

Preventing Hearing Loss in University Schools of Music

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[Walter, J. S.](#), [Mace, S. T.](#), & [Phillips, S. L.](#) (2008). *Preventing Hearing Loss*. Published Proceedings from the National Association of Schools of Music 2006 Annual Meeting, Chicago, Illinois.

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Faculty and students in schools of music spend major portions of their time in environments (e.g., practice rooms, rehearsal rooms, and teaching studios) with sound levels that may put them at risk of noise-induced hearing loss (NIHL). NIHL is caused by exposure to loud sound levels, typically for prolonged and/or repeated periods of time. NIHL is characterized by a sharp decrease in hearing sensitivity between 3000-6000 Hz, called a noise notch, with a return to better sensitivity at the frequencies above the notch. The National Institute of Occupational Safety and Health (NIOSH) defines acoustic overexposure with a time/intensity trade-off. NIOSH recommendations state that 85 decibels (dB) is a sound level sufficient to warrant a hearing protection program. Their recommendations suggest that an individual may be exposed to 85 dB for 8 hours without risk to hearing damage, which is equal to a 100% dose of noise for that day. For every 3 decibels increase in intensity, the time allowed for exposure is cut in half. Anything over a 100% dose per day exceeds the NIOSH guidelines for noise exposure and may put someone at risk for noise-induced hearing loss. The following studies were undertaken with music students and faculty members to determine the amount of noise exposure musicians were experiencing in their daily routines.

Sound Levels Experienced by Student Musicians in Practice Rooms and Measurement of Student Hearing Thresholds

Initial concern was raised as to sound levels experienced by student musicians, leading to the measurement of sound levels in the student practice rooms. These rooms are relatively new and have been constructed with sound-absorbing panels. Results indicated that sound levels in the practice rooms for all instrument groups exceeded the 85 dB at which a hearing protection program would be mandated by industry. Means for some students were above 94 dB, which would be a safe level for less than 1 hour per day. Some students received approximately 36% of allowable exposure in 50 minutes; this does not include normal daily practice of two hours per day or ensemble rehearsal time.

Measurement of student hearing thresholds was then undertaken and has been conducted on a volunteer basis for three years. Consistent findings are that 52% of students have a least a mild notch in their hearing sensitivity at 6000 Hz, with a maximum notch depth of 45 dB. More students have notches in the right ear than left ear; only 13.5% have bilateral notches. Over the three years the number of students with notches at 4000 Hz has risen dramatically, from 2% the first year to 30% the 3rd year. Of students who volunteered more than one year, half had noise notches and half of those students experienced a decrease in hearing sensitivity between years. Noise exposure, outside of music-study activities, does not appear to differ between the students with and without NIHL.

This appears to be an excellent example of an interaction between inherent susceptibility through genomic and environmental influences. In year three we asked students to indicate family history of hearing loss and have found, for example, that 7/10 trumpet players with a notch have a family history of hearing loss while 2/3 who do not have a notch do not have a

family history. All cello and bass players with notches have a family history while all without do not.

The next study, for which pilot data is now being collected, will examine the genetic bases of NIHL in music students. Students will have personal measurements of sound level exposure and will have DNA collected by cheek swabs. Music students are an ideal population for a genetic study. Music students are young and have relatively limited exposure to outside noise or chemicals. There is no confounding variable with aging effects on hearing as there are in industrial populations. Exposure to music is intermittent and not as severe as industrial noise exposure, and has been found to cause less threshold shift than industrial noise (Strasser, Irle, & Legler, 2003). This means that students who are showing signs of NIHL may be particularly susceptible. Several genes may be involved and may interact. The long-term goal of the project is to personalize preventive hearing health care.

Sound Levels Experienced by Students in Concert Bands

After considering students' practice room experiences and hearing thresholds, interest was heightened related to the other activities music majors experienced either daily or weekly. A project was undertaken to collect data from students participating in concert bands – specifically to determine the doses of noise students were receiving while participating in band, and whether students' chosen instrument and location within the rehearsal space made a difference in students' noise exposure.

