INTER-NOISE 2006

3-6 DECEMBER 2006
HONOLULU, HAWAII, USA

Professional musicians' hearing, their perception of risk, and attitudes regarding hearing protection

Maria Helena Mendes[a]
Universidade Tuiuti do Paraná
Rua Marcelino Champagnat, 505
Curitiba, PR 80.710-250
Brazil

Jair M. Marques[b]
Universidade Tuiuti do Paraná
Rua Marcelino Champagnat, 505
Curitiba, PR 80.710-250
Brazil

Thais C. Morata[c]
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, OH 45226
U.S.A

ABSTRACT

The objective of this study was to investigate the suitability of the use of hearing protection among the members of an instrumental and vocal band during their rehearsals and performances. The study group consisted of 34 members of the Indaial Municipal Band. Subjects answered questionnaires and underwent pure-tone audiometry. They also attended a lecture where informative folders and hearing protection was provided; subjects were asked to try using the protectors during a 3-month period. Mean sound pressure levels during a rehearsal ranged from 96.4 dB(A) to 106.9 dB(A). At the end of the study period, 56.2% reported they did not like hearing protection, while 43.7 % liked it. The most common complaints were discomfort with sounds (58.8 %) and tinnitus (47%). Seventy-seven percent reported that music might cause hearing impairment. When median audiometric thresholds were compared with those from age-matched unexposed controls, a statistically significant difference was observed in the right ear at 4 and 6 kHz and at the left ear in 3, 4 and 6 kHz. Although most subjects were aware of the risk, few took any preventive measure against the hearing risks. This suggests the need for periodic educational campaigns and specific legislation tailored to music professionals.

1 INTRODUCTION

The link between noise exposure and occupational hearing loss has been described for more than a century, but it was only in the sixties that some researchers became concerned with the effects of music on hearing (1, 2, 3). Studies have shown hearing loss in members of rock bands, symphony orchestras, nightclub bands, or even in individual musical training (4,5,6,7,8).

Hearing prevention measures for musicians have been suggested in several scientific studies such as: acoustic treatments in rehearsal spaces, audiological care, and the use of individual hearing protection amongst other things (6, 8).

In the past decade customized hearing protectors became available for musicians. These protectors permit an almost flat attenuation avoiding the effect of occlusion and sound distortion.

[a] Email address: mhmendesfono@yahoo.com.br
[b] Email address: jair.marques@utp.br
[c] Email address: tmorata@cdc.gov

The options vary from simple, molded alternatives that have one standard size, to customized protectors.

The current study aims to verify the acceptance of the use of individual hearing protection by members of instrumental and vocal bands during their rehearsals and performances.

2 METHODS

This study was realized in the city of Indaial, Brazil, with members of the Municipal Band. This band is made up of 36 members, 6 females and 30 males, with ages varying between 19 and 76 (mean age was 40 years old).

The band includes the following instruments: vocals (8 people), keyboards (1), saxophone (5), drum set and percussion (3), clarinet (2), tuba (1), guitar (1), bass (1), trombone (5), trumpet (6), flute (1), conductor (1), turntables (1). The band is a municipal band, and meets four times a month between rehearsals and performances.

Thirty four individuals agreed to participate and 28 (80%) were male and 6 (20%) were female. They were informed about all of the procedures of the study and they signed a informed consent form. The present study was approved by the Committee of Ethics of the University of Tuiuti do Parana, process number 001/2005.

Participants were asked to fill out a questionnaire containing: personal identification, type of instrument they play, the frequency of rehearsals and performances they participate, time in individual practice, previous or concomitant exposure to industrial noise, auditory complaints, family history of hearing loss, illness, use of medications, and other hearing concerns. The audiological evaluation of the members of the band was realized after they were not exposed to music or noise for fourteen hours. Pure-tone audiometry was conducted in an audiometric booth, with a MAICO clinical audiometer, model MA-41, TDH39 headphones, meeting the requirements of ISO 8253. The aim of the pure-tone audiometry was to determine the air conduction hearing in the frequencies 250, 500, 1000, 2000, 3000, 4000, 6000 and 8000 Hz, and by bone conduction in the frequencies 500, 1000, 2000, 3000, and 4000 Hz.

