Prevalence of Hearing Loss in Teachers of Singing and Voice Students

***Mitchell J. Isaac, †Deanna H. McBroom, *Shaun A. Nguyen, and *Lucinda A. Halstead,** *†*Charleston, South Carolina*

Summary: Objectives. Singers and voice teachers are exposed to a range of noise levels during a normal working day. This study aimed to assess the hearing thresholds in a large sample of generally healthy professional voice teachers and voice students to determine the prevalence of hearing loss in this population.

Study Design. A cross-sectional study was carried out.

Methods. Voice teachers and vocal students had the option to volunteer for a hearing screening of six standard frequencies in a quiet room with the Shoebox audiometer (Clearwater Clinical Limited) and to fill out a brief survey. Data were analyzed for the prevalence and severity of hearing loss in teachers and students based on several parameters assessed in the surveys. All data were analyzed using *Microsoft Excel* (Microsoft Corp.) and *SPSS Statistics Software* (IBM Corp.).

Results. A total of 158 participants were included: 58 self-identified as voice teachers, 106 as voice students, and 6 as both. The 6 participants who identified as both, were included in both categories for statistical purposes. Of the 158 participants, 36 had some level of hearing loss: 51.7% of voice teachers had hearing loss, and 7.5% of voice students had hearing loss. Several parameters of noise exposure were found to positively correlate with hearing loss and tinnitus ($P < 0.05$). Years as a voice teacher and age were both predictors of hearing loss ($P < 0.05$).

Conclusions. Hearing loss in a cohort of voice teachers appears to be more prevalent and severe than previously thought. There is a significant association between years teaching and hearing loss. Raising awareness in this population may prompt teachers and students to adopt strategies to protect their hearing.

Key Words: Noise-induced hearing loss–Noise exposure–Sensorineural hearing loss–Singers–Voice teachers.

INTRODUCTION

Voice teachers' ability to hear is extremely important for their teaching and performance careers. Singers and voice teachers need to be able to consistently rely on the accuracy of their hearing at all audible frequencies, more so than the general population. When a student pays a teacher for a lesson, the student is really paying for the teacher's keen hearing and years of experience, which allow the teacher to use what he or she hears to make the student a better singer. In addition, to be able to perform to their full potential, singers and voice teachers need to be able to hear themselves, the music, and others singing around them with extreme accuracy. A hearing deficit of any degree could be detrimental to their careers.

Singers and voice teachers are exposed to a wide variety of noise levels throughout a normal working day for the majority the year, often for many consecutive years. It has been found that choral singers can experience noise levels of up to 110 dB and are often exposed to sound pressure levels ranging from 86 dB to 98 dB.[1,2] Another study showed that a choral singer can be exposed to 99 dB for approximately 1 hour and a peak noise level of 105 dB.[3] The National Institute for Occupational Safety and Health recommends a noise exposure limit of 85 dB over an 8-hour time period. For every 3 dB increase in noise exposure, the time limit should be halved. In contrast to the National Institute for Occupational Safety and Health's recommendations, the current Occupational Safety and Health Administration's permissible exposure limit in an occupational setting is 90 dB over an 8-hour time period, 92 dB over a 6-hour time period, 95 dB over a 4-hour time period, ascending to a limit of 115 dB over 15 minutes.[4]

Hearing loss in general can be divided into two broad categories: conductive hearing loss and sensorineural hearing loss. Conductive hearing loss originates in the external or middle ear and stems from a disruption in energy conduction from the tympanic membrane to the oval window. Sensorineural hearing loss, on the other hand, typically originates in the inner ear and stems from pathology of the cochlea or cochlear nerve. Occupational hearing loss, which includes noise-induced hearing loss (NIHL), is sensorineural. NIHL can be caused by sudden exposure to a very loud sound or, most commonly, by prolonged exposure to high intensity noise over many years. NIHL is always irreversible but will cease to progress when the cause is eliminated. It most commonly affects higher frequency hearing. Hearing loss that musicians, instrumentalists, and singers might experience because of noise exposure would be considered NIHL. There is some documented evidence of a genetic component to hearing loss, which may explain variations in the susceptibility to NIHL in the general population.[5–9]

The prevalence of hearing loss in the general population is well documented in the current literature. In the Beaver Dam Offspring Study, Nash et al[10] analyzed the prevalence and risk factors for hearing impairment (HI) in middle-aged adults. Overall prevalence of HI was 14.1%, with increasing percentage of hearing loss in older populations. Nash et al defined HI as a pure tone average (PTA), including the frequencies 0.5, 1.0, 2.0, and 4.0 kHz, greater than 25 dB hearing level in either ear. Agrawal et al[11] investigated the prevalence of both speech frequency hearing loss (SFHL) and high frequency hearing loss (HFHL) in a randomly selected population from the United States. They found

Accepted for publication October 5, 2016.

Presented at the 45th Annual Symposium: Care of the Professional Voice, Philadelphia, PA, June 4, 2016.

From the *Department of Otolaryngology—Head and Neck Surgery, Medical University of South Carolina, Charleston, South Carolina; and the †Department of Music, College of Charleston, Charleston, South Carolina.

Address correspondence and reprint requests to Lucinda Halstead, Department of Otolaryngology—Head and Neck Surgery, Medical University of South Carolina, 135 Rutledge Ave., MSC 550, Charleston, SC 29425. E-mail: halstead@musc.edu

Journal of Voice, Vol. 31, No. 3, pp. 379.e21–379.e32

0892-1997

http://dx.doi.org/10.1016/j.jvoice.2016.10.003

overall prevalence of SFHL and HFHL of 16.1% and 32%, respectively. They defined SFHL as a PTA (0.5, 1, 2, and 4 kHz) of 25 dB or higher in either ear and HFHL as a PTA of 25 dB or higher for 3, 4, and 6 kHz.

