

Noise induced hearing loss in dance music disc jockeys and an examination of sound levels in nightclubs

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Abstract

Noise exposure, hearing loss and associated otological symptoms have been studied in a group of 23 disc jockeys using a questionnaire and pure tone audiometry. The level of noise exposure in the venues where they work has also been studied using Ametek Mk-3 audio dosimeters. Three members of the study group showed clear evidence of noise-induced hearing loss on audiometry, 70 per cent reported temporary threshold shift after sessions and 74 per cent reported tinnitus. Sound levels of up to 108 dB(A) were recorded in the nightclubs. The average level for a typical session was 96 dB(A) which is above the level at which the provision of ear protection is mandatory for employers in industry. It can be concluded that DJs are at substantial risk of developing noise-induced hearing loss and noise exposure in nightclubs frequently exceeds safe levels.

Key words: Hearing Loss; Noise, Occupational; Music

Introduction

Noise-induced hearing loss (NIHL) is a process of permanent metabolic cochlear damage, caused by chronic exposure to sound levels between 90 dB and 140 dB.¹ Several studies have looked at sound levels affecting those working in a wide range of environments exposed to loud music and more commonly loud industrial noise.² Evidence of NIHL has been shown in choristers,³ symphony orchestra musicians,⁴ in those attending rock concerts and using personal cassette players (PCPs)⁵ and in those attending discotheques.⁶

Noise levels in discotheques have been studied by Gunderson *et al.*,⁷ Lee⁸ and Sadhra *et al.*⁹ All three studies reported noise levels in excess of 85 dB(A) for the duration of the shift and Sadhra *et al.*⁹ found peak levels up to 124 dB(A). Lee also carried out audiometry on discotheque workers and controls and reported a significant increase in early sensorineural hearing loss in the study group. This appeared to be more marked in those who had worked longer in this environment. Sadhra *et al.*⁹ carried out pre- and post-shift audiograms in 14 students working in music bars and discotheques. Twenty-nine per cent showed evidence of hearing loss. Gunderson⁷ used a questionnaire to identify symptoms of noise exposure and reported that these correlated with duration of exposure. We have been unable to identify a study which has looked specifically at disc jockeys (DJs) and the sound levels to which they are exposed.

The aim of this study was to analyse the hearing levels of DJs and to obtain sound level dose data for typical DJ working sets.

Material and methods

A group of 23 disc jockeys (DJs) was assessed for evidence of noise damage to the ear. There were five females and 18 males and their ages ranged between 21 and 41 years (mean = 29 years). The mean time they had worked as DJs was eight years (range one to 26 years).

These subjects were asked to complete a 36-question questionnaire that screened for otological disease and symptoms (including specific questions relating to ototoxic drugs), and provided information on exposure to noise, possible sources of exposure other than working as a DJ, concern for hearing damage and precautions taken (Appendix). In 23 individuals stapedius reflex tympanometry and pure tone audiometry was performed after otoscopy by one observer. Hearing tests were carried out under the same conditions for all the subjects (a sound-proofed room in the Audiology Department). Pure tone audiometry was performed at 500 Hz, 1, 2, 3, 4, 6 and 8 kHz for air conduction and unmasked bone conduction at 1 kHz and 4 kHz. Published mean age specific values for males and females at 500 Hz, 1, 2, 3, 4 and 6 kHz^{1,10} were used to plot 'normal' expected hearing thresholds on each audiogram

and to tabulate the hearing data together with median values and distributions for each frequency tested.

Personal sound level dosimetry was carried out during 11 separate DJ sets. This took place in a variety of nightclub venues within Edinburgh and encompassed main room peak time sets, main room warm-up sets and back room sets varying from 56 minutes to 4 hours seven minutes in duration. A number of Ametek Mk-3 audio dosimeters were used for the personal dosimetry. These were of the Type 2 variety and calibrated to within 0.3 dB using a dosimeter calibrator, itself exactly calibrated. Calibration of the dosimeters was checked before and after every occasion of use.

The dosimeter was switched on after each DJ had begun playing records and data collection was suspended after he/she had completed their set. The dosimeter sampled continuously during this period at intervals of 1/10th of a second producing various data including minute averages of A-weight dB levels. These data were subsequently downloaded to an Ametek computer-printer interface and hard copies were printed for analysis.