Subjects were 45 undergraduate and graduate students participating in three university bands. Subjects played various instruments within the ensemble and were measured with personal noise dosimeters (doseBadges) across one typical week of rehearsals. Group A ($n = 16$) contained 59 members and rehearsed four days each week for 50 minutes each day. Subjects in

Group A experienced between 26-235% dose of noise, with the highest dosages of noise occurring in the brass sections (trumpet, horn, trombone, tuba). Group B ($n = 14$) contained 68 members and rehearsed two days each week for 75 minutes each day. Subjects in Group B experienced between 47-296% dose of noise, with the highest dosages of noise occurring in the alto saxophone, trumpet, horn, and trombone sections. Group C ($n = 15$) contained 76 members and also rehearsed two days each week for 75 minutes each day. Subjects in Group C experienced between 35-168% dose of noise, with the highest dosages of noise occurring in the bassoon, trumpet, and trombone sections.

Sound Levels Experienced by High School Marching Band Members During Band Camp

Although the following data were collected with high school students, it may be reasonable to assume that college and university marching band sound levels would be as high or higher. Thus, this information is applicable. A pilot study was undertaken to determine whether students participating in a high school marching band were at risk for noise-induced hearing loss during a typical, five-day summer band camp. There were approximately 100 members in the marching band and 16 subjects participated in the pilot study, wearing personal noise dosimeters (doseBadges). The marching band met for five days from 8 a.m. to 6 p.m. for indoor and outdoor rehearsals with breaks for water and lunch. Subjects were measured for two days of this five-day experience.

After a preliminary descriptive analysis, results indicate that on the first day of data collection, 15 of 16 subjects experienced noise doses in excess of 500% (100% is the maximum allowable dosage). On the second day of data collection 15 of 16 subjects experienced noise doses in excess of 300%. Specifically, a student playing the snare drum experienced the highest levels of noise on both days at 3,925% on day one and 1,866% on day two. A color guard

member experienced the lowest levels of noise on both days at 27% on day one and 23% on day two. Data from the other fourteen subjects ranged from 504-2302% exposure during day one and 316-1341% exposure during day two.

Sound-Level Exposure of Public School Music Teachers

Many undergraduate music majors choose to become schoolteachers. As wonderful and fulfilling a profession as teaching is, teachers may be at risk for NIHL due to teaching activities. To determine whether these teachers are at risk of NIHL, a study involving 19 music teachers at the elementary, middle, and high school level was conducted. The teachers wore a personal sound dosimeter (doseBadge) for two days, which recorded the average sound level of exposure and reported a daily sound dose percentage.

Daily sound doses ranged from 6% to 261%. Elementary teachers experienced sound exposure resulting in doses from 6% to 26%. Middle school choral/general teachers experienced sound exposure resulting in doses from 16% to 133%. One of the teachers used drumming to teach the curriculum, which produced the greatest sound-level averages in this group. High school choral teachers experienced sound exposure resulting in doses from 18% to 134%. Upon further investigation, the dose of 134% was reported to be an unusually loud day, and not experienced on a regular basis. Middle school instrumental teachers experienced sound exposure resulting in doses from 31% to 207%. In this group, the low doses were unusual, with the median exposure being 143%. High school instrumental teachers experienced sound exposure resulting in doses from 101% to 261%. Clearly, some of these music teachers are at risk of NIHL because of their chosen profession. Sound treatment of the rooms in which they teach may reduce sound exposure. The use of earplugs would definitely reduce exposure. In fact, use of earplugs with the least amount of noise reduction commercially available (9 dB) would result in less than 100% dose for all participants in this study.

