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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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Aazh and Moore

Severe hyperacusis

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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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Short title

Severe hyperacusis

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Abbreviations

HADS	Hospital Anxiety and Depression Scale
HQ	Hyperacusis questionnaire
ISI	Insomnia severity index
NHS	National Health Service
PTA	Pure tone average
SD	Standard deviation
THI	Tinnitus Handicap Inventory
THTSC	Tinnitus and Hyperacusis Therapy Specialist Clinic
ULL	Uncomfortable Loudness Level
VAS	Visual Analogue Scale

Abstract

Objectives: The objectives were 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.

Method: 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; uncomfortable loudness levels, psychological assessment; tinnitus

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 & 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 hyperacusis patients. 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, 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, since 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 (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 & Andersson, 2007; Juris et al, 2013; Schroder 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

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4 ideations, and violence towards people or animals, as has been highlighted in internet forums
5
6 for hyperacusis sufferers based in the UK and USA (MISOPHONIA UK, 2013; The
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8 Hyperacusis Network, 2013; Hyperacusis Sufferers, 2013).

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11 The aim of this study was to assess the proportion and characteristics of patients seeking
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13 treatment for tinnitus and hyperacusis under the UK National Health Service (NHS) who
14
15 have ULLs of 30 dB HL or below.

16 17 18 19 **Methods**

20 21 *Study design and patients*

22
23 This was a retrospective cross-sectional study conducted at the Tinnitus and Hyperacusis
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25 Therapy Specialist Clinic (THTSC), Royal Surrey County Hospital, Guildford, UK. The data
26
27 for consecutive patients who attended the THTSC in 2012-13 were included ($n = 362$). The
28
29 average age of the patients was 56 years (standard deviation, $SD = 16$ years). Forty eight
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31 percent (174/362) were male.

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34 Demographic data for the patients and the outcomes of their latest audiological investigations
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36 and their routine self-report questionnaires were imported from records held at the Audiology
37
38 department. These comprised:

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40 (1) Pure tone audiogram measured using the procedure described by the British Society of
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42 Audiology (BSA, 2004). The severity of hearing loss was categorized based on the pure-tone
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44 average (PTA) across the frequencies 0.25, 0.5, 1, 2, and 4 kHz, as recommended by the
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46 British Society of Audiology (BSA, 2004): mild (20– 40 dB HL), moderate (41 – 70 dB HL),
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48 severe (71 – 95 dB HL) and profound (over 95 dB HL).

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50 (2) ULLs measured following the BSA recommended procedure (BSA, 2011).

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52 (3) The following self-report questionnaires: the Tinnitus Handicap Inventory (THI; Newman
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54 et al, 1996), the Visual Analogue Scale (VAS; Maxwell, 1978) of tinnitus loudness, the
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56 Hyperacusis Questionnaire (HQ; Khalifa et al, 2002), the Hospital Anxiety and Depression
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58 Scale (HADS; Zigmond & Snaith, 1983), and the Insomnia Severity index (ISI; Bastien et al,
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2001). These questionnaires are routinely given to all patients attending the THTSC for tinnitus or hyperacusis therapy, and they are described briefly below.

(4) Age and gender.

Questionnaires

The THI has 25 items, and response choices are "no" (0 points), "sometimes" (2 points) and "yes" (4 points). The overall score ranges from 0 to 100. Scores from 0–16 indicate no handicap, scores from 18–36 indicate mild handicap, scores from 38–56 indicate moderate handicap, and scores from 58–100 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 0-7 are classified as normal, scores from 8-10 are classified as borderline abnormal, and scores from 11-21 are classified as abnormal (Zigmond & Snaith, 1983).

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4 The ISI comprises seven items that assess the severity of sleep difficulties and their effect on
5 the patient's life. Each item is rated on a scale from 0 to 4 and the total score ranges from 0 to
6 28. Scores from 0-7 indicate no clinically significant insomnia, scores from 8-14 indicate
7 minimal insomnia, scores from 15-21 indicate moderate insomnia, and scores from 22-28
8 indicate severe insomnia (Bastien et al, 2001).
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13 14 15 *Diagnosis of severe hyperacusis*

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17 There are no widely agreed diagnostic criteria for hyperacusis. Hyperacusis may be present if
18 the average ULL across the frequencies 0.25, 0.5, 1, 2, 4 and 8 kHz in the ear with the lowest
19 ULLs is below 80 dB HL (Khalifa et al, 2002; Sherlock & Formby, 2005). Scores above 26 on
20 the HQ are often taken to indicate the presence of hyperacusis handicap (Meeus et al, 2010).
21 However, the validity of both the ULL criteria for diagnosis of hyperacusis and the HQ has
22 been questioned by several authors (Baguley & Andersson, 2007; Fackrell et al, 2015; Meeus
23 et al, 2010). In this study, the criterion for diagnosing severe hyperacusis was taken as a ULL
24 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
25 kHz for at least one ear.
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36 37 *Ethical approval*