Eleven separate sets of data were collected from five different venues and nine different DJs. In each case the sound level dosimeter was carried in a pocket by the DJ or worn elsewhere on the trouser. The microphone was clipped onto clothing on the shoulder, facing upwards so as best to sample the noise level at the ear while minimally intruding upon the DJ's activities. One DJ refused to wear the device but since it was considered particularly useful to sample that environment, a compromise was reached. The microphone was placed on a shelf facing upwards in a fully exposed position at ear height of the subject, and within one metre of his usual working position during the set.

Some venues were used more than once because different styles of dance music were being played on separate evenings. Alternatively, this was because different sound systems were being used in the same venues on different occasions. The selection gave a fair representation of the venues and music types that the DJs in the hearing test study group were usually exposed to. Almost all of the dose data came from DJs who underwent hearing tests.

Each set recorded may have included brief trips to the quiet environment of the lavatory, but otherwise only included exposure to sound levels found in the DJ booth and elsewhere in the club during the period of their set.

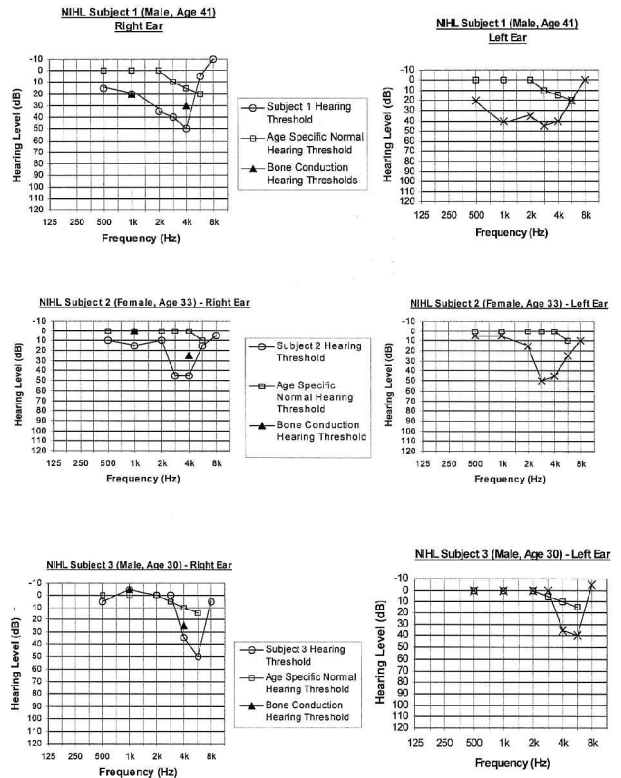


FIG. 1
Specimen audiograms from disc jockeys.

Results

In three DJs (13 per cent) pure tone audiograms showed evidence of NIHL (Figure 1 and Tables I–III), although the pattern of the audiogram for subject 1 is somewhat unusual. In four others (17 per cent), signs of early sensorineural hearing loss were present. Two DJs (nine per cent) who had a history of childhood tympanic membrane perforation showed unilateral hearing loss. Hearing in 14 DJs (61 per cent) was considered within normal ranges. The mean hearing loss for these frequencies was 20.5 dB in this group. A mean loss of 4.1 dB was calculated in the same way for the four DJs considered to show signs of possible early NIHL.

Although 20 DJs (87 per cent) were concerned about the risk of hearing damage by loud noise only three DJs (13 per cent) used ear protection during work. The majority of the group (16 DJs, 70 per cent) experienced dulled hearing, lasting from one hour to two days after exposure. Experience of tinnitus was reported by 17 DJs (74 per cent) (Figure 2). Apart from working in nightclubs, the DJs were

TABLE I
HEARING THRESHOLDS (DB) FOR SUBJECT 1 (MALE, AGE 41 YEARS) FOR FREQUENCIES 500 TO 8000 HZ COMPARED TO MEDIAN HEARING THRESHOLDS AND STATISTICAL DISTRIBUTION FOR INDIVIDUALS OF THE SAME AGE AND SEX (ISO7029)

Frequency	500 Hz	1000 Hz	2000 Hz	3000 Hz	4000 Hz	6000 Hz	8000 Hz
Thresholds right ear	15	20	35	40	50	15	-10
Thresholds left ear	20	40	35	45	40	20	0
Median of normal range	2	2	3	6	8	9	11
Distribution	-5 -6	-5 -7	-6 -15	-5 -19	-4 -23	-5 -26	-5 -30

