

A Descriptive Analysis of Metal/Nonmetal Miners with Reported Hearing Loss, 1999-2010



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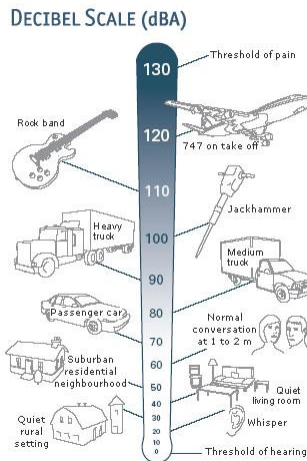
Noise



- Interchangeably used with sound
- Sound
 - Oscillations in pressure in a medium that has elasticity and viscosity
 - Characterized by frequency and amplitude
- Sound pressure level
 - Square of SPL = proportional to sound intensity level
 - Most common way to measure sound

The Decibel (dB)

- Dimensionless unit that describes most quantities related to noise
- Defined as
$$L = k \log_{10} A/B$$
- *A-weighted sound level (dBA)* used for most noise regulations



Occupational Noise-Induced Hearing Loss

- Defined as permanent, partial or complete loss of hearing in one or both ears that occurs cumulatively as a result of long-term exposure to noise at work
- Most commonly reported occupational illness in the U.S.
- Major factors:
 - Intensity of sound
 - Duration of exposure
- Caused by irreversible damage to cochlear hair cells in the inner ear
- Begins as a temporary threshold shift → over time, becomes permanent threshold shift

Noise in the Mining Industry



- Major problem due to use of heavy equipment, drilling of rock, and confined workspace
- 1971: USBM reports 73% of underground coal miners exposed to hazardous noise



- Recent studies show 80% of miners exceed TWA exposures of 85 dBA and 25% exceed TWA exposures of 90 dBA

Noise Rule (1999)



- Retained PEL of 90 dBA for 8-hr TWA shift
 - Above PEL, operator must use all feasible engineering and administrative controls to reduce exposure to/or below the PEL and enroll the miner in a Hearing Conservation Program
- If 8-hr TWA reaches 105 dBA, mine operator must provide miner with dual hearing protection
- Established Action Level at 85 dBA with a 5-dB exchange rate for 8-hr TWA shift
 - Above AL, operator required to enroll miner in a Hearing Conservation Program which includes monitoring exposure, conducting voluntary audiometric testing, and offering hearing protection





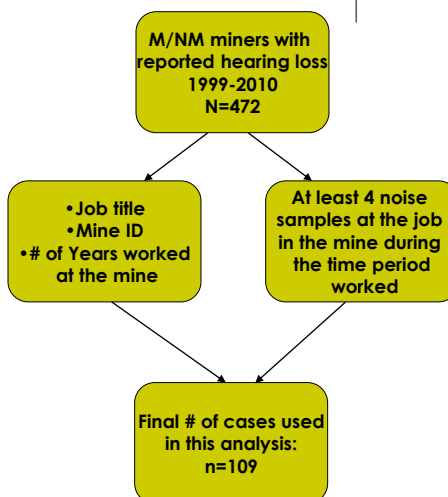
Purpose

- Assemble descriptive data on noise exposures among metal/nonmetal miners with reportable hearing loss
- Analyze the cumulative noise exposure among cases



Methods

- Study population
 - M/NM miners with reported hearing loss (1999-2010)
 - Cases reported either through Part 50 Illness Reporting or from Worker's Compensation awards



Job Exposure Matrix



Case #	Mine ID	Job	Date Reported	Job Experience	Year	MSHA Sample	Sample (dB)
1	200150	Mechanic	2010	19	1990	10.74	73.90
					1991	21.47	78.90
					1992	32.21	81.83
					1993	42.95	83.90
					1994	53.69	85.51
					1995	29.87	81.28
					1996	36.13	82.66
					1997	6.65	70.45
					1998	24.56	79.87
					1999	42.46	83.82
					2000	40.09	83.41
					2001	37.72	82.97
					2002	35.35	82.50
					2003	32.99	82.00
2004	30.62	81.46					
2005	28.25	80.88					
2006	25.88	80.25					
2007	23.51	79.56					
2008	21.14	78.79					
2009	18.77	77.93					

Cumulative Exposure Formula



$$\text{Cumulative exposure} = 10 \log \left[\sum_{j=1}^k T_j (10^{\frac{L_{eqj}}{10}}) \right]$$