Eleven individuals were excluded (32.3%) of the audiometric analysis because they were exposed to other noisy professions that are not musical in nature. This left 23 individuals (67.6%) that had their auditory thresholds compared to a control group, paired up by age and gender.

The audiometric results of 23 individuals not exposed to noise were selected from the database of the Audiology Laboratory at the University of Tuiuti do Paraná for comparison purposes (14).

Sound pressure measurements were conducted by an acoustic engineer at one of the band rehearsals. The measurements were made with a sound pressure level meter model QUEST-2700, using fast response and A scale.

The reverberant rehearsal room was divided in 18 points of measure located in: P1 (maestro), P2 (return + clarinets), P3 (return + trumpets), P4 (trombones), P5 (trombones), P6 (trombones + trumpets), P7 (trumpets), P8 (trumpets), P9 (saxophones), P10 (clarinets + flute), P11 (vocals), P12 (vocals + return), P13 (vocals + return), P14 (drum set), P15 (percussion +keyboards + return), P16 (guitar + return), P17 (contrabass + return), P18 (turntables).

A lecture was presented to the musicians with information on the results of the sound pressure measurements, risks of auditory damage through periodic exposure to intense music, basic information about the anatomy and physiology of hearing, as well as orientation and

training for the use of individual hearing protection devices during the rehearsals and performances.

Members of the band were also given HPDs along with an informational pamphlet containing all of the necessary information about the use of the HPDs, information about its necessity, and information about the anatomy and physiology of hearing. The musicians were asked to use the HPDs for a period of three months. The contents of the lecture and pamphlet were elaborated by the author, and were based on materials by NHCA (*National Hearing Conservation Association*), (15, 16, 17) as well as from other authors (18, 19, 20).

The hearing protector selected was ER-20 from E.A.R. Ultratech Earplugs. These protectors were distributed to the musicians, vocalists, and turntablists, free of charge. We took the following things into consideration when selecting this hearing protector: uniform attenuation, one size fits all, easy to use, and cost.

At the end of the proposed period of three months of trying the HPDs in rehearsals and performances, the participants answered a new questionnaire applied by the main investigator to verify the use and acceptance of the hearing protectors.

3 RESULTS

The sound pressure levels in the rehearsal room ranged between 96.4 to 106.9 dB(A). The highest sound pressure was amongst the trumpets, near the trumpets and during the parts in the music where they are featured. The results of the measurements, as well as the points of measurement referred to above, as well as the averages of the obtained values can be found in Table 1.

Table 1 –Measurement points of the sound pressure levels during a band rehersal.

MEASUREMENT POINTS	SPL/dB (Peak)	SPL/dB (Mean)
P1 (Maestro)	107.9	103.6
P2 (Return Clarinets)	107.9	103.6
P3 (Return Trumpets)	107.9	103.6
P4 (Trombones)	105.8	101.6
P5 (Trombones)	106.8	103.3
P6 (Trombones/Trumpets)	110.6	104.3
P7 (Trumpets)	110.9	106.9
P8 (Trumpets)	108.8	104.3
P9 (Saxophones)	107.1	101.5
P10 (Clarinetes/Flute)	105.5	102.1
P11 (Vocals)	104.3	100.1
P12 (Return Vocals)	101.1	96.4
P13 (Return Vocals)	104.3	98.1
P14 (Drums)	104.1	102.2
P15 (Percussion/Keys/Retorno)	103.1	98.7
P16 (Guitar/Return)	104.8	101.4
P17 (Bass/ Return)	104.6	101.3
P18 (Turntables)	98.7	98.7

The auditory complaints given by the musicians, singers, and turntabalists were discomfort from some sounds (58.8%), ringing in the ear (47%), hearing loss (25.7%), and clogged ears (4%).

