Proceedings of The Institute of Acoustics 1C2

An Evaluation of Hearing Damage Risk to Attenders at Discotheques.

J. Bickerdike and A. Gregory,
Leeds Polytechnic.

Introduction

Serial audiometry studies by Fearn and Hanson[1] and Fearn[2,3] have established small, on average 2 or 3dB, but measurable losses of hearing in persons who regularly attend discotheques when compared with non attenders. These U.K. studies, which are supported by evidence from elsewhere, are limited to audiometric data and information on attendance patterns. Studies of sound levels in such premises by Fearn[4,5,6], Martin[7], G L C[8] and others have also shown that the levels experienced by attenders, staff and performers are significantly higher, in the range 85dB(A) to 125dB(A), than the accepted level at which noise induced hearing loss begins. These audiometric and sound level surveys have been conducted either independently of each other or on a scale insufficiently large enough to make the results statistically acceptable. To date no large scale, long term, comprehensive and combined study of these areas has been conducted in this country or abroad.

The view expressed by Whittle and Robinson[9] in a review of evidence up to 1974 was that the current damage risk criteria (DRC), in particular the Burns and Robinson data[10], would apply equally well to exposure to loud music as it does to industrial noise. Accepting this assumption, damage risk can be estimated by obtaining a measure of the noise dose or, more correctly, the Noise Immission Level (NIL) to which the attending populations are exposed where,

$$NIL = L_{eq(A)} + 10 \log \frac{T}{T_o} \quad \ldots\ldots\ldots\ldots \quad (1)$$

and $L_{eq(A)}$ is the equivalent continuous sound level over the time period T and T_o is a reference period of 2000 hours. The $L_{eq(A)}$ can be determined by suitable measurements of the sound levels to which attenders are exposed whilst the duration of exposure can be obtained from the attendance patterns of attenders. In 1976 a comprehensive survey was designed, supported by the Noise Advisory Council, which included, on completion, a sound level survey in 49 discotheques and attendance data from 4166 individuals collected in 54 discotheques, schools and colleges etc. A preliminary report on sound levels was presented in 1978; Bickerdike and Carter[11].

Method

Sound level measurements were obtained using personal dose meters (PDM) and static L_{eq} devices (SDM) together with spot measurements by SLM at various positions in the premises. The PDMs were worn by normal attenders whilst the SDMs were placed at a position representing the highest level to which the attending population was exposed and this value was designed the Maximum Practicable Exposure Level (MPEL). The attendance survey was conducted by questionnaire and interview, additionally objective methods were used to determine duration of stay and activity within the premises. Comparative data was also obtained from other regions of the country.

An Evaluation of Hearing Damage Risk to Attenders at Discotheques.

Results

The sound level survey produced a large amount of data which was divided into licenced (18 years plus) (commercial) and unlicenced premises (Youth groups etc.). Whilst differences between the two groups were measurable appropriate corrections allow them to be treated together. Fig.1 shows the distribution of DM L_{eq}s for 154 samples. The corrected mean is 97dB(A) and assuming a normal distribution the 10% and 5% levels are 102 and 103dB(A) respectively. The mean MPEL was 101dB(A); S.D. 5.8dB(A) and SLM measurements at various points in the premises showed means of 99dB(A) on the dance floor, 93dB(A) in the seating area and 91dB(A) in the bar. Percentile levels range from 56dB(A) L_{99} to 122dB(A) L_1 whilst the highest r.m.s. 'fast' 'Peak' level was 128dB(A). Relationships were explored between MPEL and DM values and Fig.2 shows the relationship between the difference in MPEL and the average DM values in individual premises as a function of MPEL. Variation of L_{eq} with time over the duration of the performance was obtained and for licenced premises the MPEL increased by, on average, 8dB(A) with a corresponding increase in DML of 5dB(A), values for unlicenced premises were 6dB(A) and 3dB(A) respectively, representing the difference in mode of operation of the premises.

