

The risk of musicians' high sound exposure during performances of classical music

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Abstract

When playing instruments, musicians are exposed to loud sounds that can increase the risk of music-induced hearing loss (MIHL). The purpose of this study was to measure the sound exposure for a group of musicians playing classical music, and to examine how this exposure varies with the type of musical activity. Sound level was measured for a group of musicians using dual-channel noise dosimetry, with microphones attached near the right and left ear. The measurements were performed during individual practice and playing in musical ensembles. The equivalent sound level L_{Aeq} and daily sound exposure $L_{EX,8h}$ were measured separately for the right and left ear. In 74% of the measured samples the daily sound exposure ($L_{EX,8h}$) exceeded 85 dB. The data indicated a significant risk of music-induced hearing loss in musicians performing classical music, especially when playing the flute, violin, viola, trombone, and saxophone. Musicians playing violin, viola, flute, and harp experienced asymmetric sound exposure with significant difference between the right and left ear.

Keywords: sound exposure, music-induced hearing loss, noise dosimetry

1. Introduction

Musicians' exposure to high-level sounds during daily rehearsals and performances can lead to temporary and permanent hearing problems, even including noise-induced hearing loss (NIHL). Harmful sound pressure levels, although mainly associated with unwanted and unpleasant sounds, also occur during the daily work of musicians performing either classical and popular music [1-3] and can be as damaging to hearing as industrial noise [4].

When music is the cause of hearing loss, it is referred to as music-induced hearing loss (MIHL). A number of papers in the literature indicate that musicians are exposed to high-level sounds both when playing an instrument individually [5, 6] and when playing in chamber ensembles and orchestras [7, 8]. Most data focused on examining the risks associated with only one type of musical activity, most commonly playing in a large symphony orchestras, while there are few studies that take into account variety of musical activity as well as their duration throughout the day. The purpose of this study was to

conduct sufficiently comprehensive measurement of musicians' exposure to sound, taking into account the variety of activities in which musicians can participate.

2. Methodology

The study was conducted with the participation of twenty-seven students from the Fryderyk Chopin University of Music in Warsaw (UMFC), playing: flute (1 person), clarinet (2), saxophone (1), French horn (2), trumpet (4), trombone (5), tuba (1), violin (3), viola (1), cello (2), double bass (1), harp (2) and percussion instruments (2).

The musicians indicated the most typical days in terms of the number of hours spent at the university and the type of activities performed. Sound pressure level was measured with the use of two dual-channel noise dosimeters (Svantek SV 102+), meeting the requirements of Class 2 sound level meters, equipped with SV 25D measurement microphones, which were calibrated before each measurement. On designated days, musicians were equipped with the dosimeter whose microphones were mounted on musicians' shoulders, approximately 10-15 cm from their ears, symmetrically on both sides of the head. For such instruments as violin, viola, harp, and trombone, the microphones were placed on the back of the arm due to the need to maintain the comfort of the musician playing. The dosimeters recorded the A-weighted equivalent continuous sound pressure level averaged over each second of measurement, which was saved to a result file. Further data analysis was performed using SvanPC++ and Matlab software. The A-weighted equivalent continuous sound pressure level L_{Aeq} recorded within one-second intervals was then used to calculate the daily sound exposure level, i.e., the A-weighted noise exposure level normalized to an 8-hour working day ($L_{EX,8h}$) and represented musician's exposure to sound during full day of activities.

3. Results

The daily sound exposure level $L_{EX,8h}$ is the major parameter used in the evaluation of the occupational hearing loss risk. At the workplace, $L_{EX,8h}$ must not exceed 85 dB [9]. In this study, for each musician playing different instrument, the value of $L_{EX,8h}$ was determined for each day of their activity. Depending on particular person the measurement included one to seven days.

The daily sound exposure level $L_{EX,8h}$ exceeded the permissible value of 85 dB for 31 out of 42 days (74%) on which measurements were conducted. In more detail, the $L_{EX,8h}$ values of 85-90 dB and

90-95 dB occurred at the highest rate of 24% and 40%, respectively (Figure 1). In 7% of the measured days, the $L_{EX,8h}$ values were in 95-100 dB range, and in 2% (i.e., one day), exceeded 100 dB. It is remarkable that the $L_{EX,8h}$ levels were below 85 dB for relatively small fraction (26%) of the measurement days.