When they were asked if the possibility of music causing auditory damage, 27 individuals (77.1%) admitted to the possibility and 7 (20%) denied it. Also, 9 subjects (25.7%) admitted to having some hearing loss. Only 9 individuals (25.7%) indicated that they take care of their hearing in some way, and 25 (71.4%) affirmed that they take no care at all of their hearing. The most commonly mentioned precautions taken are: the use of HPD in industrial work as well as in shooting practice, the use of cotton in the ears while listening to loud music, playing their instrument quietly, walking away from loud noises.

The median thresholds in the experimental and control groups were calculated, and the Wilcoxon Test was performed for the comparison of the auditory thresholds of the experimental group and control group in the left and right ears. In considering the significance level of 5% ($\alpha = 0.05$) there is a significant difference between the thresholds in the two groups if $p < \alpha$. It indicated that musicians had significant poorer thresholds in the frequencies of 4 and 6 kHz in the right ear, and in the frequencies 3, 4, and 6 kHz in the left ear ($p < 0.05$).

The classification of the audiometric results suggest hearing loss induced by music found in the participants that were singers (2), trumpet players (3), trombone players (1), saxophone players (2) and guitar players (1).

Thirty two individuals participated in the analysis of the suitability of the use of HPDs. Two individuals were not available to respond the second questionnaire, so they were excluded form this analysis. When asked about whether or not they enjoyed using hearing protection 18 if them (56.2%) said no, while 14 (43.7%) said yes. There was no statistically significant association between these responses and age, hearing loss, or instruments played.

4 DISCUSSION

Of the 34 subjects that were part of this study, many of them have played previously or play in other musical settings, as well as other noisy professional activities, or in noisy personal activities, which contribute to hearing loss.

When asked about the possibility of music adding to hearing damage, 27 individuals (77.1%) responded affirmatively and 7 (20%) responded negatively. However, it was observed that the subjects of the study did not know how to protect their hearing even though they knew about the possibility of hearing damage through the exposure of loud music.

Analysis demonstrated significant differences between the audiometric thresholds of the experimental and control groups, suggesting the presence of hearing loss induced by music (MIHL) in the subjects exposed only to music. These findings are in agreement with past studies (24, 6, 25, 7, 26).

Of the 23 individuals exposed only to music, 12 (52.1%) showed signs of hearing loss, a higher number than the findings from a previous study with the Municipal Band of Blumenal, when 13% of the participants had some hearing loss. This was probably due to the fact that the individuals in the present study are older and have been in this profession longer, including in dance bands with amplified sound (7).

In the present study the measure of the sound pressure levels was conducted during a collective rehearsal of the band, with results ranging between 96.4 and 106.9 dB(A), with peaks up to 110 dB(A). Over-attenuation may have occurred in the present study, i.e., the hearing

protector might have offered attenuation above the needs of the musicians. Musicians' exposures depend on the duration of the performances, the location of the performances, rehearsals and individual practice time, and lifestyle amongst other factors.

When industry workers are exposed to a sound pressure level higher than 85 dB it is known that they might develop hearing loss, depending on the duration and characteristics of the exposure (28). However, it is not clear if the industrial regulations are appropriate to musicians (2,1,6).

Musicians will be exposed to music during their entire professional career, and it is fundamental that the integrity of their hearing is maintained. Any hearing loss is undesirable because depending on the severity it can make the perception of some tones and timbres difficult, which can affect the balance between the instruments (27, 30, 29).

In Brazil there is still no legislation that protects musicians from the damages done through music at loud volumes, so it is challenging to implement preventative measures for hearing loss induced by music (MIHL) to this type of professional. The lack of legal legislation about sound exposure specific for musicians can create the false assumption that this type of work environment is free of auditory risks, one time that all of the musicians would benefit from a specific standard of hearing protection (31).

Currently in Sweden two recommendations exist about occupational safety limits, which deal with noise on the jobsite and musical activities for musicians as well as listeners (22).