Sound-level Exposure of University Music Performance Teachers

An acute sense of hearing is essential for music teachers while teaching individual lessons and classes, rehearsing, and performing. Although these teachers are likely to enjoy their jobs, it's likely that some of them are at risk for NIHL due to teaching activities and job-related responsibilities. Thirty-seven studio teachers, conductors, and accompanists wore doseBadges for two days to determine whether they experience sound levels that place them at risk for NIHL. Daily sound doses ranged from 2% to 727%. Group averages revealed that accompanists and teachers of brass, percussion, jazz conducting, voice, woodwinds, and two staff accompanists are at risk for NIHL. Sound levels for individuals indicated that all brass teachers are at risk, whereas percussion teachers, jazz conductors, and accompanists have a 50% chance of being at risk for NIHL. Woodwind and voice teachers have a 33% and 42% risk of NIHL, respectively. According to measurements of two days, teaching groups including instrumental conducting, choral conducting, strings, and keyboards were not at risk for NIHL. The use of earplugs with the least amount of noise reduction commercially available (9 dB) would result in less than 100% dose for all participants in this study.

Conclusions

Because hearing health is of the utmost importance to musicians and music teachers, education for hearing conservation is needed. Two practical strategies for individuals to reduce sound exposure are maintaining the greatest distance possible from sound sources while still being an effective musician and teacher and, when appropriate, allow for rest periods from intense sounds. Maintaining distance from loud sounds and scheduling rest periods will allow musicians and music teachers to reduce their sound exposure, thereby reducing their risk for noise-induced hearing loss. Among the university performance teachers, for example, one faculty member reported that when students came in for their lesson, they tended to move closer and closer to the performance teacher. By the end of the

day, the student and the teacher were much closer together in the room, thereby exposing the performance teacher to greater levels of sound. Adding tape to the floor to indicate where music stands, chairs, and other equipment must remain may help teachers prevent noise exposure from this type of situation.

Another practical strategy includes using wall treatments such as sound panels or heavy curtains in the studios, practice rooms and rehearsal spaces. Consider using sound-absorbing panels made of thick fabric and batting, heavy velvet drapes, or even tapestries to absorb excess sound. Remember that these panels and drapery must remain unadorned with photographs, papers, framed diplomas and the like in order to be effective.

Lastly, musicians and music teachers should consider the use of earplugs. Although the use of earplugs is not particularly appealing to musicians and music teachers, it remains the most efficient and customizable form of hearing protection available.

Currently, many schools offer inexpensive (\$.15 - \$.25) foam earplugs for use in rehearsal rooms. Inserted properly, these earplugs offer approximately 29 dB reduction. Because foam earplugs reduce high frequencies to the extent that timbre perception is affected greatly, they are an option best suited for drumming and drum set musicians. For further prevention of hearing loss, foam earplugs are must for all musicians during use of loud machines and when near intense impact sounds (e.g., lawnmowers, vacuum cleaners, leaf blowers, hammering).

Another inexpensive (\$12) type of earplug is the Etymotic ETY-PLUGS, also known as ER-20s. When fully inserted, these earplugs offer approximately 20 dB reduction. What makes these different from the foam earplugs is that they are designed to attenuate frequencies similar to that of the auditory canal. This design results in timbre perception much more acceptable than when using foam earplugs.

Of all earplugs, the most accurate and true timbre perception is experienced with custom musician's earplugs. Because these earplugs are made for each individual, an ear mold made at the office of a hearing professional is required. The cost of these earplugs (including the ear mold) is approximately \$120. Compared to the cost of a music instrument, private instruction, and college tuition, this option remains relatively inexpensive. Other than providing close to a flat response (attenuation near that of unplugged ear), users of this plug have the option of purchasing more than one set of filters, thus having the option of changing the amount of dB reduction. At the time of this writing, Etymotic Research produces 9 dB, 15 dB, and 25 dB filters for custom musician's earplugs, which would be sufficient for nearly any musical situation.

Hearing protection is an issue that must be addressed at all levels of music instruction. As musicians and music teachers, our livelihood can depend on our ability to hear. An even more critical issue is that our quality of life will be reduced if the protection of hearing is not addressed in an effective manner. Whether the argument is focused on timbre perception or monetary cost of hearing protection, the answers are that there is no acceptable amount of hearing loss for musicians, nor can one buy back their ability to hear and enjoy the music they so love to create.

Selected References

Strasser, H., Irle, H., and Legler, R. (2003). Temporary hearing threshold shifts and restitution after energy equivalent exposure. *Noise and Health* 20, 75-84.