 Production of this document was supported by cooperative agreement OH 009762 from the National Institute for Occupational Safety and Health (NIOSH). The contents are solely the responsibility of the authors and do not necessarily represent the official views of NIOSH.

Akbar-Khanzadeh, F., et al. (2013). "Task-specific noise exposure during manual concrete surface grinding in enclosed areas-influence of operation variables and dust control methods." J Occup Environ Hyg 10(9): 478-486.

Noise exposure is a distinct hazard during hand-held concrete grinding activities, and its assessment is challenging because of the many variables involved. Noise dosimeters were used to examine the extent of personal noise exposure while concrete grinding was performed with a variety of grinder sizes, types, accessories, and available dust control methods. Noise monitoring was conducted in an enclosed area covering 52 task-specific grinding sessions lasting from 6 to 72 minutes. Noise levels, either in minute average noise level (Lavg, dBA) or

respirable silica increased from 0.41 to 0.74 mg m-3 in sampler 1 (P = 0.012) and from 0.41 to 0.89 mg m-3 in sampler 2 (P = 0.024); levels above the NIOSH recommended exposure limit of 0.05 mg m-3. Likewise, mean noise levels increased from 112.8 to 114.4 dBA (P < 0.00001). Drilling productivity declined with increasing wear from 10.16 to 7.76 mm s-1 (P < 0.00001). Discussion: Increasing bit wear was associated with increasing respirable silica dust and noise and reduced drilling productivity. The levels of dust and noise produced by these experimental conditions would require dust capture, hearing protection, and possibly respiratory protection. The findings support the adoption of a bit replacement program by construction contractors.

Cheng, W., et al. (2018). "Meta-analysis of job-exposure matrix data from multiple sources." J Expo Sci Environ Epidemiol 28(3): 259-274.

The objectives of this study were to determine the heterogeneity of data sources used to construct a job-exposure matrix (JEM) for occupational noise, and to calculate pooled exposure estimates for different job titles using different sources. The JEM was populated with measurements from government databases, private industry, and the published literature. Data were organized by job title using the US standard occupational classificationtr(ur)y5 (o)2 sng"upa410 (") (u (ng

of activity logs with simultaneous dosimetry measurements. With these measurements, we evaluated potential predictors of HPD use based on components of Pender's revised health promotion model (HPM) and safety climate factors. RESULTS: Observed full-shift equivalent noise levels were above recommended limits, with a mean of 89.8 +/- 4.9 dBA, and workers spent an average of 32.4 +/- 18.6% of time in each shift above 85 dBA. We observed a bimodal distribution of HPD use from the activity card/dosimetry measures, with nearly 80% of workers reporting either almost never or almost always using HPDs. Fair agreement (kappa = 0.38) was found between the survey and activity card/dosimetry HPD use measures. Logistic regression models identified site, trade, education level, years in construction, percent of shift in high noise, and five HPM components as important predictors of HPD use at the individual level. Site safety climate factors were also predictors at the group level. CONCLUSIONS: Full-shift equivalent noise levels on the construction sites assessed were well above the level at which HPDs are required, but usage rates were quite low. Understanding and predicting HPD use differs by methods used to assess use (survey versus activity card/dosimetry). Site, trade, and the belief that wearing HPD is not time consuming were the only predictors of HPD use common to both measures on an individual level. At the group level, perceived support for site safety and HPD use proved to be predictive of HPD use.

Fernández-Esquer, M. E., et al. (2015). "The influence of demographics and working conditions on self-reported injuries among Latino day laborers." International Journal of Occupational and Environmental Health 21(1): 5-13.

Background: The majority of day laborers in the USA are Latinos. They are engaged in high-risk occupations and suffer high occupational injury rates. Objectives: To describe on-the-job injuries reported by Latino day laborers, explore the extent that demographic and occupational factors predict injuries, and whether summative measures for total job types, job conditions, and personal protective equipment (PPE) predict injuries. Methods: A community survey was conducted with 327 participants at 15 corners in Houston, Texas. Hierarchical and multiple logistic regressions explored predictors of occupational injury odds in the last year. Results: Thirty-four percent of respondents reported an occupational injury in the previous year. Education, exposure to loud noises, cold temperatures, vibrating machinery, use of hard hats, total number of job conditions, and total PPE significantly predicted injury odds. Conclusion: Risk for injury among day laborers is not only the product of a specific hazard, but also the result of their exposure to multiple occupational hazards. © W. S. Maney & Son Ltd 2015.