Many different studies have demonstrated the presence of hearing loss induced by music (MIHL), as with other hearing disorders between the musicians such as tinnitus, hyperacusis, or discomfort from loud noises amongst others (24, 21, 7, 26, 23, 29), which justify the necessity of hearing conservation programs for this population.

Prevention strategies addressing the risk of hearing loss induced by noise in this type of location can be found in the literature (23):

-Promoting health: Distribution of informative materials about hearing loss through loud music to schools and universities, music stores, shopping malls, concert producers and promoters, and medical clinics.

-Engineering controls: Limiting sound pressure levels in concerts through acoustic dampening, acoustic walls and avoiding amplifiers with excessive high frequencies.

-Education: Educational programs to sound technicians about the risks of noise and hearing loss prevention methods, and to encourage listeners to give their ears 16 hours of rest after the exposure to high sound levels.

-Individual protection: Concert promoters should offer disposable ear plugs at rock concerts. Avid rock fans should consider the use of personalized hearing protectors.

Hearing loss prevention amongst musicians continues to be a difficult goal because musicians are reluctant to wear hearing protection (26).

A study conducted with five orchestras to discover the attitudes of musicians in relation to hearing loss(29) showed that 94% of the participants were worried about some decrease of their hearing, tinnitus, pain, as well as about stress and fatigue but only 6% of the participants always used individual hearing protectors. The author argued that motivation and practice is necessary to improve the use of hearing protectors between the musicians.

In the industrial arena campaigns are becoming more and more creative, by speaking the language of the workers about their day to day hardships, as well as using strategies such as posters and plays (32).

5 CONCLUSIONS

In the present study we observed a resistance to the use of HPDs, as recently indicated by other authors (8, 29). Several of the complaints registered in the study resemble those referred to by other hearing protector users: difficulty in communication, difficulty in hearing their own instruments, a sense of isolation, occlusion effect, amongst others, despite the fact that they were provided uniform attenuation HPDs.

6 REFERENCES

[1] Schmidt JM., Verschure J, Brocaar MP. "Hearing loss in students at a conservatory". Audiology; **33**:185-94 (1994).

[2] Mcbride D, Gill F, Harrington M, Gardiner K, Attwell, C. "Noise and classical musician". British Medical Journal **305**:1561-3 (1992).

[3] Palin SL. "Does classical music damage the hearing of musicians? Review of the literature". Occupational Medicine, **44**:130-6 (1994).

[4] Russo ICP, Santos TMM, Busgaib BB, Osterne, FJV. "Um estudo comparativo sobre os efeitos da exposição à música em músicos de trios elétricos." Revista. Brasileira. de Otorrinolaringologia; **61**:477-84 (1995).

[5] Early KL, Horstman SW. "Noise exposure to musicians during practice". Applied Occupational and Environmental Hygiene; **9**: 1149-53 (1996).

[6] Samelli, AG, Schochat E. "Perda auditiva induzida por nível de pressão sonora elevado em um grupo de músicos profissionais de rock-and-roll". Acta Awho **19**: 136-43 (2000).

[7] Mendes MH, Koemler LA, Assencio-Ferreira, V. J. "A prevalência de perda auditiva induzida pelo ruído em músicos de banda instrumental". Rev CEFAC; **4**:179-85 (2002).

[8] Laitinen HM, Toppila EM, Olkinuora PS, Kuisma K. "Sound exposure among the Finnish National Opera Personnel". Applied Occupational and Environmental Hygiene; **18:** 177-82 (2003).

[9] Morata TC,Carnicelli MVF. *Audiologia e saúde dos trabalhadores*. (PUC EDUC:São Paulo, 1988).

[10] Costa , EA, Morata, TC, Kitamura, S. "Patologia do ouvido relacionada com o trabalho". In: Mendes, R. *Patologia do Trabalho*. (Atheneu:São Paulo, 2003). p. 1254-82.

