Noise-induced hearing loss in Dutch construction industry
comparisons to ISO-1999 predictions

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Introduction

Noise is a major occupational health risk in construction

- High prevalence
- Large variation in exposure
  - Differences in activities and equipment used
  - Hearing protection devices are not always used consistently

- NIHL in Dutch construction industry:
  - prevalence in 2008: 15.7%
  - second most reported occupational disease
European Directive 2003/10/EC

- **Lower action level 80 dB(A)**
  - Provide hearing protection devices (HPD)
  - Education & training

- **Upper action level 85 dB(A)**
  - Use of hearing protection devices is obligatory
  - Hearing checked by preventive audiometry

- **Exposure limit 87 dB(A)**
  - Exposure minus attenuation of HDP
    → Workers effective exposure
Prevention of NIHL

- 88% of construction workers is exposed to noise levels > 80 dB(A)
- Hearing conservation relies on a consistent use of individual hearing protection devices (HPD)
- Consistency of HPD use is “threatened” by
  - Intermittent noise levels
  - Need for oral communication
  - Need for hearing warning signals
  - Discomfort

Introduction
ISO 1999:1990 (ANSI-S3.44)

Describes relationship noise exposure and hearing loss

NIHL is predicted by:

- exposure level, > 80 dB(A)
- years of exposure, 10-40 years

[first 10 years of exposure are predicted by extrapolation to 0 dB HL at beginning of exposure]

Total hearing loss includes age-related threshold shift

- age > 18, adds to NIHL
- screened reference population (database A)
Objectives

- Describe hearing status of Dutch construction workers
- Compare hearing threshold levels of construction workers to ISO 1999
  - Database A as reference population
  - Predicted NIHL as function of exposure level
  - Predicted NIHL as function of exposure time
    - 10-40 years as described in ISO-1999
    - First ten years as extrapolated in ISO-1999
- Influence of hearing protection and other factors on NIHL
Methods

- Dataset with audiograms of 29,216 construction workers
  - 955 female workers are excluded
- Records of Periodic Occupational Health Examination (POHE)
- POHEs are provided for all employees
  - Participation is voluntary (high % agrees)
- POHEs consist of:
  - Self-administered questionnaire
  - Blood tests
  - Physical examination, including audiometry
Audiometry

- Assessed by trained medical assistant
- At workplace in mobile unit with soundproof booth
- Manual audiometer, TDH-39 headphones
  - Annual calibration according to ISO 389
  - Per ear tested at 0.5, 1, 2, 3, 4, 6 and 8 kHz
  - Upper limit of measurements was 90 dB HL
    → 703 ears were excluded due to non-response at maximum level
- Testing during workshift, noise-free period was 2 hrs
Noise exposure

- Exposure time = years employed in construction
- TWA noise exposure level is estimated based on job title
  - Personal dosimetry recordings (in a sample)
  - Sound level measurements during specified activities
- 449 subjects were excluded because of missing or inconsistent data on job title or employment duration
- 2,974 subjects were not exposed to noise →
  - This group was used as an internal control group
Data analyses

- HTLs at each frequency are averaged over both ears
- HTLs are corrected for age (median ISO-1999 A)
- HTLs are compared to
  - Internal control group of non-exposed workers
  - ISO 1999 database A
- Multivariate regression analyses investigated predictors of hearing loss, adjusted for age and noise exposure
  - Pure tone averages $\rightarrow$ PTA_{124} and PTA_{346}
Results

- Total population:
  - 24,670 exposed employees, age 44.3 (± 11.4)
  - 2,974 controls, age 44.3 (± 10.9)

- In the exposed group
  - 75% used HPD
  - 22% had complaints about hearing
  - 39% was bothered by noise during work
Audiometric data as a function of age

Results

- **< 25 years (n=2360)**
- **25-34 years (n=2414)**
- **35-44 years (n=6384)**
- **45-54 years (n=8342)**
- **55-64 years (n=5170)**
Relationship noise and hearing

Hearing loss as a function of noise *exposure level*

Results
Discussion Relationship with exposure level → role of HPDs

- We found only a weak relationship between hearing loss and noise exposure level.

- ISO-1999 overestimated hearing loss for employees exposed to noise levels ≥ 91 dB(A)
  - This can be understood from the use of HPDs (85%).

- Employees exposed to noise intensities of 80-90 dB(A) showed more hearing loss than predicted by ISO-1999
  - This CANNOT be understood from the use of HPDs (54%).
  - Leisure noise exposure may be a factor.
Relationship noise and hearing

Hearing loss as a function of noise exposure time

Results
Discussion  Relationship with *exposure time* → leisure noise?

- Median hearing loss as function of exposure duration was similar to ISO-1999 predictions after 10-40 years.

- HOWEVER, median hearing loss in the first decade of exposure is larger than predicted by ISO-1999.
  - Is there a pre-existing hearing loss when entering workforce → due to leisure noise?
  - Hearing losses seem to increase during the first decade in the same rate as predicted for 10-40 years → is the extrapolation of the ISO-1999 valid for this population?
Predictors of hearing loss

- Significant factors in multivariate regression model were:
  - Age
  - Noise exposure level and duration
  - Use of hearing protection
  - No change in job history
  - Hearing complaints
  - Bothering by noise in work

- Interesting finding: Employees claiming to use hearing protection showed greater hearing losses than employees who never wore HPDs.
  - Employees wait too long before they start using HPDs?

Results

- Positive association
- 42% explained variance for PTA_{346}-values
Discussion

- The dataset is large, but this brings some restrictions
- Some restrictions of this study:
  - No bone conduction
  - No information on leisure noise
  - No information on consistency of HPD usage
- Noise exposure levels are estimated based on job title
- Follow-up data will become available.
Conclusions

- Hearing of construction workers was poorer than in the both reference groups
- The relationship between hearing loss and the levels of noise exposure was only weak
- ISO-1999 predicted hearing loss as function of exposure duration well, but during the first decade of exposure
  - Hearing loss was already present in this population
  - Or the increase of (early) NIHL is faster than predicted by ISO-1999
Stop that noise
Thank you!

Questions?