**Prevalence of Hearing Loss among Noise-Exposed Workers within the Construction Sector, 2010-2019**

**Presenters and Co-Authors:** Masterson, Elizabeth (Primary Presenter)

**Background:** The purpose of this study is to estimate the prevalence of hearing loss among noise-exposed U.S. workers within the Construction sector.

**Methods:** Audiograms for 1.6 million workers (29,185 within Construction) from 2010-2019 were examined. Prevalence and adjusted risk for hearing loss as compared with a reference industry (Couriers and Messengers) were estimated for the Construction sector and sub-sectors, and all industries combined.

**Results:** The prevalence of hearing loss within the Construction sector was 18% compared to 15% for all industries combined. The sub-sectors with the highest prevalences for hearing loss were: Electrical Contractors and Other Wiring Installation Contractors (22%), Industrial Building Construction (22%), Commercial and Institutional Building Construction (22%), and Masonry Contractors (21%). The sub-sectors with the highest adjusted risks were Other Heavy and Civil Engineering Construction, Finish Carpentry Contractors, Commercial and Institutional Building Construction, and Industrial Building Construction, with risks 64%, 56%, 49%, and 49% higher than the reference industry, respectively.

**Conclusions:** Hearing loss continues to be a significant issue within the Construction sector. Reducing noise exposure is critical, including buying quieter equipment, keeping moving parts oiled and well-maintained, and enclosing noise sources. Barriers to workers consistently and correctly wearing their hearing protection also need to be addressed.

**Fit testing results and training outcomes: Effects of training on personal attenuation rating for uniform fit earplugs**

**Presenters and Co-Authors:** Jansen, Conner (Primary Presenter), Duren, Amanda (Co-Author (not presenting)), Le Prell, Colleen (Co-Author (not presenting))

Significant differences between individual attenuation, measured as a personal attenuation rating (PAR), and labeled noise reduction rating (NRR) have driven recommendations for fit testing in hearing loss prevention programs. Fit testing provides a process to verify individuals can obtain appropriate attenuation. We assessed PAR in participants using earplugs marketed for music appreciation using real ear at threshold (REAT) techniques in sound field before and after training on HPD insertion. After the first HPD insertion, participants were trained to insert HPDs, with PAR reassessed after two trained insertions. Participants were tested with four HPD brands over four sessions with order counter-balanced. For each HPD, some participants have
no previous training whereas others were trained on other HPDs. Trained PARs were significantly larger than untrained PARs, suggesting training was effective. Interestingly, study-provided training on other HPDs did not reliably increase initial PAR for HPDs assessed at later study sessions. PAR measures after the first and second training interventions were not reliably different, suggesting most training benefit was accomplished during the first trained insertion. Taken together, these data support recommendations that HPD attenuation should be verified using fit testing, and suggest PAR is reliably improved when training is provided.

The Use of In-Ear Dosimetry to Understand Musician’s Unique Sound Exposure (MUSE)  
Presenters and Co-Authors: Woodford, Allison (Primary Presenter), Le Prell, Colleen (Co-Author (not presenting)), Malyuk, Heather (Co-Author (not presenting)), Myers, Emily (Co-Author (not presenting))

Sound, the product of musicians’ art and work, can lead to auditory deficits impacting quality of life from communication difficulty to career implications. However, damage due to sound exposure is 100% preventable. The MUSE study was designed to measure sound exposure near the tympanic membrane providing more accurate assessment of ear-specific exposure, risk inherent in musical activities, and the actions necessary to protect against overexposure. Sound levels were measured both near- and in- the ear while playing the violin, (closer to the left ear), providing insights into potential overexposure and sound level asymmetries. Functional asymmetries were assessed through conventional (0.5-8 kHz) audiometry, questionnaires, and the Words-In-Noise (WIN) test. Early warning signs of auditory damage—extended high frequency (EHF) thresholds and distortion product otoacoustic emission (DPOAE)—were also measured. MUSE will ultimately enroll musicians ranging from pediatric early learners to adult professionals, providing a lifetime approach to musician hearing health. Data presented in this poster are from school aged participants ages 10-17. MUSE builds on previous research exploring music-induced hearing disorders (MIHD) by looking specifically at ear-specific sound levels while playing violin, thus incorporating asymmetric exposure and ear-specific amplification, with the goal of facilitating evidence-based practices for the prevention of MIHD.

Hearing Loss, Environmental Exposures, and Work History in Female Farmers & Ranchers  
Presenters and Co-Authors: Moore, Jan (Primary Presenter)

Progressive and permanent sensorineural hearing loss associated with noise exposure (NIHL) is a chronic health condition in agricultural workers. In terms of hearing health, there is little information about the exposures of noise and other environmental hazards on women primary operators of crop and livestock producers. Hearing loss has been identified as a modifiable risk factors across the lifespan associated with dementia later in life. The purpose of our study is to examine the relationship between long-term noise-induced hearing loss (NIHL) and risk for dementia in independent female farmers and ranchers. This presentation will focus on demographic data, work history, noise exposures, and other comorbidities associated with NIHL and dementia in 23 women primary and secondary operators of farms and ranches. Our
protocol includes audiological assessment, a comprehensive background history, and a survey of communication concerns. Among primary operators, there was a wide range of hearing loss across participants with women participants demonstrating similar hearing status as the men. Some patients exhibited multiple risk factors for dementia. We are continuing to gather data on women operators and examine their unique health and communication concerns.

**Hearing status over time among firefighters: Analyses of the Wildland Firefighter Study**

**Presenters and Co-Authors:** Deiters, Kristy (Primary Presenter), Byrne, David (Co-Author (not presenting)), Flamme, Gregory (Co-Author (not presenting)), Graydon, Pamela (Co-Author (not presenting)), Themann, Christa (Co-Author (not presenting))

Wildland firefighters work primarily outside densely populated areas to manage wildfires. These workers are exposed to many hazards, including noise, asphyxiants, and organic solvents. The Wildland Firefighter Exposure and Health Effects (WFFEHE) study collected cross-sectional and longitudinal data across multiple domains. This presentation describes factors related to hearing and tinnitus among participants in the WFFEHE. Hearing sensitivity was characterized using the Global Burden of Disease metric and average better ear thresholds at 3, 4, and 6 kHz. Tinnitus was self-reported. Generally, relationships between hearing, tinnitus, systemic inflammation biomarkers, cholesterol, NSAID use, hearing protector use, airway symptoms, cigarette use, rock dust exposure, and previous firefighting were identified. Interleukin (IL) 8, tinnitus, prior exposure to rock dust, increased cholesterol, regular NSAID use, cigarette use, and history of firefighting were related to poorer hearing status. IL-6 and hearing protector use while firing weapons were inversely related to poorer hearing status. Some factors (e.g., arterial stiffness, results for women) were not included in these analyses due to small sample sizes. These results can inform future large-scale studies of hearing and related factors among firefighters.

**The Education Level, Promotion, and Attitudes Towards the Wearing of Hearing Protection Devices by High School Band Directors**

**Presenters and Co-Authors:** Myers, Emily (Primary Presenter), Le Prell, Colleen (Co-Presenter)

Myers, E., Le Prell C.G.

Band directors are at risk for Music-Induced Hearing Disorders (MIHD) as a consequence of their sound exposure during band direction as well as any individual rehearsal and performance activities. MIHD can be prevented by use of hearing protection devices (HPDs). The primary purpose of this study was to assess previous education on hearing loss prevention for high school band directors. Relationships between education and use of HPDs, the extent to which directors educate students on MIHD and recommend or require HPD use, and auditory complaints of participating band directors were assessed. The Beliefs About Hearing Protection and Hearing Loss [BAHPHL] scale was modified for use with musicians and used to assess attitudes about HPDs. The Musicians’ Hearing Handicap Index (MHHI) was used to collect a self-
evaluation of auditory deficits, and the abbreviated Speech, Spatial and Qualities of Hearing scale [SSQ-12] was used to assess hearing in noise ability. Participants were recruited virtually using electronic mail addresses posted on high school band websites. The high school bands were selected using the Bands of America regional and national competition lists and the Horn Rank lists. All data were collected via electronic survey.

**Comparing earplug attenuation and speech perception in individuals with normal hearing and hearing loss**

**Presenters and Co-Authors:** El Mawazini, Ahmed (Primary Presenter), Giguere, Christian (Co-Presenter)

Fit-testing technology is emerging as an important tool to guide the selection of hearing protectors and verify attenuation. The Personal Attenuation Rating or PAR provides a more direct estimate of the protection that individual workers are expected to obtain compared to laboratory measures with a group of test subjects. As such, the PAR value is invaluable for determining the effective noise exposure from the use of hearing protectors and identifying cases of insufficient protection. Another objective when selecting hearing protectors is to be able to communicate verbally and hear the important sounds in one’s working environment. This presentation will report on a pilot study aimed at comparing the attenuation produced by earplugs to speech perception outcome in participants with normal hearing and hearing loss, before and after providing fitting instructions. Preliminary results showed that the attenuation achieved was similar between the two groups, but adverse impact on speech perception was more evident in some participants with hearing loss that obtained large attenuation values when properly fitting their earplugs. The goal of this research is to develop tools and provide more detailed guidance on hearing protector selection to control the risk of overprotection.

**Acoustic Properties of High-Fidelity Hearing Protection Devices and Music Quality Perception**

**Presenters and Co-Authors:** Coste, Azalea (Primary Presenter)

Earplugs marketed for music listening vary in both degree and uniformity of attenuation. These acoustic variables are hypothesized to be associated with sound quality. The primary purpose of this study was to examine relationships between acoustic variables and music quality ratings from participants using earplugs in real-world settings. In addition, the role of sound quality and comfort in likelihood of recommending earplugs to others was assessed. Four earplug brands were included with one brand assessed per study visit and earplug order counter-balanced across participants. At each visit, attenuation was measured before and after training on correct earplug insertion. After participants wore the earplugs in loud music environments, they submitted sound level measurements and sound quality ratings via electronic surveys. Although there were no statistically significant differences in overall sound quality ratings across HPDs, the data suggest that music quality ratings decrease as attenuation increases, indicating the importance of music audibility to music listeners. In contrast to previous results collected in a
lab setting, relationships between uniformity (flatness across frequencies) and sound quality were not observed. Both sound quality and comfort were statistically significantly associated with recommendation ratings. For music listeners, audibility needs and comfort are key factors.

**Synergistic effects of noise and vibration on auditory function**

**Presenters and Co-Authors:** Krishnamurti, Sridhar (Primary Presenter)

Vibration exposure may increase hearing loss in workers exposed to noisy jobs coupled with Whole Body Vibration (WBV) or segmental vibration (HAV). Working frequently for long hours and exposure to vibration simultaneously with loud noise increase the susceptibility to hearing loss. A custom-made wooden box was made to house the Craftsman Drill at torque setting of 9 to generate vibrations (Hand Arm Vibration or HAV exposure) and noise. During noise exposure, the subject was only exposed to noise coming from drill from the vibration box with a filled glove placed under 500 grams of sandbag. The personal noise exposure was recorded with Larson Davis Spark 706 noise dosimeter. The hand arm vibration was measured with Xsens Dot tied with Velcro above the right ear on head. Otoacoustic emissions (OAEs) were recorded using Scout Sport Bio-logic System. Every subject in the study was required to participate in the two exposure conditions (Noise versus Noise +HAV). TEOAE measurements were completed before exposure (Pre-Exposure SNR) and following exposure (Post Exposure SNR). The effects of time (Pre-Exposure SNR versus Post-Exposure SNR) was highly significant. However, the main effects of exposure (Noise versus Noise+HAV) was not found to be significant.

**Using hearing aid algorithms to improve speech intelligibility of digital hearing protectors: a pilot study in lab with industrial noise**

**Presenters and Co-Authors:** Ollivier, Solenn (Primary Presenter), Bonnet, Fabien (Co-Author (not presenting)), Bouserhal, Rachel (Co-Author (not presenting)), Giguère, Christian (Co-Author (not presenting)), Nélisse, Hugues (Co-Author (not presenting)), Voix, Jérémie (Co-Author (not presenting))

Wearing hearing protection devices (HPDs) has become a widespread practice to mitigate noise-induced hearing loss (NIHL) among workers exposed to high noise levels. However, while HPDs effectively reduce noise exposure for most individuals, they can bring challenges for those already afflicted with NIHL. These individuals often face increased difficulties in communication and sound detection while wearing HPDs. Some attempt to overcome these challenges by wearing hearing aids either alone or in conjunction with HPDs (e.g., under earmuffs), but the consequences of such practices on hearing health remain uncertain.

To address this issue, a hybrid device combining hearing protection and hearing aid features is needed. Hearing aid algorithms (e.g., Modulation-Based Digital Noise Reduction, Wide Dynamic Range Compression, Fast Dynamic Compressor) have been programmed on an electronic Auditory Research Platform (ARP), which can connect to digital earpieces designed for hearing protection.
This study explores the effects of algorithm adjustments on speech intelligibility in typical workplace noise. An adapted Hearing In Noise Test (HINT) is performed on participants with mild-to-moderate and without hearing loss. Speech Reception Thresholds (SRT) and reaction times are compared in various conditions to recommend the optimal algorithm combinations and parameters adjustments compatible with a real-time implementation on the ARP.

**Hearing it out: Can a Webtool Help Prevent Occupational Hearing Loss?**

**Presenters and Co-Authors:** Brogan, Ursula "Asha" (Primary Presenter)

Occupational Hearing loss affects 22 million Americans each year, despite a wealth of hearing loss prevention solutions. Researchers at the National Institute for Occupational Safety and Health investigated which barriers are holding workers back from utilizing prevention solutions conducted through surveys and in-depth interviews in English and Spanish with construction company employees and workers. They found the biggest barrier was awareness of serious health risks associated with preventable hearing loss. To spread messaging, the team built a new webtool: Preventing Occupational Noise-Induced Hearing Loss. The site provides a place for employers and safety professionals to find easy-to-implement solutions based on the hierarchy of controls. Published in May 2023, the landing page singularly hosted 1,469 visitors in the first three months. The first subpage “Understand Noise Exposure” is the most visited subpage with 1,037 visits from the first reporting period (May 1 — Aug. 31, 2023) emphasizing the need for hearing loss awareness information. Web metrics such as these from the webtool’s first year of publication can help researchers better understand which aspects of prevention solutions audiences are spending time reading, helping to infer topics for future intervention campaigns.