TABLE II

HEARING THRESHOLDS (DB) FOR SUBJECT 2 (FEMALE, AGE 33 YEARS) FOR FREQUENCIES 500 TO 8000 HZ COMPARED TO MEDIAN HEARING THRESHOLDS AND STATISTICAL DISTRIBUTION FOR INDIVIDUALS OF THE SAME AGE AND SEX (ISO7029)

Frequency	500 Hz	1000 Hz	2000 Hz	3000 Hz	4000 Hz	6000 Hz	8000 Hz
Thresholds right ear	10	15	10	45	45	15	5
Thresholds left ear	5	5	15	50	45	25	10
Median of normal range	1	1	1	1	1	2	2
Distribution	-6 -9	-6 -9	-6 -10	-7 -11	-7 -12	-8 -14	-10 -17

TABLE III

HEARING THRESHOLDS (DB) FOR SUBJECT 3 (MALE, AGE 30 YEARS) FOR FREQUENCIES 500 TO 8000 HZ COMPARED TO MEDIAN HEARING THRESHOLDS AND STATISTICAL DISTRIBUTION FOR INDIVIDUALS OF THE SAME AGE AND SEX (ISO7029)

Frequency	500 Hz	1000 Hz	2000 Hz	3000 Hz	4000 Hz	6000 Hz	8000 Hz
Thresholds right ear	5	-5	0	0	35	50	5
Thresholds left ear	0	0	0	0	35	40	-5
Median of normal range	1	1	1	2	2	3	3
Distribution	-6 -9	-5 -11	-7 -11	-7 -13	-7 -14	-8 -16	-9 -11

subjected to many other noise situations. Nineteen of them (83 per cent) visited nightclubs, when not working as DJs, more often than once per fortnight. Every second DJ reported extensive use of personal music players.

Personal sound level dosimetry revealed that mean minute average levels per DJ sets in the nightclubs tested varied from 97.8 dB(A) to 107.9 dB(A). The average per set was 103.2 dB(A), the minute average overall was 102.4 dB(A) and average set duration was 113 minutes (1 hour 53 minutes).

Extrapolated L_{eq} (average sound level for eight-hour work session) values assumed no further noise exposure other than that measured during the DJ set (i.e. the sound energy collected during the set spread over eight hours instead of the length of the individual set). The average L_{eq} value calculated in this way was 96.1 dB(A).

Discussion

The study group of 23 DJs yielded three (13 per cent) who showed evidence of noise-induced hearing loss. However one of the subjects with NIHL had a history of noise exposure in a previous job. The mean age of the DJs with NIHL was seven years higher than the mean age in the rest of the group. This corresponds with an average of eight years longer working as a DJ. This is in line with the study by Lee⁸ who reported that a higher proportion of

those in the study group who were older and who had worked longer showed more NIHL. However the dose relationship is not purely quantitative. Many DJs in the study had exposures equal to or more than some of those exhibiting NIHL and the degree of hearing loss was not related to the length of noise exposure in all the subjects. This adds weight to current thinking that there is a range of susceptibility among individuals, which allows certain people to withstand significant exposures without any damage to hearing, while others exhibit extensive hearing loss.¹ Experience of tinnitus lasting longer than a few minutes was reported by 74 per cent of the subjects. Long-lasting tinnitus can be considered as an indicator of cochlear damage after chronic loud music exposure or a precursor of NIHL.

The average eight hour L_{eq} value of 96.1 dB(A) obtained in our study, can be compared to exposure for workers with agricultural machinery (93 dB(A)), road drilling (96 dB(A)) or lumber work (99 dB(A)).¹¹ The value of 96.1 dB(A) is much higher than the government's set limits of 90 dB(A) for this time period.¹² It is mandatory for employers to provide hearing protection for their employees in environments exceeding this level. However since most DJs are self-employed, the medico-legal implications are limited in this group, but are likely to be more important in other staff working in nightclubs. Gunderson *et al.*⁷ reported similar results of sound level measurements for different members of staff in nightclubs. The sound levels ranged from 94.9 dB(A) to 106.7 dB(A). Sadhra *et al.*⁹ also reported that ear protection was seldom worn by the subjects in their study.