In contrast to the general population, fewer studies have investigated NIHL in musicians and instrumentalists, choir singers, and general singers. Halevi-Katz et al[12] investigated NIHL in professional pop/rock/jazz musicians and found significant positive correlations between hearing loss and musical experience, years playing, and hours playing per week. When controlling for years playing, hours playing per week was most contributory to hearing loss. There was also a significant positive correlation between musical experience and sporadic tinnitus. In predicting hearing threshold deficits, more musical experience was associated with poorer hearing thresholds. Hours of exposure per week were more contributory than years of exposure in predicting hearing threshold deficits.

Dudarewicz and colleagues[13] investigated temporary changes in hearing in orchestral students after rehearsal via transient-evoked otoacoustic emissions (TEOAEs). This is a more sensitive test for hearing function according to Libbin.[11] After rehearsal, participants had a statistically significant reduction in TEOAEs for the 2-kHz and 3-kHz frequencies. The authors also tested noise levels during the rehearsal and found peak sound levels to reach 135 dB and continuous sound pressure levels up to 90 dB. Similar results for reduction in TEOAEs were found in the study conducted by Libbin,[14] including additional frequencies.

Phillips et al[15] analyzed NIHL in student musicians. The prevalence of NIHL in at least one ear was found to be 45%, consistent with the range of 33%–50% found by other studies of classical musicians, although most studies report data from older populations than this study. Based on their data, the authors surmise that noise-induced threshold notches occur at a younger age. The 6-kHz frequency was most common for a notch to appear in this study population. Bilateral NIHL was observed in 11.5% of all tested subjects.

Schink et al[16] studied the risk of developing hearing deficits in musicians. The incidence for NIHL among musicians was 3.51-fold higher than the general population, and the incidence rate for tinnitus was 1.45-fold higher for musicians. These results also showed a hazard ratio of 1.45 for hearing loss, 3.61 for NIHL, and 1.57 for tinnitus in professional musicians.

Most studies examining hearing loss in musicians demonstrate at least some statistically significant higher rate of hearing loss than in the general public. Schmidt et al,[17] in contrast, looked at hearing loss in students at a conservatory and found no statistically significant difference in hearing thresholds between the music students and the control group. There are two important studies analyzing hearing loss in singers, including professional choral singers and general singers. Steurer et al[1] studied hearing loss in professional choral singers. Their study population included 62 singers. Unlike the vast majority of other studies investigating NIHL, this study found hearing loss to be more prominent in lower frequencies, most notably permanent threshold shifts at 250 Hz. A commonly accepted explanation for a finding of unexpectedly high hearing thresholds in lower frequencies is excessive ambient noise levels in the testing environment. The only group found to have both low frequency hearing loss and HFHL included the 30- to 39-year age group. The authors attributed this inconsistent finding to possible exposure to recreational noise. However, this study did not include an age-matched control group, and there was a discrepancy in the inclusion criteria between the control group and the experimental group.

Hu et al[18] conducted a retrospective case cohort study that included 172 singers with an average age of 44.7 years who presented to the office with other singing-related injuries. Of these singers, 17.5% demonstrated hearing loss. Age, male gender, years singing, and baritone voice all showed a statistically significant positive association with hearing loss. Bilateral sensorineural hearing loss was the most common type of hearing loss found in the study. Of note, singers in the study who were found to have hearing loss did not have a notch at 3–6 kHz with a recovery at 8 kHz as is typically seen in NIHL.

It has been shown time and time again, through many studies, that excessively high levels of noise exposure over long periods of time can lead to NIHL. One study explored the general population's attitudes toward NIHL and the effects of knowledge of one's own hearing status, and education about NIHL on attitudes toward NIHL and the use of hearing protection. This study found that neither knowledge of one's hearing status nor personal experience of hearing-related symptoms significantly affect behaviors, such as the decision to use hearing protection. The only experience significantly associated with behavior change and an increase in use of hearing protection was hearing education.[19] There has been one good study, a randomized control trial, which looked at the effectiveness of earplugs on preventing hearing damage. They found that wearing earplugs to a rock concert did indeed result in a decrease in transient threshold shifts.[20]

Consistently it has been shown that excessively high levels of noise exposure over long periods of time can lead to NIHL. We hypothesize that singers and voice teachers have a high prevalence of HFHL because they are exposed to noise levels that exceed the acceptable limits. A career as a singer or voice teacher implies continuous exposure to piano and orchestral accompaniment and exposure to high sound pressure levels from ensemble singing. Although no formal study has looked at this issue, many long-time voice teachers and their students endorse auditory symptoms such as tinnitus and subjective loss of hearing. Objectively, we aim to assess the levels of hearing loss and factors associated with hearing loss in this population.

MATERIALS AND METHODS

This prospective cross-sectional study was approved by the institutional review boards at the Medical University of South Carolina and College of Charleston. The subjects for this study were all generally healthy professional singing teachers and voice students participating in a State and Mid-Atlantic Regional Competition of the National Association of Teachers of Singing (NATS) held on February 20, 2016 and March 18 and 19, 2016, respectively, at the College of Charleston in Charleston, South Carolina. The state competition included singers and voice teachers from South Carolina; the regional competition included singers and voice teachers from South Carolina, North Carolina, Virginia, Maryland, and Washington, D.C.