k = number of average annual noise exposure estimates per case

T_j = duration of work history period j

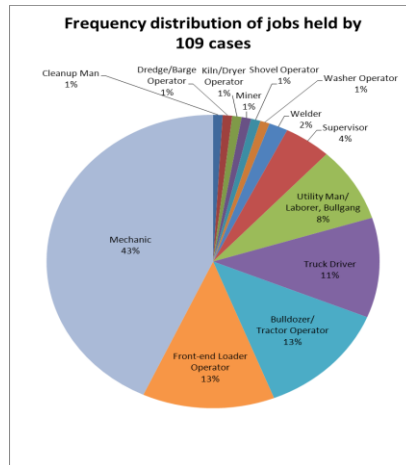
j = 1 year

L_{eqj} = estimate mean noise exposure for a job held in work period j

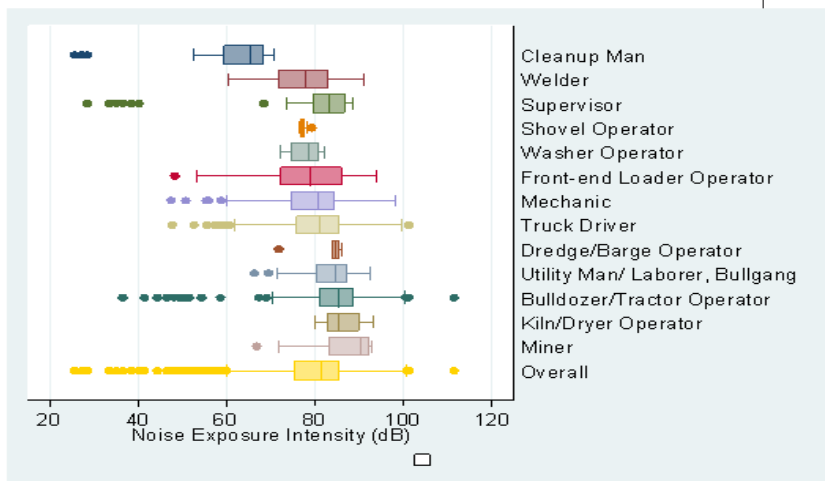
Units = dB-years

Results

- # of cases analyzed: n=109
- Cases held 13 unique job titles
- Represented 50 mines
- Years of job experience ranged from 1-41 years
- Many jobs underrepresented



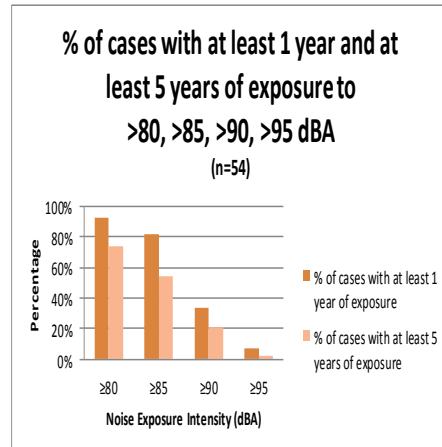
Yearly Noise Estimates for Job Titles Held by Cases



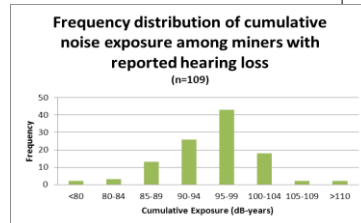
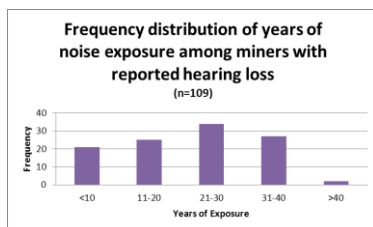


Results

- 18% of cases did not have a single year of exposure above MSHA's AL of 85 dB
- 67% of cases did not have a single year of exposure above MSHA's PEL of 90 dB
- Focused on miners with at least 25 years of experience (n=54)

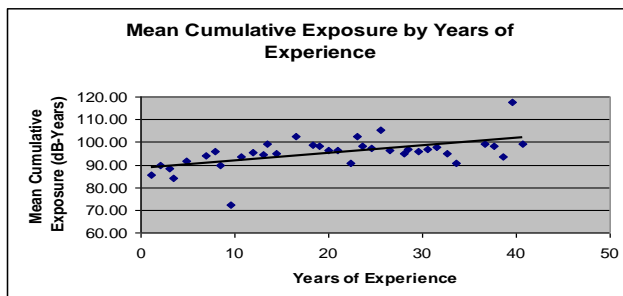


Cumulative Exposure Results



- Highest frequency of miners with reported hearing loss have:
 - 21-30 years of experience
 - Cumulative exposure of 95-99 dB-years

Years of Experience vs. Cumulative Exposure



- Cumulative exposure increases with years of experience
- Small increase may be explained by small sample size or by different yearly noise intensity samples

Summary of Findings



- Mean yearly noise exposures of cases ranged from 26.64 to 111.49 dBA with a mean yearly noise exposure at 80.01 dBA, well below MSHA's AL
- Most frequent category of miners had 21-30 years of experience with a cumulative noise exposure of 95-99 dB-years



Strengths

- Quantitative, rather than qualitative, approach to reconstruct miner's cumulative exposure history
- Very specific exclusion criteria to minimize exposure misclassification
- Working with a cohort of "cases" so minimal outcome misclassification



Limitations

- Limited to MSHA's database
 - Non-uniform selection criteria: some cases reported by Part 50, others from Worker's Comp. Awards
 - Any mistakes made by inspectors or MSHA employees who enter data into system may have affected results
 - Data are collected to determine compliance, rather than for the purpose of a health study, resulting in a lot of missing information
- Clear that many mines and contractors do not report hearing loss
 - Many noisy jobs, such as drill operators, were underrepresented



Limitations

- Many assumptions due to lack of information
 - Miner worked same job at the same mine for his entire career
 - Noise sample representative of case in study
 - Noise sample represented entire year
 - Interpolated points used for missing years
- No information on other possible factors that may lead to hearing loss
 - E.g. age, use of hearing protection, leisure activities



Conclusions

- 18% of miners with reported hearing loss do not have a single yearly sample above MSHA's AL and 67% do not have a single yearly sample above the PEL
- Yearly noise exposures below the PEL still add up to a high cumulative noise exposure over a long period of time
- MSHA's standards are set based on a daily 8-hour TWA but it is important to consider long-term risks to noise exposures that are below the standard
- NIHL continues to be a major issue for M/NM miners despite the enactment of MSHA's 1999 Noise Rule
- Mine operators and MSHA must continue to collaborate in order to reduce noise exposures and protect workers' health



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