Proceedings of the Institute of Acoustics

LOW FREQUENCY NOISE AND POSSIBLE INCREASED SUSCEPTIBILITY WITH AGE

A P L Baldock[1] and B M Shield[2]

[1]Tunbridge Wells Borough Council, Town Hall, Tunbridge Wells, Kent, TN1 1RS

[2]South Bank University, Borough Road, London, SE1 OAA

1. INTRODUCTION.

In the summer of 1994 a number of low frequency noise complaints were brought to the attention of Tunbridge Wells Borough Council. One of the complainants conducted a postal questionnaire survey, the results of which were made available to the authors. The respondents were contacted by the authors and asked to participate in a further study which involved interviews, audiometric tests and noise measurements. It was thought that sensitivity to low frequency noise might be affected by changes in hearing acuity associated with ageing, and it was hoped that the results of this survey would complement findings of other workers relating to changes in the auditory system caused by age.

2. PREVIOUS WORK.

In the last twenty years several authors have carried out studies which suggest that response to low frequency noise is affected by particular characteristics of the hearing mechanism which may be related to the ageing process.

Walford [1] investigated the aural health of people suffering from low frequency noise annoyance, whom he termed 'hummers', and hospital patients known to be suffering from low frequency tinnitus. The subjects took part in tone matching experiments and low frequency audiometric tests. Walford found that a number of the subjects who heard low frequency noises suffered from low frequency tinnitus. The hummers were divided into two groups: those with 'good' hearing and those with 'poor' hearing, and compared to a control group as shown in Figure 1. It can be seen that the low frequency noise complainants with 'good' hearing had hearing thresholds several dB lower than those of the control group at frequencies below 80 Hz, although the average audiometric threshold of the total group of hummers was higher than that of the control group at all frequencies.

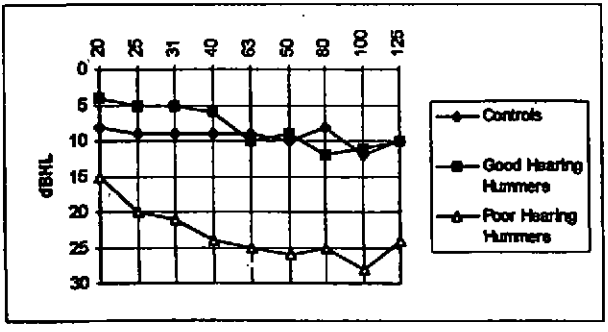

Figure 1 Thresholds of hearing of 'hummers' and control group [1].

Walford also found that even subjects suffering from various ear disorders or significant hearing loss were convinced that the hum was of an external nature and not due to tinnitus. Audiograms of some hummers showed increased hearing acuity at the hum frequency identified by the subject. For example Figure 2 shows the audiogram of a subject who identified the frequency of the hum heard as 40 Hz.

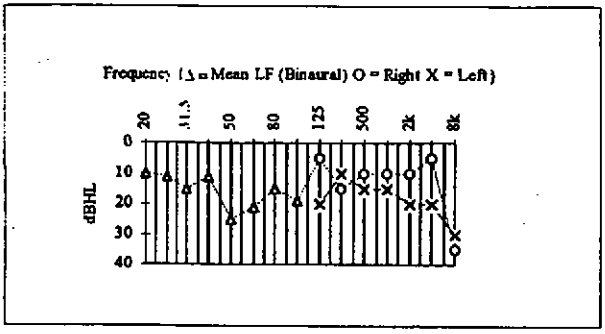

Figure 2 Audiogram of 'hummer' [1]

Similar results were reported by Frost [2] who investigated hearing acuity at low frequencies and found exceptionally good response at certain 'spot frequencies'. Hummers investigated by Frost demonstrated such responses at frequencies which coincided with the hum frequencies previously identified by the subjects.

A recent survey by Sargent [3] examined the incidence of low frequency noise complaints with a view to developing a reliable method for their investigation. Ten out of the twenty five low frequency noise complainants studied in detail underwent audiological testing. The audiological tests revealed one case of hyperacusis (hypersensitivity to all sound); three cases of specific hypersensitivity (hypersensitivity to a specific sound), and one case of low frequency tinnitus. In most cases no noise source could be detected at the home of the complainant, thus highlighting the importance of audiological testing in such cases. The study concluded that a number of cases were probably caused by a neural condition such as hyperacusis or low frequency tinnitus.

