NOISE EXPOSURE ESTIMATES OF URBAN MP3 PLAYER USERS

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NIHL: Incidence

• Approximately ten percent of Americans aged 20 to 69

• One in eight 6-19 year olds (est. 5.2 million in US) (3rd National Health and Nutrition Examination Survey, Niskar et al., 2000)

• An increase in 2nd graders and 8th graders with hearing loss over the ten years (Montgomery & Fujukawa, 1992)

The Effects of NIHL

• Reduced pure-tone thresholds 3 – 6k Hz (“4k Hz notch”)

• Other injuries: tinnitus, loudness intolerance, abnormal perception of pitch

• Renders sounds distorted or muffled

• Leading to difficulty understanding speech and appreciating music
**The Cause of NIHL**

- **Time + Intensity** ("how loud and how long")

- **Damage Risk:**
  - 85 dBA for 8 hours
  - 88 dBA for 4 hours
  - 91 dBA for 2 hours…

- **Described as “Noise Dose” or Equivalent Continuous Level “Leq”**
  (Risk > 100% dose; > 85 dBA Leq)

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**Guidelines: The “80-90 Rule”**

- Estimates 50% noise dose (Roughly 89 dBA for 90 min)
Effect of ambient noise levels

\[ y = 0.3292x + 50.669 \]

\[ R^2 = 0.3659 \]

Estimated Ambient Noise Level in the Ear Canal in dBA

Free-field Equivalent CLL in dBA

Social Factors Associated with Portable Music Players

- The sociological aspect associated with portable music players places users at risk for NIHL
- The iPod, in particular, has become ubiquitous with its unmistakable white headphones
- Called an *urban Sherpa* - meaning that people rely on the iPod to navigate today’s urban world (Bull, 2007)
- College students rated listening to their iPods as the coolest free time activity (The Associated Press, 2006)
The early onset of NIHL may result in a Minimal Hearing Impairment (MHI)

- As little as a 10 dB reduction from normal thresholds reduces the subjective loudness sensation of a speech signal by half (Hearing Loss, 2001)

- Children with a MHI loss of 25 dB found to have lower academic skills than children with normal hearing sensitivity (Halligan, 1996)

MHI correlated with risk for academic success (Goldberg & McCormick Richburg, 2004)

- Reduced receptive and expressive vocabulary

- Difficulty with multiple meanings (write/right)

- Difficulty with figurative language that requires non-literal interpretation (Culbertson, 2007; Tye-Murray 2007)

- Overall grammatical patterns similar to younger normal hearing children (Elfeinbein, Hardin-Jones, & Davis, 1994)

  - Example: subject-verb-object - even when inappropriate

  - Weak consonants: fricatives (e.g., s, z, f, v, h) and stops (i.e., p, b, t, d, k, g)

  - Unstressed morphemes
May have difficulty with reading comprehension and phonological processing (Moeller, Tomblin, Yoshiaga-Itano, McDonald, & Jerger, 2007)

- Poor word reading and decoding skills (Bess, Dodd-Murphy, & Parker, 1998)
- A hearing loss of 15-26 dB correlated with a 1.2 year delay in language skills (Halligan, 1997)

- MHI not as apparent as a more severe hearing loss (Goldberg & McCormick Richburg, 1998)
- A MHI may be missed, given that hearing screenings are generally placed at 1000, 2000, and 4000 Hz
- Professionals must consider screening hearing at higher frequencies (specifically, 6000 and 8000 Hz)

**The Current Study**

*Participants*
- Sixty subjects (30 male, 30 female),
  - average 20.5 years of age (range: 18-32)
- Walked onto a college campus in New York City, adjacent to NYC subway station exit, were asked to:
  - Have their earphone levels measured
  - Fill out a questionnaire requesting demographic information
- Ambient sound levels at measurement location average 60.5 dBA (range 56-68)
They were also asked:

- Whether or not they commuted using the subway
  - (Gershon, et al 2006: subway = 83-106 dBA)
- Whether they adjusted the volume of their PMP after leaving the subway
- The type of PMP and earphones they used
- The duration and frequency of PMP use: average hours per day and times per week

INTRODUCING JOLENE

- Levels were measured using a mannequin built according to “The Jolene Cookbook” (Oregon Health and Sciences University, 2007)
- Calibrated by investigators using Microphone-in a Real Ear technique (ISO 11904-1, 2002) to determine a coupler to free-field correction factor to report free-field equivalent levels
Results

- Average measured level from PMP earphones was 93.2 dBA (SD = 9.82) with a range of 72-113 dBA
- Average hours of use per week were 20.8 hours (SD = 19.1) with a range of 1-105 hours per week
- Keep in mind:
  - The combination of level over time defines risk
    - Noise Dose > 100% = Risk
    - Leq (8-hour, weekly) > 85 dBA = Risk

- Noise exposure by listening session and by week estimated on reported duration of use per session and days per week of use

- Findings: the average noise dose was
  - 2322% per listening session
  - 2071% per week

- Findings suggest the average subject was exposed to twenty times the allowable noise exposure from his or her PMP on a weekly basis

Listening Level, dBA

Box-and-whisker plot showing listening level median, interquartile range, and maximum and minimum

Mean level, female = 93.1 dBA
Mean level, male = 93.5 dBA

No significant difference for gender (p>0.05)
Single-session sound exposure (8-hr LAeq)

Box-and-whisker plot showing 8-hr Leq median, interquartile range, and maximum and minimum

Estimated weekly sound exposure (LAwkn)

Box-and-whisker plot showing weekly average exposure median, interquartile range, and maximum and minimum

Descriptive Statistics

- A majority (60%) of subjects exceeded the maximum NIOSH recommended exposure level on a weekly basis
- Over half of subjects at risk for NIHL from PMP use alone
- Men had markedly higher weekly noise dose than women (2486% vs. 1655%) - although this trend did not reach statistical significance
Descriptive Statistics

- At least 39% of PMP users reported adjusting the volume control of their devices when leaving the subway.

- The average measured level (dBA) of the PMP users who reported adjusting their volume after leaving the subway ($M = 90.50$, $SD = 9.67$) was lower than the level of those who reported not adjusting their volume ($M = 94.56$, $SD = 11.56$), although this difference was not statistically significant.

Comparative Statistics

- No difference in listening levels or duration of use per week between male and female subjects.

- No difference in listening level or duration of use between subjects who used the subway to commute compared to those who did not.

- No significant correlation between chosen listening level and duration of use.

Conclusions

- Estimates of noise exposure based on measured listening levels and reported listening duration suggests that the average PMP user commuting in NYC is at risk for NIHL.

- Ten percent exceeded 102 dBA for exposures normalized over a week.

- The exposure estimates indicate a similar percent of both sexes are at risk for NIHL.
• Implications for hearing, language, and sociological aspects of misuse of PMP

• While further research is needed to assess the accuracy of these estimates, these findings warrant efforts to provide targeted education and technological solutions for people using mass transit

Collaboration

• We need better partnerships between the professions of audiology and speech-language pathology as well as between clinicians and scientists


• Stronger and more formal collaboration between members of the professions (Smiley & Threats, 2006).

  …Given that the goal of both professions is to establish and maintain good health
References