The 4166 valid questionnaires from the attendance survey were divided into two groups; 1498 obtained in discotheques and 2668 in education premises etc. All results were computerised and analysed initially by sex and age group but subsequently the sexes were merged. The age range encountered in the survey was from 11 years to 49 years plus with a median value of 21 years and 10th and 5th percentiles of 32 and 36 respectively. Some 10% of attenders attend on a casual basis, ie. less than once per month and all subsequent results apply to Regular Attenders only, ie. once a month or more. The median weekly hours of attendance turns out to be 4.5 hours with a 10% level of 10.5 hours and 5% of 15 hours over the whole range of age groups and although individual age groups do differ the error, in terms of NIL, is small. The overall duration of regular attendance was estimated from the increasing and declining proportion of attenders in the age groups and the median duration of attendance is put at 7 years and 18 years and 24 years respectively for the 10th and 5th percentiles. Other factors such as additional noise exposure ar work, marital status, attitude to music were investigated but are not presented here. The principal results of the sound level and attendance surveys are shown in Table 1.

Evaluation of NIL and Associated Hearing Damage Risk

NILs were calculated from the above variables in accordance with Eqn.1, together with small corrections for variation in attendance which are also shown in Table 1. The probabilities associated with these NILs are low and combinations of L_{eq}, weekly and years attendance were produced which correspond to the 50th, 10th and 5th percentiles of NIL which turn out to the 85dB, 96dB and 97dB respectively.

Age corrected hearing levels (H') ar frequencies from 0.5 to 6kHz were calculated using the Robinson and Shipton Tables[12] and the % of the population at risk of reaching 30dB ave. at 1, 2 & 3kHz obtained from various probabilities of NIL. Reported in Table 2 are the values obtained for the 50th, 10th and 5th percentiles of NIL.

An estimate of numbers regularly attending based on the distribution and

proportion of attenders in each age group puts the total number at risk at about 6 million of which some 0.025% will reach the 30dB ave. at 1, 2 & 3kHz 'low fence' at the end of their attendance period, increasing to 0.2% at age 60.

Discussion

The sound level data from the SLM and MPEL compares generally with that reported earlier and suggest that the levels, in discotheques at least, have remained reasonably constant over the years although the introduction of more live music has led to increases in some premises. Fig.2 indicates that there is a generally acceptable level of MPEL, at around 102dB(A) L_{eq}, above which attenders appear to limit their exposure and which still gives reasonable audibility and 'feeling' above the background noise without undue discomfort. This is also supported by responses to questions on the loudness of the music, not reported here, wherein the premises with higher values of MPEL more attenders considered the music too loud. The increase of DM and MPEL levels over the duration of the events may be due, either to increased power output to compensate for increased absorption with increasing numbers of attenders later in each session or; to an element of Temporary Threshold Shift which attenders and performers may be experiencing at this time or a combination of both. The average DM level of 97dB(A) is rather less than previous estimates which have been based, mainly, on SLM measurements around the dance floor and near to speakers. They do, however, agree closely with DM measurements obtained in discotheques by Martin[7] in 1976 who reported an average of 96.7dB(A) from discos.

The attendance survey results are not comparable with other data as little information exists by way of large scale investigations into attendance patterns. Overall attendance is probably less than previously estimated although some claimed attendance patterns are clearly excessive. We would conclude that, overall, the data shows maximum exposure, as our assumptions in determining the years of attendance is that attendance is continuous throughout that period, whereas in practice it is more likely to occur spasmodically as the individual's taste in leisure activities change with age and fashion. The attendance survey results also showed that a major influence on attendance is the male/female contact and subsequent pairing off incourtship and marriage significantly reduces attendance.

The predicted PTS shows that only a small percentage of attenders, 0.025% will reach the 30dB law fence at the end of their attendance period amounting to some 1500 persons out of an estimated 6 million at risk. These results are not directly comparable with the audiometric data mentioned earlier as those results also included attendance at pop concerts which are excluded from our results. However, differences between Fearn's results, which are the closest available for comparison, and those obtained from the survey data are small and lead to the conclusion that existing DRC can be used to predict hearing loss from exposure to loud music in discotheques.

An Evaluation of Hearing Damage Risk to Attenders at Discotheques.

