84 (14) n = 319	87 (14) n = 344	87 (13) n = 349	87 (14) n = 347	89 (14) n = 234	88 (14) n = 341	88 (15) n = 248	84.5 (16) n = 313
ULL left	84 (14) n = 313	86 (14) n = 339	87 (13) n = 345	86 (13.4) n = 344	88 (13.4) n = 232	88 (14.3) n = 337	88.5 (15) n = 245	84 (16.4) n = 307

Note: The number of patients included in each cell is indicated by n.

high frequencies, ULLs are not lower at 8 kHz than at lower frequencies, perhaps because the hearing loss at high frequencies reduces the loudness of high-frequency sounds. More research is needed to establish whether this interpretation is correct.

Patients with very low ULLs only at high frequencies may find sounds with strong high-frequency components to be very unpleasant, but sounds with most of their energy at low frequencies may be less aversive. The strong across-frequency variations in ULLs for our patients classified as having severe hyperacusis might be an indication of adverse reactions only to specific sounds, which is consistent with the definitions of annoyance and fear hyperacusis (Tyler et al, 2014) and misophonia (Cavanna and Seri, 2015; Kumar et al, 2017). Future studies should explore the pattern of ULLs for individual patients and their relationship to the everyday sounds that are found to be aversive by the patients.

The mean ULL for our study population as a whole, including the group with severe hyperacusis, was 84 dB HL (SD = 15), which is consistent with the results of Sheldrake et al (2015), who reported that the mean ULL for 381 patients with a primary complaint of hyperacusis was 85 dB HL (SD = 17). Our results showed that 6% of the study population had mean ULLs across frequency below 55 dB HL for the ear with the lower mean ULL. By contrast, Zaugg et al (2016) reported that only two of 139 (1.4%) patients with tinnitus who received treatment from a U.S. military veterans center had mean ULLs below 55 dB HL (the mean ULLs for these

Table 4. The Table Shows, for Each of the Patients with Severe Hyperacusis: Age, Gender, HQ Score, and Otological, Mental Health, and Medical Histories

Age, Yrs	Gender	HQ Score	Otological History	Mental Health History	Medical History
50	Male	36	Otalgia, tinnitus	Anxiety, depression, PTSD	Hypertension, diabetes, headaches, head trauma, takes antidepressants
39	Male	23	Tinnitus	Depression	Insomnia, takes antidepressants
27	Female	18	Tinnitus	Anxiety, anger, suicidal ideations	Takes antidepressants
71	Male	30	N/A	Anxiety	Stroke, speech difficulty
12	Female	19	N/A	Generalized anxiety disorder, depression, panic attacks	N/A
52	Female	22	Otalgia, Bell's palsy, tinnitus	Anxiety and depression	Severe migraines, hemifacial spasm, takes antidepressants
16	Male	27	Ear infections, drug-induced hearing loss, tinnitus	Anxiety	Surgery and chemotherapy
42	Male	37	Tinnitus, otalgia	Anxiety	N/A
47	Female	42	Tinnitus	Anxiety	N/A
36	Male	17	Tinnitus, otalgia	N/A	Epilepsy
27	Male	20	Clicking on left TMJ, tinnitus, headaches	Anxiety	Osteotomy of mandible, headaches
48	Female	34	Otalgia, vertigo, tinnitus	Anxiety and depression	Arthritis in neck, insomnia, takes antidepressants
56	Female	22	Vestibular neuronitis, tinnitus	Anxiety and depression	Eczema, takes antidepressants

two were 35 and 27 dB HL). Their study population differed in several ways from that of the current study, which might have contributed to this discrepancy. The differences were (a) their study population included military veterans who, among other things, may have had greater noise exposure and were more likely to have experienced traumatic situations than our study population; (b) the main complaint of their study population was tinnitus, whereas our population included patients whose main complaint was hyperacusis; (c) only 4% of their patients were female compared with 52% in our study; and (d) the mean ULL for their population was 96 dB HL (SD = 14), which is higher than the mean ULL for our sample.

In our study, the difference in average ULLs between ears was 5 dB or less for most of the patients with severe hyperacusis. The maximum between-ears difference in average ULLs was 12.5 dB. There is little published information about between-ear differences in ULLs for patients with hyperacusis. Formby et al (2007) reported that less than one percent (1/68) of their patients had unilaterally reduced ULLs. More recently Jüris et al (2013) used ULLs below 90 dB HL in one or both ears (averaged across 0.5, 1, 2 and 3 kHz) as one of their criteria for including patients in a study of hyperacusis. They reported that 95% (59/62) of the included participants met the criteria for both ears. No further details were given, so the magnitude of any interaural asymmetry is unknown. Overall, it appears that hyperacusis is only rarely associated with a strong interaural asymmetry in ULLs.

Most of our patients with severe hyperacusis had a history of otological abnormalities, which is consistent with past studies reporting otological disorders among patients with hyperacusis (Johns, 1986; Klein et al, 1990; Spyridakou et al, 2012; Fioretti et al, 2016). This highlights the need for otological evaluation and treatment (when possible) of patients presenting with severe hyperacusis.

Twelve of our patients with severe hyperacusis had a history of mental health problems and six of them were taking antidepressants. This is consistent with past studies that suggest a relationship between hyperacusis and mental health problems (Dubal and Viaud-Delmon, 2008; Goebel and Floezinger, 2008; Hasson et al, 2013; Jüris et al, 2013; Aazh et al, 2014; Aazh and Allott, 2016). This highlights the need for psychiatric evaluation and treatment (when needed) of patients with severe hyperacusis.

CONCLUSIONS

Thirteen of 362 patients who sought help from a National Health Service audiology clinic for their tinnitus and/or hyperacusis had severe hyperacusis as indicated by ULLs of 30 dB HL or less for at least one of the test frequencies for at least one ear. These patients mostly had normal hearing thresholds or mild hearing loss and they mostly had similar ULLs across ears, but strong across-frequency variation in ULLs, suggesting hypersensitivity to specific sounds, often high-frequency sounds. The most common frequency for which the ULL was 30 dB or less was 8 kHz.

The patients with severe hyperacusis had a grand mean ULL of 47.5 dB HL and were younger and exhibited more hyperacusis handicap, as measured by the HQ, than the remainder of the sample.

There was a high incidence of otological abnormalities and mental health problems among the patients with severe hyperacusis. Therefore, combined audiological, otological, and psychological evaluations are recommended in the assessment of patients suffering from severe hyperacusis.

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