Sadhra *et al.*⁹ analysed noise exposure and incidence of hearing loss among students working part-time in music bars and discotheques. Using a questionnaire, personal dosimeters and pure-tone audiometry in 14 students, they found that both security and bar staff were exposed to sound levels exceeding 90 dB(A). In 29 per cent of subjects from that study permanent hearing loss of more than 30 dB was diagnosed. It is noteworthy that this specific group is often subjected to noise other than

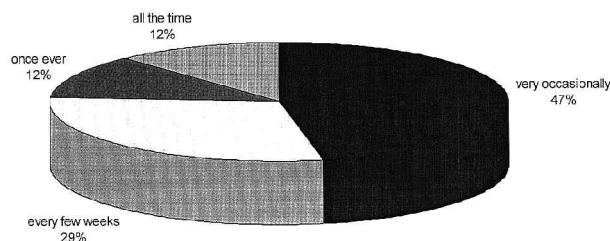


FIG. 2

Experience of tinnitus by disc jockeys.

- **It is known that musicians and those attending concerts and discotheques as well as those using personal stereos are at risk of noise damage**
- **In this paper the noise exposure and hearing loss in 23 disc jockeys is explored. Seventy per cent reported a temporary threshold shift and 74 per cent reported tinnitus**
- **Sound pressure levels of up to 108 dB were recorded**
- **The conclusions of the study are that disc jockeys are at risk of noise-induced hearing loss and that noise levels in nightclubs are excessive**

from their work in nightclubs. The subjects in our study group reported use of personal music players and regular visits to music clubs when not working. These factors may also contribute to developing NIHL.

The sound level is invariably raised through the evening as the sound is 'soaked-up' by more people entering the venue, hence one can usually expect 'warm-up' sets to be quieter than the later evening 'peak time' sets (in Edinburgh approximately 10 pm–1 am and 1 am–3 am respectively) for a given venue on a particular evening. Back room sets are usually played on a different sound system to the main room, the volume of which is set independently. It was important to sample all three varieties of environment since a DJ may be exposed to any of them in his/her routine work. Some of the DJs also play records in bars, which will be included in their appraisal of the question 'how often do you work as a DJ?'. However it is to be expected that this type of work is less common (and proportional to their frequency of nightclub work) and would in most cases involve sound levels far lower than that found in nightclubs.

Conclusion

We conclude that DJs are at substantial risk of developing noise-induced hearing loss and noise exposure in nightclubs frequently exceeds safe levels.

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References

- 1 Clark WW. Hearing: the effects of noise. *Otolaryngol Head Neck Surgery* 1992;**106**:669–76
- 2 Taylor W, Person J, Mair A, Burns W. Study of noise and hearing in jute weaving. *J Acoust Soc Am* 1965;**38**:113–20
- 3 Steurer M, Simak S, Denk DM, Kautzky M. Does choir singing cause noise-induced hearing loss? *Audiology* 1998;**37**:38–51
- 4 Teie PU. Noise-induced hearing loss and symphony orchestra musicians: risk factors, effects and management. *Med Med J* 1998;**47**:13–8
- 5 Meyer-Bisch C. Epidemiological evaluation of hearing damage related to strongly amplified music (personal cassette players, discotheques, rock concerts)- high-definition audiometric survey on 1364 subjects. *Audiology* 1996;**35**:121–42
- 6 Metternich FU, Brusis T. Acute hearing loss and tinnitus caused by amplified recreational music. *Laryngo-Rhino-Otol* 1999;**78**:614–9
- 7 Gunderson E, Moline J, Catalano P. Risks of developing noise-induced hearing loss in employees of urban music clubs. *Am J Ind Med* 1997;**31**:75–9
- 8 Lee LT. A study of the noise hazard to employees in local discotheques. *Singapore Med J* 1999;**40**:571–4
- 9 Sadhra S, Jackson CA, Ryder T, Brown MJ. Noise exposure and hearing loss among student employees working in University entertainment venues. *Am Occup Hyg* 2002;**46**:455–63
- 10 International Standards Organisation. *Acoustics Statistical Distribution of Hearing Thresholds as a Function of Age*. (ISO7029). 2000.
- 11 Browning GG. *Clinical Otology and Audiology*. 2 edn. London: Arnold, 1998
- 12 Health and Safety Executive. *Noise at Work Regulation*. London: HMSO, 1989

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Dr R. Mills takes responsibility for the integrity of the content of the paper.