Fig. 1 Distribution of DM L_{eq}'s

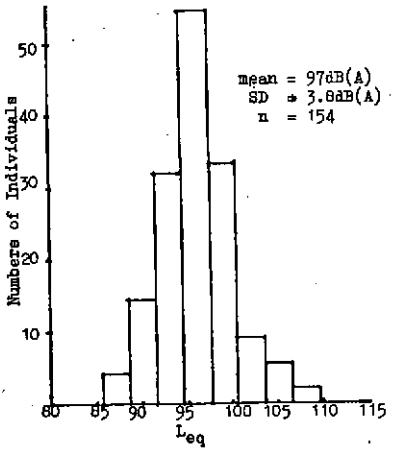

Fig. 2 Relationship between MPEL & MD

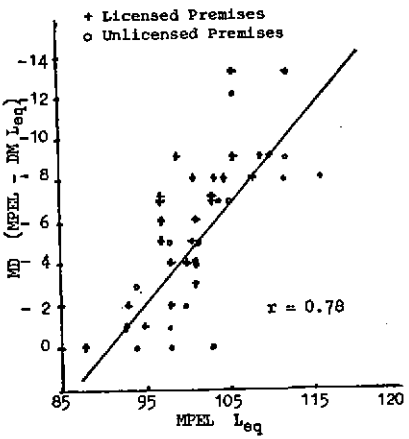

Table 1. NILs and 50th, 10th and 5th Percentile Values of L_{eq}, Weekly Hours of Attendance and Years of Exposure

P	L_{eq} dB(A)	Weekly Attendance (hrs)	Years of Attendance (years)	Correction for duration of each Attendance (-1dB)	Correction for variation of Yearly Att. (-1dB)	NIL (dB)
0.125	97	4.5	7	-	-1	95
0.001	102	10.5	18	-1	-1	107
0.000125	103	15.0	24	-1	-1	111

Table 2. Threshold Hearing Levels (H') for stated Percentiles of Discotheque Attenders and 50%, 10% and 5% NIL values (NIL = 0 represents normal population)

NIL	Ave. Threshold Levels (H') at 1, 2 and 3kHz (dB)			BS 5330 % at Risk of 30dB ave.
	50%	10%	5%	
50% = 85	0.6	9.3	12.0	-
10% = 96	2.5	13.9	17.8	-
5% = 97	2.8	14.6	18.7	-
0	0	7.7	9.9	-

An Evaluation of Hearing Damage Risk to Attenders at Discotheques.

cknowledgments and References

he project was funded by the Noise Advisory Council. A comprehensive report covering all aspects of the survey is available price £4.00 to cover production and postage costs.

1. Fearn R.W. and Hanson D.W. 1975. Hearing Acuity in Young People Exposed to Pop Music and Other Noise, Lancet, 2:1975, 203-205.
2. Fearn R.W. 1976a. Hearing Loss Caused by Amplified Pop Music. J. Sound Vib., 46, 462-464.
3. Fearn R.W. 1976b. Hearing Loss Caused by Different Exposures to Amplified Pop Music, J. Sound Vib., 47, 454-456.
4. Fearn R.W. 1971. Risk of Hearing Damage from Record Players in Clubs. Leeds Polytechnic, Rpt. No.AS71/5.
5. Fearn R.W. 1972a. Hearing Damage Risk in Youth Clubs. Leeds Polytechnic, Report No. AS72/7.
6. Fearn R.W. 1972b. Noise Levels in Youth Clubs. J. Sound Vib., 22, 127-131.
7. Martin A.M. 1978. Pop Music and Hearing: A Pilot Study, AcLetters 1 139-145.
8. Greater London Council. 1978. Scientific Branch of Director-General's Department - Private Correspondence.
9. Whittle L.S. and Robinson D.W. 1974. Discotheques and Pop Music as a Source of Noise Induced Hearing Loss - A Review and Bibliography. N.P.L. Acoustics Report Ac.66.
10. Burns and Robinson. 1970. Hearing and Noise in Industry. HMSO.
11. Bickerdike J. and Gregory A. 1978. A Survey of Sound Levels in Discotheques. Proc. Inst. Ac.4. 15.J2. 1 - 4.
12. Robinson and Shipton. 1973. Tables for the Estimation of Noise Induced Hearing Loss. N.P.L. Acoustics Report Ac.61.