Other authors have examined the effect of age on response to sound at different frequencies, and the annoyance caused by tinnitus. Leske [4] found that annoyance due to tinnitus peaks in late middle age and gradually fades as the subject becomes older.

Willott [5] investigated the effects of ageing on the brain and neuronal response to acoustic stimuli in studies of young adults and animals. He found significant changes in the central auditory system of middle aged mice, which resulted in loss of sensitivity to high frequencies, together with an increased response to middle and low frequencies

This suggests that people in middle age may be more sensitive to problems of low frequency noise than the young or elderly. Work by Hellbruck [6] on young and old human subjects is in general agreement with these findings.

3. THE SURVEY.

The results of the analysis of the original postal survey by the complainant showed that the majority of the sufferers were in the age range 55 to 70, with an average of 58 years. The distribution of ages in this survey and that of Sargent [4] were very similar, as can be seen from Figure 3, and seemed to support the findings of other workers that people in middle age may be more sensitive to low frequency noise than other age groups. It was therefore decided to follow up the subjects who responded to the original survey and carry out a more thorough investigation through personal interviews , noise measurements and audiometry.

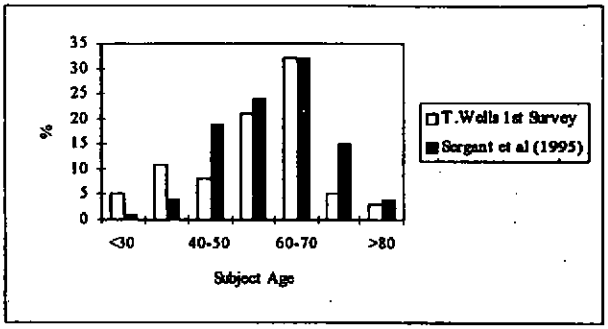

Figure 3 Age distribution of surveys

Of the thirty seven subjects in the original survey only thirteen agreed to take part in this further survey. The age range of these thirteen subjects was 28 to 80 years , with an average of 52 years, although the majority of respondents in this case were in the 30 to 40 age group. As the numbers in the second survey were small the results cannot be regarded as statistically significant; nevertheless the study showed some interesting results which suggest that a larger study would be worthwhile.

All but one of the subjects in the second survey lived in the borough of Tunbridge Wells. Six subjects lived within 3 km of elderly electrical transformers that were responsible for a very low noise level at 100 Hz.

4. REACTIONS TO THE NOISE

The subjects showed varying degrees of annoyance and disturbance due to the low frequency noise. Of the thirteen subjects in the detailed study, four were in a very distressed state and complained of sleep disturbance and interference with concentration. Three were not bothered by the noise but were merely interested in its origin. Most of the subjects described the noise as a 'hum'; others used the terms 'rumble', 'drone', or 'buzz'.

The subjects claimed to have heard the noise for between six months and twelve years; most of them claiming that the noise was continuous from midnight to 6 am. It is possible that the noise is more noticeable at this time owing to the low level of background noise. Also, probably for the same reason, most of the subjects thought that the noise only occurred, or was most noticeable in the bedroom. However the four who were particularly annoyed by the noise claimed that it occurred in every room of the house.

5. AUDIOMETRIC RESULTS.

It was not possible as a part of this survey to carry out low frequency audiometry. Audiometric testing was carried out at the standard frequencies, and the results examined in part to determine whether there was any significant high frequency loss which might correspond to increased sensitivity at low frequencies. One subject was aware of a hearing defect and another suffered from an illness that could affect the hearing.

All except one subject showed significant losses in both ears at high frequencies, the majority having dips in their audiograms at 6000 Hz. Interestingly, the only subject with no significant hearing loss, a woman aged thirty three, could hear the noise but was not annoyed by it. The four subjects that were most distressed by the sound they were hearing had binaural hearing losses of between 30 and 80 dB at 6000 Hz. An audiogram of one of these subjects , aged 46, is shown in Figure 4.

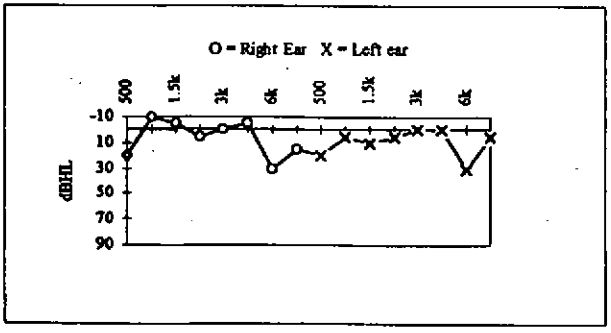

Figure 4 Audiogram of annoyed subject

The average audiogram of the thirteen subjects is shown in Figure 5. The audiograms of both ears show a dip at 6000 Hz, the average loss at this frequency being over 30 dB. The loss at 6000 Hz is significantly greater than the loss at 4000 Hz, by 16 dB for the left ear and 8 dB for the right ear.The loss at 8000 Hz is is less pronounced in both ears causing a 'dip' in the audiogram at 6000 Hz.

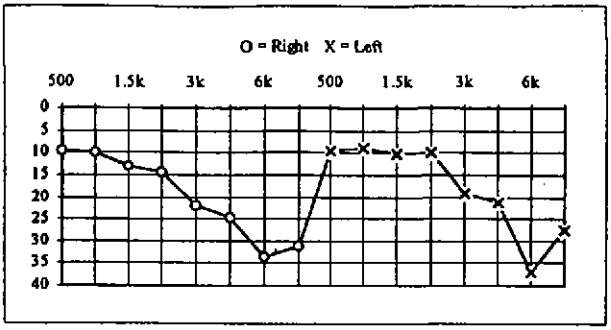

Figure 5 Average audiogram of all subjects

6. NOISE MEASUREMENTS.

Continuous overnight noise monitoring was carried out at the properties of the four most annoyed subjects. Thirty minute L_{eq}s in one third octave bands were measured between 2200 and 0800 hours.

A low frequency noise was audible in two of the homes, where the measured spectra were found to peak in the 100 Hz third octave band. In both cases one member of the household was extremely distressed by the noise, but other members of the family were unaware of the sound. In the other two cases no specific low frequency noise was detected by the measurements.

7. CONCLUSIONS

The small survey of low frequency noise sufferers in Tunbridge Wells shows similarities with other, larger, surveys of low frequency noise problems. Of particular interest are the audiometric results of the survey which show that almost all the complainants had significant hearing loss at high frequencies. The age of the complainants and the audiograms are consistent with the results of previous studies suggesting that there is a strong relationship between aural health and sensitivity to low frequency noise. Further investigations of low frequency noise complaints are required to achieve more conclusive results. This work was carried out as an MSc project at South Bank University, where research involving laboratory experiments is currently being undertaken to further investigate response to low frequency sound.

8. REFERENCES.

1. R.E Walford, (1982) A Classification of Environmental "Hums" and Low Frequency Tinnitus. Journal of Low Frequency Sound and Vibration ,2(2) pp60-84.
2. G.P Frost, (1983). The effect of variations in the microstructure of individual low frequency thresholds and loudness function on noise control criteria. Proceedings of Inter-Noise Conference. pp 319-323.
3. J.W Sargent,(1995). A study of low frequency noise complaints. Proceedings Institute of Acoustics Vol. 17: Part 4, pp17-24.
4. Leske, M.C. (1981). Prevalence estimates of communicative disorders in the U.S.: Language, hearing and vestibular disorders. American Speech and Hearing Association, 23, pp229-237.
5. Willot, J.F. (1994). Ageing and the auditory system, anatomy, physiology and psychophysics. Whurr Publishers Ltd London.
6. Hellbruck, J., (1988). Strukturelle veranderungen des horfeldes in abhangigkeit vom lebensalter. Zeitschrift fur Gerontologie, 21, pp146-149.