[11] Arezes PM, Miguel AS. "Hearing protector's acceptability in noise environments". Annals of Occupational Hygiene; **6**: 531-6 (2002).

[12] Sterret, M. "Breaking the hearing protection barrier". Occupational Health & Safety; **71**:28-32 (2002).

[13] Fiorini AC. *Conservação auditiva: Estudo sobre o monitoramento audiométrico em trabalhadores de uma indústria metalúrgica.* [Master's degree thesis] São Paulo. Pontifícia Universidade Católica de São Paulo, 1994.

[14] Daroit, R. *Estudo do registro das emissões otoacústicas em indivíduos com limiares audiométricos normais*. [monografia]: Curitiba. Universidade Tuiuti do Paraná; 2005.

[15] NHCA, National Hearing Conservation Association. *Practical guide. Fitting hearing protection*. (Denver, USA: NHCA). http: www.hearingconservation.com

[16] NHCA, National Hearing Conservation Association. Practical guide. *Hearing loss prevention for musicians*. (Milwaukee, USA:NHCA). http: www.hearingconservation.com

[17] NHCA, National Hearing Conservation Association. Practical guide. *Selecting hearing protection.* (Denver, USA:NHCA). http: www.hearingconservation.com
[18] Gerges SNY. “Protetores auditivos: recomendações para seleção, uso, cuidado e manutenção”. Revista CIPA; **236**:20 (1999).
[19] Gerges SNY. “Protetores auditivos para músicos”. Revista CIPA **282**:76. (2003).
[20] Graciolli LS. *Desenvolvimento de uma estratégia para o uso correto de protetores auditivos em músicos.* [Qualifying exam, doctoral degree] Florianópolis: Universidade Federal de Santa Catarina; 2003.
[21] Marchiori LLM, Melo JJ. “Comparação das queixas auditivas com relação à exposição ao ruído em componentes de orquestra sinfônica”. PRÓ-FONO; **13**:9-12. (2001).
[22] Kähäri KR, Zachau G, Eklöf M, Sandsjo L, Müller, C. Assessment of hearing and hearing disorders in rock/ jazz musicians. International Journal of Audiology; **42**: 279-88 (2003).
[23] Bogoch II. House RA, Kudla I. Perceptions about hearing protection and noise-induced hearing loss of attendees of rock concerts. Canadian Journal of Public Health; **1**: 69-72. (2005).
[24] Antoniolli FB. *Perfil audiométrico x banda de música – um estudo de caso*.[monografia] Itajaí: Centro de Especialização em Fonoaudiologia Clínica – CEFAC; 2000.
[25] Andrade AIA, Russo ICP, Lima, MLLT, Oliveira, LCS. Avaliação auditiva em músicos de frevo e maracatu. Revista Brasileira de Otorrinolaringologia; **5**: 714-20, (2002).
[26] Juman S, Karmody CS, Simeon D. Hearing loss in steelband musicians. Otolaryngology-Head and Neck Surgery ; **131**:461-5 (2004).
[27] Royster JD, Royster LH, Killion MC. Sound exposures and hearing thresholds of symphony orchestra musicians. Journal of the Acoustical Society of America; **89:** 2793-803 (1991).
[28] Russo ICP. “Ruído, seu efeitos e medidas preventivas”. In: *Acústica e psicoacústica aplicada à fonoaudiologia*. (Editora Lovise: São Paulo, 1993). p. 123-38.
[29] Laitinen H. Factors affecting the use of hearing protectors among classical music players. Noise & Health; **7**: 21-9. (2005).
[30] Teie, PU. “Noise-induced hearing loss and symphony orchestra musicians: risk factors, effects and managements”. MMJ; **47**:13-8 (1998).
[31] Owens DT. Sound Pressure levels experienced by the high school band director. Medical Problems of Performing Artists, 109-15 (2004).
[32] Viegas, C. Melhorando a eficiência. Revista Proteção, **148**:37-54. (2004).