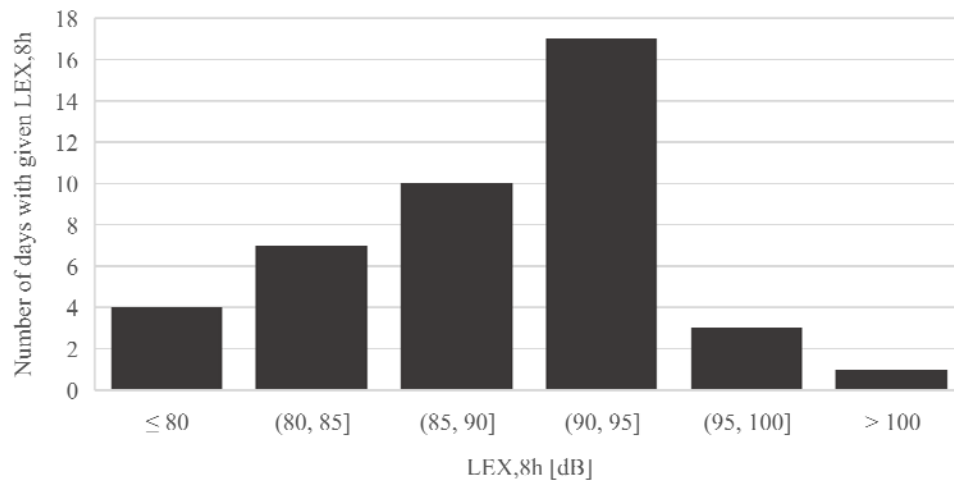


Figure 1. Histogram of the $L_{EX,8h}$ values

Figure 2 shows values of L_{Aeq} recorded for each instrument at different activities. In most cases, the highest L_{Aeq} were found during musicians' individual practice. The highest values of 104.9 dB and 103.5 dB were measured in solo flute and violin playing. Smaller but still significant values of 95 were observed for musicians playing the violin, trumpet, and harp. Playing percussion, trombone, French horn and clarinet produced levels exceeding 90 dB. This shows that individual practice can be an important component of musicians' daily sound exposure.

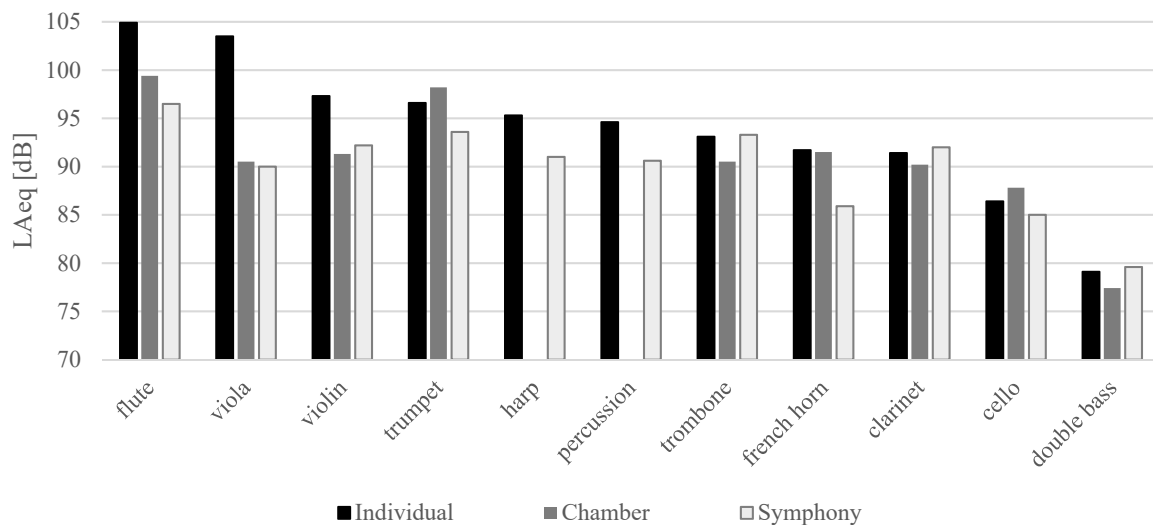


Figure 2. A-weighted equivalent continuous sound pressure level (L_{Aeq}) during individual practice, playing in chamber ensembles and symphony orchestra

Playing in chamber ensembles, was associated with the highest L_{Aeq} experienced by flutists (99.4 dB) and trumpeters (98.2 dB). For musicians playing French horn, violin, trombone, viola, and clarinet, the L_{Aeq} levels were lower but still exceeding 90 dB. As is the case of individual playing the lowest L_{Aeq} values occurred for cellists and double bass players. Playing in symphony orchestra was associated with the highest L_{Aeq} of 96.5 dB for flutist. The L_{Aeq} values exceeded 90 dB for musicians playing trumpet, trombone, violin, clarinet, harp and percussion.

Analysis of the differences in L_{Aeq} levels between the right and left ears are shown in Figure 3. Positive values indicate that the right ear was more exposed than the left ear. This was the case for harp, flute, French horn, percussion, double bass and saxophone players. Negative values in Figure 3 occurring for viola, violin, tuba, clarinet and trombone mean that the left ear was more exposed to sound than the right ear. However, significant interaural L_{Aeq} differences were observed for viola, violin and harp, and to a lesser extent flute players. In the case of other instruments the interaural difference in L_{Aeq} was less than 2 dB and cannot be considered significant.