Competing interests: None declared

Appendix

Hearing and noise exposure questionnaire

Name:

Age:

Questionnaire for DJs

(Any information given is confidential and will only be shared with members of the research team.)

Please Circle Correct Answers

1. How often do you work as a DJ (on average)?
 A. More than once per week B. Once per week C. Once per fortnight
 D. Once per month
2. How long have you DJed that often?
 Please state no. of years (to nearest year)
3. How long have you been DJing in total?
 Please state no. of years (to nearest year)
4. How long ago were you subjected to loud noise of any kind?
 A. Within the last 24 hrs B. Within the last 48 hrs C. Longer than 48 hrs ago
5. Have you ever suffered any ringing/noise in the ears (for more than a new minutes)?
 A. Yes B. No
6. If 'Yes', then how long for? (N.B. please circle more than one answer if not always the same length of time.)
 A. Hours B. Days C. Weeks
 D. Longer
7. If 'Yes' to question 5, how often?
 A. After every night's work B. Every few weeks C. Every few months
 D. Very occasionally E. Once ever F. All the time
 G. Other. Please state:
8. Has your hearing ever been dulled after a night's work? (e.g. like having cotton wool in your ears)
 A. Yes B. No
9. If 'Yes', how long for? Please write answer here:
10. Have you ever had problems with a fluid discharge from either of your ears?
 A. Yes. Please state which ear: B. No
11. Have you ever consulted a doctor or other health professional about your hearing/ears?
 A. Yes B. No
12. If 'Yes', was the diagnosis:
 A. Noise induced damage B. Other. Please state:
13. Is there any history of deafness in your family? (Other than old age related.)
 A. Yes B. No
14. If 'Yes', do you know what kind? Please state type of deafness if known:
15. What medical problems/illnesses do you suffer from or have suffered from in the past?
 Please list, or circle 'None':
16. Please circle any of the following medication that you have ever taken in the past?
 A. Gentamicin or Streptomycin B. Quinine (for malaria) C. Frusemide (a 'water' tablet)
17. Have you ever been concerned about hearing problems associated with loud noise?
 A. Yes B. No
18. Were you concerned about your hearing prior to participation in this study?
 A. Yes B. No
19. Do you wear ear protection when DJing?
 A. Yes B. No

20. If 'Yes', what kind?
 A. Foam earplugs (e.g. from chemist) B. Professionally fitted earplugs C. Cotton wool or similar
 D. Other. Please state:
21. When not working as a DJ, how often do you visit nightclubs (on average)?
 A. More than once per week B. Once per week C. Once per fortnight
 D. Once per month E. Rarely F. Never
22. Do you wear ear protection when you visit nightclubs as a customer?
 A. Yes B. No
23. If 'Yes', what kind?
 A. Foam earplugs (e.g. from chemist) B. Professionally fitted earplugs C. Cotton wool or similar
 D. Other. Please state:
24. When DJing, which ear do you usually cover with headphones?
 A. Right ear B. Left ear C. Both ears
25. Do you use a portable personal music player (e.g. walkman/discman)?
 A. Yes B. No
26. If 'Yes', how often?
 A. Every day B. Once or twice per week C. Once or twice per month
 D. Rarely
27. If 'Yes' to question 25, do you bother about how high the volume is?
 A. Yes B. No
28. Do you listen to loud music in the car?
 A. Yes B. No
29. If 'Yes', how often?
 A. Every day B. Once or twice per week C. Once or twice per month
 D. Rarely
30. Do you listen to loud music at home?
 A. Yes B. No
31. If 'Yes', how often?
 A. Every day B. Once or twice per week C. Once or twice per month
 D. Rarely
32. Do you have any other job that involves exposure to loud noise/music?
 A. Yes. Please state: B. No
33. If 'Yes', how often do you work in the noisy environment stated? (N.B. If the job does not always involve loud noise, please answer how often it does.)
 A. Every day B. Once or twice per week C. Once or twice per month
 D. Rarely
34. Do you have any other pastimes that involve loud noise (e.g. motorsport, shooting etc)?
 A. Yes. Please state: B. No
35. If 'Yes', how often do you participate in this activity?
 A. Every day B. Once or twice per week C. Once or twice per month
 D. Rarely
36. Please add any comments or extra information here and overleaf: