The Risks of Amplified Music for Disc-Jockeys Working in Nightclubs

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Objectives: Here, we evaluate the risks of amplified music for disc-jockeys (DJs) working in nightclubs.

Design: Sound level measurements were performed within the DJ mixing booths. A questionnaire was used to obtain exposure to noise and length of time in the profession. Audiograms and tinnitus pitch matching was also performed.

Results: The DJs' audiograms showed the expected noise-induced hearing loss at 6 KHz, but also low frequency losses at 125–500 Hz. Three quarters of them have tinnitus with a frequency corresponding to hearing loss.

Conclusions: This study highlights the risk of amplified music on hearing and tinnitus.

(Ear & Hearing 2009;30;291–293)

INTRODUCTION

In European countries, there is legislation that defines what noise exposure is allowed in the workplace. The decree 2006–892 (July 18, 2006) stipulates that a worker cannot be exposed to sound levels greater than 80 dB (A) for more than 8 hr a day without auditory protection. Gunderson et al. (1997) measured the sound levels in several New York discos and reported average levels ranging from 94.9 to 106 dB (A). Such levels are probably harmful to the clientele that visit them but certainly for the personnel who work there several nights a week. Among these employees, disc-jockeys (DJs) are a particularly exposed population. Therefore, we evaluate the risks of amplified music for DJs. To assess this, we have measured the sound levels in the mixing booth and evaluated hearing and auditory complaints of a population of DJs.

MATERIALS AND METHODS

Acoustic Measurements

Measurement of sound levels was undertaken in six nightclubs in and around Montpellier. The selected nightclubs played almost exclusively "techno music." Acoustic measurements were taken at the most crowded time of the night (between 1 and 2.30 A.M.). These measurements were taken in the DJ mixing booth, 20 cm from the head of the DJ and 1.5 m from the front or lateral feedback speakers.

The measures were taken using the SIP 95 Aclan class 2 sound level meter fitted with an octave band filter. Sound levels equivalent Leq (A) were recorded during 1 min at three different times of the night. Octave band measurements were performed with an unweighted filter network, that is, Z (or Linear). Ten octave bands centered on 31.5, 63, 125, 250, 500, 1,000, 2,000, 4,000, 8,000, and 16,000 Hz were used for this purpose. Measurements were taken during 30 sec for each octave band.

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Study Population

To increase the number of subjects tested, we extended our recruitment over three sites: Montpellier, Toulouse, and Paris. Among the 29 DJs, 13 were tested at the Centre Amplifon of Montpellier, 8 at the Centre Audika of Toulouse, and 8 in the Meganix Record school of Paris. The control population was made up of 21 subjects tested in the same conditions, of which 11 were tested in Montpellier, 5 in Toulouse, and 5 in Paris. Control subjects have been selected based on three criteria: (1) the absence of habitual noise exposure, (2) the lack of known otologic problem, and (3) the age required to match with the age of the DJ population.

Experimental Protocol

Questionnaire • A questionnaire was used to obtain usual administrative details, weekly exposure to noise, length of time in the profession, and any known otologic problems.

Clinical examination • Otoscopy was performed on both the ears. If there was no ear pathology (e.g., TM perforation or wax blockage), tuning fork assessment (1024 Hz, Hartmann AG, Heidenheim, Germany) was undertaken. This method was chosen over the use of tympanometry because of speed. Subjects were only included if there was no evidence of conductive hearing loss on the tuning fork test.

Evaluation of Auditory Function

Pure-tone audiometry • Air conduction pure-tone audiometry was undertaken in a soundproof booth (Montpellier and Toulouse) and in a quiet room (Paris) using TDH39 earphones but different audiometers, that is, Aurical in Montpellier, Midimate 622 in Toulouse, and Intrasonic AD229e in Paris. Test procedure for hearing threshold measurements was based on the Hughson-Westlake method (up 5 dB and down 10 dB) and conforms to International Standards Organization 8253. Test frequencies were 125, 250, 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz.

Basic standard International Standards Organization 389-1, which gives reference equivalent threshold sound pressure levels for supraaural earphones in the frequency range 125 to 8 kHz, has been used for calibration of audiometers. Calibrations were performed less than 6 mo before starting the experiments.

Tinnitus measurements • For the tinnitus identification task, the audiometer was used as a synthesizer. Tinnitus pitch matching was performed using air conduction to one ear at a

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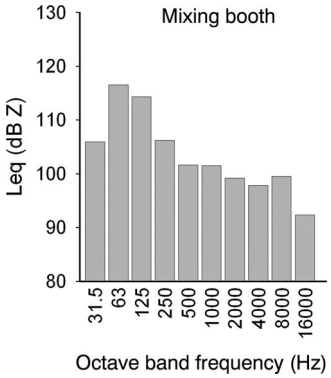

Fig. 1. Average equivalent levels Leq [dB (Z)] by octave, measured in the DJ mixing booth.

time. This method consists of quantifying the tone of the tinnitus by subjectively matching it to a noise or a pulsed pure tone, centered around a frequency presented to the contralateral ear.