Griffin, S. C., et al. (2009). "Indicators of hearing protection use: self-report and researcher observation." J Occup Environ Hyg 6(10): 639-647.

Hearing protection devices (HPD) are commonly used to prevent occupational noise-induced hearing loss. There is a large body of research on hearing protection use in industry, and much of it relies on workers' self-reported use of hearing protection. Based on previous studies in fixed industry, worker self-report has been accepted as an adequate and reliable tool to measure this behavior among workers in many industrial sectors. However, recent research indicates self-reported hearing protection use may not accurately reflect subject behavior in industries with variable noise exposure. This study compares workers' self-reported use of hearing protection with their observed use in three workplaces with two types of noise environments: one construction site and one fixed industry facility with a variable noise environment, and one fixed industry facility with a steady noise environment. Subjects reported

for workers in Healthcare and Social Assistance, and the prevalence was consistently high for Mining and Construction workers. Conclusions: While progress has been made in reducing the risk of incident hearing loss within most industry sectors, additional efforts are needed within Mining, Construction and Healthcare and Social Assistance. Am. J. Ind. Med. 58:392-401, 2015. © 2015 Wiley Periodicals, Inc.

Masterson, E. A., et al. (2013). "Prevalence of hearing loss in the United States by industry." Am J Ind Med 56(6): 670-681.

BACKGROUND: Twenty-two million workers are exposed to hazardous noise in the United States. The purpose of this study is to estimate the prevalence of hearing loss among U.S. industries. METHODS: We examined 2000-2008 audiograms for male and female workers ages 18-65, who had higher occupational noise exposures than the general population. Prevalence and adjusted prevalence ratios (PRs) for hearing loss were estimated and compared across industries. RESULTS: In our sample, 18% of workers had hearing loss. When compared with the Couriers and Messengers industry sub-sector, workers employed in Mining (PR = 1.65, CI = 1.57-1.73), Wood Product Manufacturing (PR = 1.65, CL = 1.61-1.70), Construction of Buildings (PR = 1.52, CI = 1.45-1.59), and Real Estate and Rental and Leasing (PR = 1.61, CL = 1.51-1.71) [corrected] had higher risks for hearing loss. CONCLUSIONS: Workers in the Mining, Manufacturing, and Construction industries need better engineering controls for noise and stronger hearing conservation strategies. More hearing loss research is also needed within traditional "low-risk" industries like Real Estate.

Methner, M. M. (2000). "Identification of potential hazards associated with new residential construction." Appl Occup Environ Hyg 15(2): 189-192.

There were several advantages and limitations of this observational study. The most important advantage of this study was the opportunity to observe residential construction workers performing their jobs. By observing work practices, valuable information was gathered about specific trades and their potential exposure to various chemical and physical agents. This information will be useful in guiding subsequent exposure assessments. Probably the greatest limitation of this study was the lack of participation by homebuilders. Ideally, observations of construction processes would have been more objective if the study included the participation of more than one homebuilder. Aside from one worker who was observed to wear safety glasses, leather gloves, and a dust mask, virtually no personal protective equipment (PPE) was observed onsite. Often small contractors do not have the financial resources necessary to procure the appropriate PPE and issue these items to the workers. Based on hazard prevalence, professional judgement, and the degree of hazardous product use, potential exposures that warrant quantitative sampling efforts during Phase 2 of this study are: bulldozer/backhoe operators--noise, vibration, diesel exhaust; concrete workers--naphtha, mineral spirits, Portland cement; asphalt workers--petroleum hydrocarbons, asphalt, mineral spirits; plumbers--methylethyl ketone, acetone, tetrahydrofuran, cyclohexanone; drywall finishers--total and respirable dust, hexane, acetone; painters--ethylene glycol, VOCs; masons--dust (during the preparation of mortar); floor preparation technicians--total and respirable dust; and ceramic tile installers--toluene, naphtha, silica (from grout powder).