38 This study was approved by the South West-Cornwall and Plymouth Research Ethics
39 Committee and the Research and Development department at the Royal Surrey County
40 Hospital.
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46 47 *Data analysis*

48 The data were anonymised prior to statistical analysis. Descriptive statistics (means and
49 standard deviations, SDs) for the characteristics of the patients and scores for the self-report
50 questionnaires, were calculated. Since the data for the sub-group with severe hyperacusis
51 were not normally distributed, the non-parametric Mann-Whitney test was used to compare
52 the mean differences in questionnaire responses and audiological measures between patients
53 with severe hyperacusis and the remainder of the sample. Two-tailed tests were used. The
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4 Spearman rank correlation coefficient, r_s , was used to assess the relationship between ULLs
5 and HQ scores. Some of the patients did not complete all of the questionnaires or
6 audiological examinations. The analyses were restricted to responders with complete data on
7 all variables required for a particular analysis. The number of patients included in each
8 analysis (n) is reported. The STATA programme (version 13) was used for statistical
9 analyses.
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17 Results

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19 Thirteen out of 362 (3.6%) patients were diagnosed as having severe hyperacusis based on a
20 ULL of 30 dB HL or less for at least one ear and one frequency. Their mean age was 40 years
21 (SD = 17), 16 years younger than for the remainder of the study population ($p = 0.0007$). The
22 scores on the THI, VAS, HQ, HADS, and ISI for these 13 patients and for the remainder of
23 the study population are given in Table 1. Table 2 shows the audiological characteristics of
24 the patients diagnosed with severe hyperacusis and Table 3 shows the means and SDs of
25 hearing thresholds and ULLs for each ear and each frequency for the remainder of the study
26 population.
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36 For the patients with severe hyperacusis the mean PTA was 16 dB HL (SD = 16) for the right
37 ears and 17 dB HL (SD = 14) for left ears. These values are slightly lower (better) than the
38 corresponding values for the remainder of the study population, which were 23 dB HL (SD =
39 16) for both right and left ears, but the difference was not significant ($p = 0.12$).
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46 Among all patients in the study population for whom ULLs had been measured for both ears
47 at all frequencies, the average ULL across frequencies was below 55 dB HL for 6% (19/326)
48 of the patients for at least one ear. For the group with severe hyperacusis, the grand mean of
49 the ULLs (averaged across frequencies, ears and patients) was 47.5 dB HL (SD across
50 patients = 9.3). This is 38 dB lower than for the remainder of the study population, which was
51 85.5 dB HL (SD across patients = 12.6). The difference between groups was significant ($p <$
52 0.001).
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TABLES 1 AND 2 HERE

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 to 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 ($r_s = -0.4, p < 0.001$).

TABLE 3 HERE

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 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

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3 ULL values. There were 11 patients for whom the ULL values varied across frequency by 30
4 dB or more for at least one ear. Overall, the results indicate that most of the patients with
5 severe hyperacusis were especially sensitive to one or a few frequencies, usually high
6 frequencies, but sometimes middle or low frequencies.
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17 Table 4 gives the age, gender, score on the HQ, and otological, mental health, and medical
18 history for each of the patients with severe hyperacusis. Only one of the patients was aged
19 over 56 years. Seven patients were male. Scores on the HQ ranged from 17 to 42, where 42 is
20 the maximum possible (worst) score. Eleven patients had tinnitus, eight had a history of
21 otological abnormalities, twelve had a history of mental health problems, and six were taking
22 antidepressants.
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31 **Discussion**

32 Severe hyperacusis in this study was defined by a ULL of 30 dB HL for less for at least one
33 of the measured frequencies, 0.25, 0.5, 1, 2, 3, 4, 6, and 8 kHz, and at least one ear. We found
34 13 patients with severe hyperacusis among 362 patients who had sought help with regard to
35 their tinnitus and/or hyperacusis, i.e. about 4%. This proportion may not be representative of
36 the general population of people with tinnitus and/or hyperacusis, since such people often do
37 not seek help. Nevertheless our data are relevant to audiology services that offer rehabilitative
38 interventions for patients with troublesome tinnitus or hyperacusis who seek professional
39 help.
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49 Although only 6/13 of patients with severe hyperacusis had HQ scores above 26, the value
50 that is usually used as an indicator of hyperacusis handicap, all patients reported that they
51 were severely affected by their intolerance to sound. Their hyperacusis led to significant
52 disability and was associated with a high prevalence of emotional disorders (12/13 had
53 mental health problems). It seems that the HQ did not capture the full extent of hyperacusis
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3 handicap for many of the patients with severe hyperacusis. This is consistent with a previous
4 report questioning the validity and reliability of the HQ in the assessment of hyperacusis
5 handicap in the UK population (Fackrell et al, 2015). Recently an HQ score of 22 and above
6 has been recommended as the criteria for diagnosing hyperacusis handicap (Aazh & Moore,
7 2017). Using this criterion, nine of the thirteen patients with one or more ULLs below 30 dB
8 HL would also have hyperacusis handicap.
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17 For our data there were significant correlations between the grand mean ULLs for each
18 patient and the scores on the HQ. The correlation coefficients were -0.6 for the patients with
19 severe hyperacusis and -0.4 for the remainder of the population. The moderately high
20 correlation found for the patients with severe hyperacusis needs to be interpreted with caution
21 due to the small sample size. Further research is needed to explore the relationship between
22 ULLs and HQ scores and the way that each of these is related to the impact of hyperacusis on
23 the patient's life.
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33 Most of the patients diagnosed with severe hyperacusis had very low ULLs only over a
34 limited frequency range, most commonly at high frequencies. For eleven patients the
35 difference between the maximum and minimum ULL across the frequency range in each ear
36 was 30 dB or more. Past studies have typically shown that ULLs averaged across participants
37 did not change markedly across the frequency range (Formby et al, 2007; Meeus et al, 2010;
38 Sheldrake et al, 2015), but the authors did not report the ULL threshold variations across
39 frequency for individual patients. Our data suggest that severe hyperacusis may typically be
40 characterized by strong across-frequency variations in ULL, but data from a larger sample of
41 patients with severe hyperacusis are required to test this further.
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51 The most common frequency associated with ULLs of 30 dB HL or below was 8 kHz; this
52 occurred for nine patients. This is consistent with the finding of Sheldrake et al (2015) that
53 the mean ULL at 8 kHz for patients with hyperacusis was about 7 dB lower than the average
54 ULL at 0.25, 5, 1, 2, 3, 4, and 6 kHz. Our finding is also consistent with the results of de
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4 Klaver et al (2007), who assessed ULLs for 15 patients with regional pain syndrome and
5 hyperacusis; the mean ULLs across patients were 45, 55, 55, 50, 55, and 45 dB HL at 0.25,
6 0.5, 1, 2, 4, and 8 kHz, respectively. Thus, for these patients, the mean ULLs were lower at
7 0.25 and 8 kHz than at other frequencies. The ULLs for our study population excluding the
8 population with severe hyperacusis (Table 3) showed a similar trend, but the variation across
9 frequency was less pronounced, possibly because our study population included people
10 whose primary complaint was tinnitus rather than hyperacusis.
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19 Meeus et al (2010) assessed ULLs for 46 tinnitus patients with or without hyperacusis, most
20 of whom had mild high-frequency hearing loss. The mean ULLs for the right ears were 105,
21 109, 110, 110, 111, 112, 110, and 104 dB HL at 0.25, 0.5, 1, 2, 3, 4, 6, and 8 kHz,
22 respectively. The mean ULLs for the left ears were 104, 109, 110, 110, 111, 109, 108, and
23 102 dB HL at 0.25, 0.5, 1, 2, 3, 4, 6, and 8 kHz, respectively. These ULLs are markedly
24 higher than the ULLs reported in the current study, perhaps because of differences in the
25 measurement method or the instructions to the patients (the authors did not specify the exact
26 method used to measure the ULLs). However, the results of Meeus et al (2010) again show
27 lower ULLs at 8 kHz than at lower frequencies. Meeus et al (2010) did not report ULLs
28 separately for those with hyperacusis plus tinnitus and those with tinnitus only. Formby et al
29 (2007) did report ULLs separately for tinnitus patients with hyperacusis as their main
30 complaint (135 ears, 68 patients) and patients with tinnitus only (140 ears, 70 patients). For
31 the hyperacusis group, the mean ULLs were approximately 90 dB HL at 1, 2, and 4 kHz and
32 95 dB HL at 8 kHz; ULLs at 8 kHz were not lower than for other frequencies. This may have
33 been a consequence of the fact that the audiometric thresholds of their patients at high
34 frequencies were higher (worse) than those of Meeus et al (2010) and of our study population
35 or the 13 patients with severe hyperacusis.
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54 To sum up, it appears that for patients with hyperacusis and normal hearing or mild hearing
55 loss at high frequencies, ULLs are often lower at 8 kHz than at lower frequencies. Thus,
56 hypersensitivity to sounds with strong high-frequency components may be the primary
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4 problem. Such sounds include the noise produced by high-speed hand-driers in toilet facilities
5 and the sound of frying bacon (although we do not know whether the patients in our sample
6 actually found these sounds to be aversive). However, for people with moderate or severe
7 hearing loss at high frequencies, ULLs are not lower at 8 kHz than at lower frequencies,
8 perhaps because the hearing loss at high frequencies reduces the loudness of high-frequency
9 sounds. More research is needed to establish whether this interpretation is correct.
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17 Patients with very low ULLs only at high frequencies may find sounds with strong high-
18 frequency components to be very unpleasant, but sounds with most of their energy at low
19 frequencies may be less aversive. The strong across-frequency variations in ULLs for our
20 patients classified as having severe hyperacusis might be an indication of adverse reactions
21 only to specific sounds, which is consistent with the definitions of annoyance and fear
22 hyperacusis (Tyler et al, 2014) and misophonia (Cavanna & Seri, 2015; Kumar et al, 2017).
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24 Future studies should explore the pattern of ULLs for individual patients and their
25 relationship to the everyday sounds that are found to be aversive by the patients.
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35 The mean ULL for our study population as a whole, including the group with severe
36 hyperacusis, was 84 dB HL (SD = 15), which is consistent with the results of Sheldrake et al
37 (2015), who reported that the mean ULL for 381 patients with a primary complaint of
38 hyperacusis was 85 dB HL (SD = 17). Our results showed that 6% of the study population
39 had mean ULLs across frequency below 55 dB HL for the ear with the lower mean ULL. In
40 contrast, Zaugg et al (2016) reported that only 2 out of 139 (1.4%) patients with tinnitus who
41 received treatment from a U.S. military veterans center had mean ULLs below 55 dB HL (the
42 mean ULLs for these two were 35 and 27 dB HL). Their study population differed in several
43 ways from that of the current study, which might have contributed to this discrepancy. The
44 differences were: (1) their study population included military veterans who, among other
45 things, may have had greater noise exposure and were more likely to have experienced
46 traumatic situations than our study population; (2) the main complaint of their study
47 population was tinnitus whereas our population included patients whose main complaint was
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4 hyperacusis; (3) only 4% of their patients were female compared to 52% in our study; and (4)
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6 the mean ULL for their population was 96 dB HL (SD = 14), which is higher than the mean
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8 ULL for our sample.
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11 In our study, the difference in average ULLs between ears was 5 dB or less for most of the
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13 patients with severe hyperacusis. The maximum between-ears difference in average ULLs
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15 was 12.5 dB. There is little published information about between-ear differences in ULLs for
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17 patients with hyperacusis. Formby et al (2007) reported that less than one percent (1/68) of
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19 their patients had unilaterally reduced ULLs. More recently Juris et al (2013) used UCLs
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21 below 90 dB HL in one or both ears (averaged across 0.5, 1, 2 and 3 kHz) as one of their
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23 criteria for including patients in a study of hyperacusis. They reported that 95% (59/62) of the
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25 included participants met the criteria for both ears. No further details were given, so the
26
27 magnitude of any interaural asymmetry is unknown. Overall, it appears that hyperacusis is
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29 only rarely associated with a strong interaural asymmetry in ULLs.
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32 The majority of our patients with severe hyperacusis had a history of otological
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34 abnormalities, which is consistent with past studies reporting otological disorders among
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36 patients with hyperacusis (Fioretti et al, 2016; Klein et al, 1990; Spyridakou et al, 2012;
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38 Johns, 1986). This highlights the need for otological evaluation and treatment (when
39
40 possible) of patients presenting with severe hyperacusis.
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44 Twelve of our patients with severe hyperacusis had a history of mental health problems and
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46 six of them were taking antidepressants. This is consistent with past studies that suggest a
47
48 relationship between hyperacusis and mental health problems (Aazh & Allott, 2016; Aazh et
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50 al, 2014; Dubal & Viaud-Delmon, 2008; Goebel & Floezinger, 2008; Hasson et al, 2013;
51
52 Juris et al, 2013). This highlights the need for psychiatric evaluation and treatment (when
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54 needed) of patients with severe hyperacusis.
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56 57 58 **Conclusions** 59 60

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Thirteen out of 362 patients who sought help from an NHS 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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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 tinnitus handicap inventory (THI), the visual analogue scale (VAS) for tinnitus loudness, the hyperacusis questionnaire (HQ), the hospital anxiety and depression scale (HADS), and the insomnia severity index (ISI). 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.

Questionnaire	Study population (excluding those with severe hyperacusis)			Group with severe hyperacusis		<i>p</i> -value
	<i>n</i>	Mean	SD	Mean	SD	
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

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TABLE 2. Audiological characteristics of the 13 patients with severe hyperacusis. 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.

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)

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

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

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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, years	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	Generalised 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.