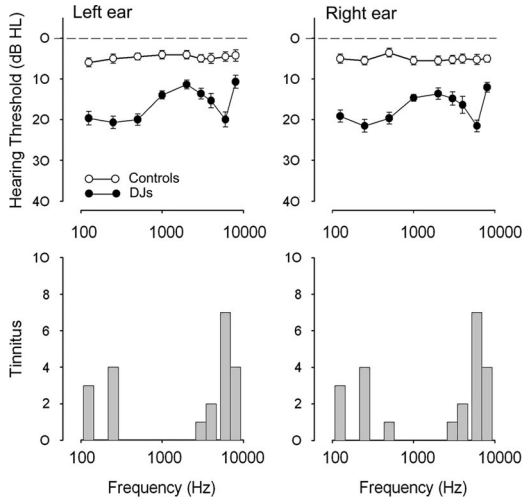

Fig. 2. Audiogram and tinnitus pitch matching in DJs and control subjects. Note the hearing losses at 6 kHz and in the low frequencies. The pitch of the tinnitus is correlated with the auditory loss.

RESULTS

Acoustic Measurements

Acoustic measurements in the DJ mixing booth showed a sound level equivalent Leq (A) of between 92.3 and 102.1 dB (A), making an average sound level of 98.7 dB (A). Figure 1 shows the average equivalent sound level (dB Z) at each octave. Note the levels in the bass frequencies: 116.5 and 114.3 dB (Z) at 63 and 125 Hz, respectively.

Audiometric Results

Demographics • Pure-tone thresholds were measured in 29 DJs. A description of the DJ population is given in Table 1. Most of the DJs were young men (26.35 ± 5.74 yr) who had worked in nightclubs for 6 yr (6.62 ± 6 yr) on average for 3 nights a week (21.58 ± 12.64 hr). The 21 control subjects were similar in age (28.71 ± 6.73 yr).

Hearing thresholds • The audiograms were undertaken in the same conditions for both DJ and control subjects. Although the control subjects had an average loss of 5 dB HL across the frequencies tested, the DJs had a high frequency hearing loss reaching 20 dB HL at 6 kHz. More surprising was a similar hearing loss in the low frequencies between 125 and 500 Hz (Fig. 2).

Tinnitus characteristics • Analysis of the questionnaire (Table 1) revealed that 75.9% of the DJs complained of tinnitus. The tinnitus was described as a high pitched whistle in 63.6% of cases and as a low pitched buzzing in 27.4%; 9% described both types. The tinnitus was perceived as coming from both ears or in the head (nonlateralized) in 88.9%. Pitch analysis of the tinnitus showed that the two thirds of tinnitus described as whistling was centered around 6 kHz, and the other third described as buzzing was centered at approximately 250 Hz.

Table 1. Description of the DJ population

Age (yr)	26.35 ± 5.74
Time spent in the profession (yr)	6.62 ± 6
Weekly exposure (hr)	21.58 ± 12.64
Subjects with tinnitus (%)	75.9
High-pitched tinnitus (%)	63.6
Low-pitched tinnitus (%)	27.4
High- and low-pitched tinnitus (%)	9
Nonlateralized tinnitus (%)	88.9

DISCUSSION

Few scientific articles describe low-frequency hearing loss in relation to exposure to amplified music. Axelsson and Lindgren (1981) report hearing losses of more than 20 dB between 3 and 8 kHz in 13% of the rock or pop musicians that they studied. Lee's study (1999) mentions hearing loss that is more frequent among the DJs (42%) than controls without detailing the frequencies affected by the hearing loss. Bray et al. (2004) report that 70% of the personnel working in nightclubs (DJs, bar staff, bouncers, etc.) have a hearing loss. Their study showed an average level of sound within the nightclubs of 96 dB (A), which is similar to our findings. However, again this study does not document the hearing loss by frequency. Finally, a recent study performed among DJs before and 12 hr after exposure to levels of music between 93.2 and 109.7 dB showed both temporary and permanent hearing losses at all measured frequencies (Santos et al. 2007).

A consensus of opinion is forming around the development of tinnitus with exposure to amplified music. A study by Nicolas-Puel et al. (2006) shows that 40% of tinnitus induced by acute sound trauma was as a result of exposure to amplified music (discos, concerts, and so on). In our study, 76% of DJs reported tinnitus. These results are similar to those of Bray et al. (2004) who described 74% of DJs as having tinnitus. In our study, the tinnitus was described as a whistling sound in 64% of cases, as a buzzing in 27%, and as both types in 9%. Tinnitus pitch matching confirms these descriptions with two-thirds of the tinnitus matching frequencies between 4 and 8 kHz, and the other third, described as buzzing, characterized between 125 and 500 Hz. These results are in accordance with studies showing that the pitch of the tinnitus generally corresponds to the predominant hearing loss frequency (Nicolas-Puel et al. 2002; Norena et al. 2002). The majority of DJs (approximately

90%) state that their tinnitus is not lateralized (i.e., it seems to be coming from both ears equally or from their head). These findings agree with those in the study by Nicolas-Puel et al. (2006), showing that exposure to acute sound trauma is associated with nonlateralized tinnitus, consistent with a symmetrical hearing loss. On the contrary, young military personnel who have been exposed to gunfire describe tinnitus that is lateralized to the side of their hearing loss (Job et al. 2004; Khalfa et al. 1997).

In conclusion, our study demonstrates that three-quarters of the DJs tested have tinnitus. The pitch of their tinnitus corresponds to the frequency of their hearing loss. Although the dip at 6 kHz is well documented in people who have had noise exposure, few studies remark on a low-frequency hearing loss.

ACKNOWLEDGMENTS

The authors thank Dr. Achour Aknine, Guy Rebillard, and Jérôme Ruel for the helpful discussions on data analysis. They also thank all the ENT department of Gui de Chauliac Hospital and the disc-jockeys who participated in this experiment.

This work was supported by Inserm.

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Received April 3, 2008; accepted September 18, 2008.

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