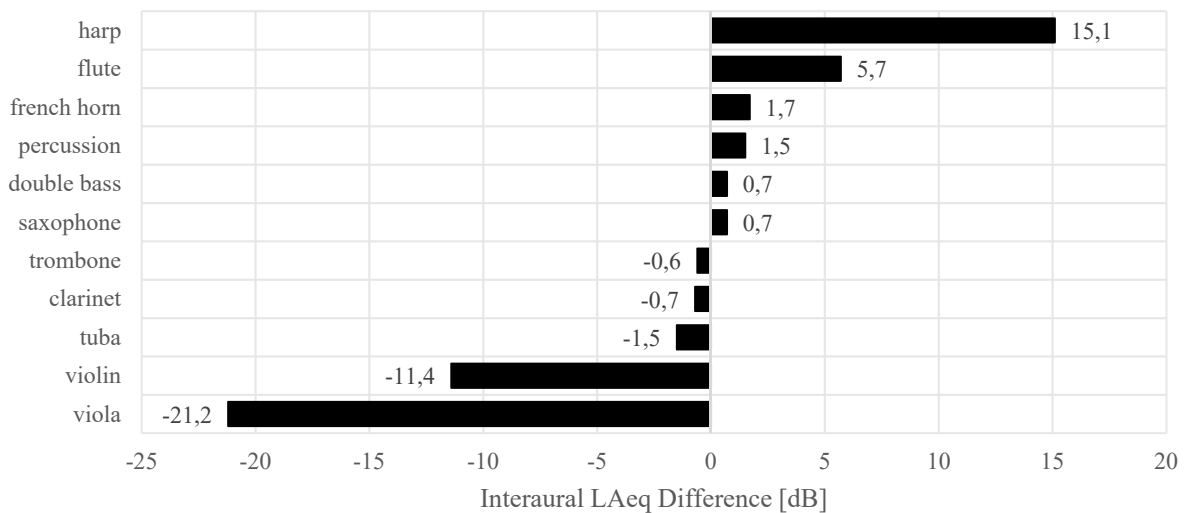


Figure 3. Interaural differences in A-weighted equivalent continuous sound pressure level, L_{Aeq} ; positive and negative values indicate respectively more exposed right or left ear

4. Conclusions

This study analyzed the sound exposure of musicians during individual practice, playing in chamber ensembles and in symphony orchestra. Obtained musicians' daily sound exposure level ($L_{EX,8h}$), calculated from the equivalent sound level L_{Aeq} measured using noise dosimetry, can be considered as affecting their hearing for the majority of conditions.

Although musicians devoted an average of 4 hours per day to professional musical activities, yet the 85 dB value of the $L_{EX,sh}$ level was exceeded in 74% of occurrences. The sound generated by many instruments was of such a high SPL that even within a short exposure time (as compared to an 8-hour work day) the sound dose to which musicians were exposed was significant.

The highest L_{Aeq} were recorded during individual practicing. This indicates that this important activity in every musician curriculum is a significant threat to hearing. For flute and viola L_{Aeq} during individual practice exceeded 100 dB, for violin, trumpet and harp values were greater than 95 dB.

Significant asymmetry of L_{Aeq} between the right and left ears was recorded for harp, flute (right ear more exposed), violin and viola (left ear more exposed), which is related to the way the instrument is held, at close proximity to the right or left ear.

References

- [1] Obeling L, Poulsen T. Hearing ability in Danish symphony orchestra musicians, *Noise and Health*. 1999;1(2):43.
- [2] Kähäri K, Zachau G, Eklöf M, et. al. Assessment of hearing and hearing disorders in rock/jazz musicians. *International Journal of Audiology*. 2003;42(5):279-288.
- [3] O'Brien I, Wilson W, Bradley A. Nature of orchestral noise. *Journal of the Acoustical Society of America*. 2008;124(2):926-939.
- [4] Chasin M. Musicians and the Prevention of Hearing Loss, Audio Engineering Society Conference, 2018, AES International Conference on Music Induced Hearing Disorders.
- [5] O'Brien I, Driscoll T, Ackermann B. Sound exposure of professional orchestral musicians during solitary practice. *Journal of the Acoustical Society of America*. 2013;134:2748-2754.
- [6] Phillips SL, Mace S. Sound level measurements in music practice rooms. *Music Performance Research*. 2008;2:36-47.
- [7] Royster JD, Royster LH, Killion MC. Sound exposures and hearing thresholds of symphony orchestra musicians. *Journal of the Acoustical Society of America*. 1991;89(6):2793-2803.
- [8] Schmidt JH, Pedersen ER, Juhl PM, et al. Sound Exposure of Symphony Orchestra Musicians. *Annals of Occupational Hygiene*. 2011;55(8):893-905.
- [9] Regulation of the Minister of Family, Labour and Social Policy of 12th June 2018 on the Maximum Admissible Concentrations and Intensities of Harmful to Health Agents in the Working Environment (Dz. U. No 1286).