Neitzel, R., et al. (2008). "Development and pilot test of hearing conservation training for construction workers." Am J Ind Med 51(2): 120-129.

BACKGROUND: Hearing conservation efforts in construction frequently rely on use of hearing protection devices (HPDs): however, training on HPDs is often not provided, and usage rates remain low. In this study, a hearing conservation training program was developed and pilot tested. METHODS: A theoretical model was selected as the basis for the program, and program contents and delivery methods were selected to optimize the effectiveness and flexibility of the training. Two evaluation measures were selected to assess training-related changes in self-reported HPD use. The first was a validated method using concurrent work-shift noise dosimetry, and the second was a survey concerning workers beliefs and attitudes towards HPDs and HPD use. RESULTS: The training program was pilot tested on a single construction site. Complete assessment data were available for 23 workers. The percent of time when hearing protection was used during noise levels above 85 dBA nearly doubled post-training, and the change was statistically significant. CONCLUSIONS: Pre- and post-training data from participating workers demonstrated that HPD use can be increased significantly with basic model-based training, even in industries with complex noise exposures such as construction.

Neitzel, R. and N. Seixas (2005). "The effectiveness of hearing protection among construction workers." J Occup Environ Hyg 2(4): 227-238.

Effective hearing conservation programs in the construction industry are rare. Where programs are present, they often rely on workers' use of hearing protection devices (HPDs) rather than on exposure controls to reduce noise exposure levels. Dependence on HPDs for protection from high noise is problematic, as the protection provided by the HPD depends on both the HPD's attenuation level and the time the HPD is used. This article presents an analysis of data on noise exposure and hearing protection among construction workers drawn from several large datasets covering nine construction trades. A unique combination of 1-min dosimetry noise exposure levels and simultaneous self-reported use of HPDs was evaluated, as were occupational and nonoccupational HPD use data collected by questionnaire as part of a longitudinal study of noise exposure and hearing loss among apprentices. Direct measurements of HPD attenuation were also made on workers at their work site. The workers assessed in this

loss study and completed questionnaires at 1 yr of follow-up to determine their episodic activities (e.g. concert attendance, power tool use, firearms exposure). Noise exposure levels for these episodic exposures were determined from the published literature. Routine activities were assessed using activity cards filled out over 530 subject-

for outcomes with strong regulatory and legal incentives to reduce exposures and associated risks, such as those associated with inhalation hazards (asbestos and silica), while lowest improvement was for hearing impairment, for which little regulatory enforcement and few prevention incentives have been adopted.

Ringen, K., et al. (2022). "Hearing impairment and tinnitus among older construction workers employed at DOE facilities." Am J Ind Med 65(8): 644-651.

BACKGROUND: Few studies have defined the risk of hearing impairment and tinnitus after retirement. This report measures hearing impairment and tinnitus prevalence among older construction trades workers. METHODS: The study cohort included 21,340 participants in a national medical screening program (www.btmed.org). Audiometric hearing impairment was classified according to the Global Burden of Disease Study. Tinnitus was determined by self-report. An internal subcohort of nonconstruction trades workers served as a reference group. Stratified analyses and multivariate analyses were used to measure the prevalence of hearing impairment and tinnitus by age, sex, and job category. RESULTS: Prevalence of any hearing impairment was 55.2% (males, 57.7%; females, 26.8%) and increased rapidly with age. Construction trades workers were 40% more likely to have hearing impairment than the reference group. The overall prevalence of tinnitus was 46.52% and followed patterns similar to hearing impairment. Workers with hearing impairment were more likely to also have tinnitus, but tinnitus was frequent

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external microphones combined with certain noise measurement applications did not differ significantly from levels measured with the Type 1 sound measurement system. Results showed that it may be possible to use iOS smartphones and smart devices, with specific combinations of measurement applications and calibrated external microphones, to collect reliable, occupational noise exposure data under certain conditions and within the limitations of the device. Further research is needy boo usend Hrc itady h-2 (t)-t
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Saleh, S., et al. (2017). "The Use of Noise Dampening Mats to Reduce Heavy-Equipment Noise Exposures in Construction." Saf Health Work 8(2): 226-230.

The performance of sound barriers was evaluated to determine their technical effectiveness and practicality in reducing noise exposures to operating engineers in construction. Commercially purchased sound dampening mats (SDMats) were installed inside three heavy-

newly enrolled construction industry apprentices and a comparison group of graduate students, using standard pure tone audiometry and distortion product otoacoustic emissions (DPOAEs). A total of 328 subjects (632 ears) were monitored annually an average of 3.4 times. In parallel to these measures, noise exposure and hearing protection device (HPD) use were extensively monitored during construction work tasks. Recreational/non-occupational exposures also were queried and monitored in subgroups of subjects. Trade specific mean exposure L(eq) levels, with and without accounting for the variable use of hearing protection in each trade, were calculated and used to group subjects by trade specific exposure level. Mixed effects models were used to estimate the change in hearing outcomes over time for each exposure group. RESULTS: Small but significant exposure related changes in DPOAEs over time were observed, especially at 4 kHz with stimulus levels (L1) between 50 and 75 dB, with less clear but similar patterns observed at 3 kHz. After controlling for covariates, the high exposure group had annual changes in 4 kHz emissions of about 0.5 dB per year. Pure tone audiometric thresholds displayed only slight trends towards increased threshold levels with increasing exposure groups. Some unexpected results were observed, including an apparent increase in DPOAEs among controls over time, and improvement in behavioural thresholds among controls at 6 kHz only. CONCLUSIONS: Results indicate that construction apprentices in their first three years of work, with average noise exposures under 90 dBA, have measurable losses of hearing function. Despite numerous challenges in using DPOAEs for hearing surveillance in an industrial setting, they appear somewhat more sensitive to these early changes than is evident with standard pure tone audiometry.

Seixas, N. S., et al. (2004). "Predictors of hearing threshold levels and distortion product otoacoustic emissions among noise exposed young adults." Occup Environ Med 61(11): 899-907.

AIM: To examine the relations between noise exposure and other risk factors with hearing function as measured by audiometric thresholds and distortion product otoacoustic emissions. METHODS: A total of 456 subjects were studied (393 apprentices in construction trades and 63 graduate students). Hearing and peripheral auditory function were quantified using standard, automated threshold audiometry, tympanometry, and distortion product otoacoustic emissions (DPOAEs). The analysis addressed relations of noise exposure history and other risk factors with hearing threshold levels (HTLs) and DPOAEs at the baseline test for the cohort. RESULTS: The cohort had a mean age of 27 (7) years. The construction apprentices reported more noise exposure than students in both their occupational and non-occupational exposure histories. A strong effect of age and years of work in construction was observed at 4, 6, and 8 kHz for both HTLs and DPOAEs. Each year of construction work reported prior to baseline was associated with a 0.7 dB increase in HTL or 0.2 dB decrease DPOAE amplitude. Overall, there was a very similar pattern of effects between the HTLs and DPOAEs. CONCLUSIONS: This analysis shows a relatively good correspondence between the associations of noise exposures and other risk factors with DPOAEs and the associations observed with pure-tone audiometric thresholds in a young adult working population. The results provide further evidence that DPOAEs can be used to assess damage to hearing from a variety of exposures including noise. Clarifying advantages of DPOAEs or HTLs in terms of

highest prevalence of noise exposure and hearing loss, there are noise-exposed workers in every sector and every sector has workers with hearing loss. Noise-induced hearing loss is preventable. Increased understanding of the biological processes underlying noise damage may lead to protective pharmacologic or genetic therapies. For now, an integrated public health approach that (1) emphasizes noise control over reliance on hearing protection, (2) illustrates the full impact of hearing loss on quality of life, and (3) challenges the cultural acceptance of loud noise can substantially reduce the impact of noise on worker health.

Trabeau, M., et al. (2008). "A comparison of "Train-the-Trainer" and expert training modalities for hearing protection use in construction." Am J Ind Med 51(2): 130-137.

BACKGROUND: Few assessments have been conducted on the impact of a "Train-the-Trainer" (T3) approach for training delivery. The present study compared the effectiveness of a noise induced hearing loss (NIHL) prevention training delivered using "Train-the-Trainer" and expert trainer modalities. METHODS: Participating construction companies2 00 (tr)5(H)4 (O)4 (D)4 8rH(s)-9 (

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