The Health Risks of Noise are Loud and Clear: Investigating the Public Health Significance of Occupational Noise-induced Hearing Loss

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Conflict of Interest Declaration

- *I have no relationship with industry and therefore no conflict of interest to declare*

Sound vs Noise

- Sound is pressure change detectable by the ear
- Measured by pitch (Hz) and volume (dB)

- Noise is loud, unexpected, unpleasant/undesirable/unwanted sound
- Noise can be continuous or intermittent (impact or impulse)

Health Risks of Noise

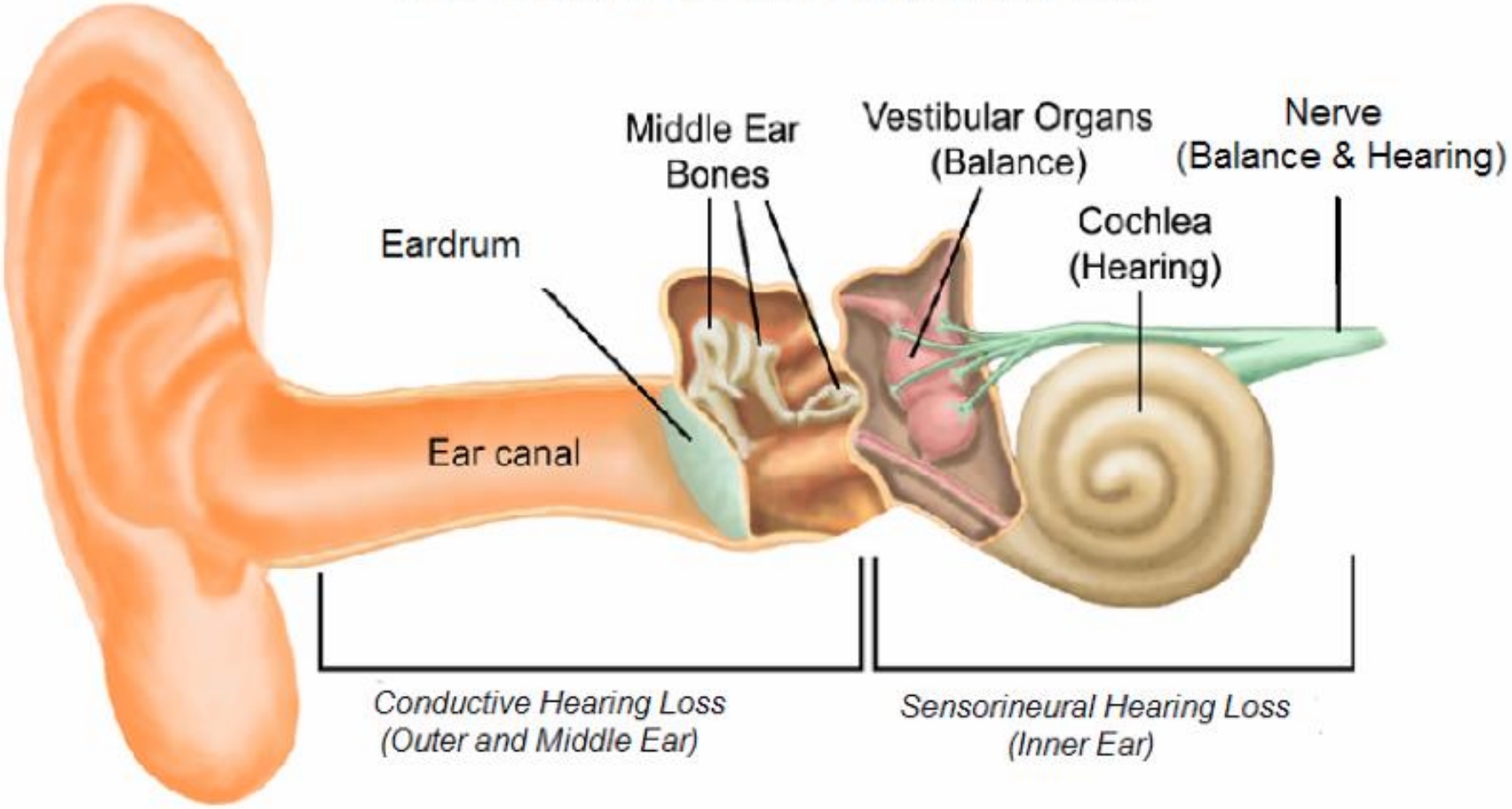
- Temporary and permanent hearing loss (threshold shift)
- Tinnitus (ringing in the ears)

- Possible risks:
  - Stress
  - Anxiety
  - Muscle tension
  - Ulcers
  - Increased blood pressure and hypertension
  - Cardiovascular disease

Non-health Impacts of Hearing Loss

- Impaired communication
- Social isolation
- Frustration, irritability
- Decreased self-esteem and negative self-image
- Decreased awareness and ability to monitor environment (sirens, warning signals, equipment sounds)
- Lost productivity and increased absenteeism

Structure of the Human Ear



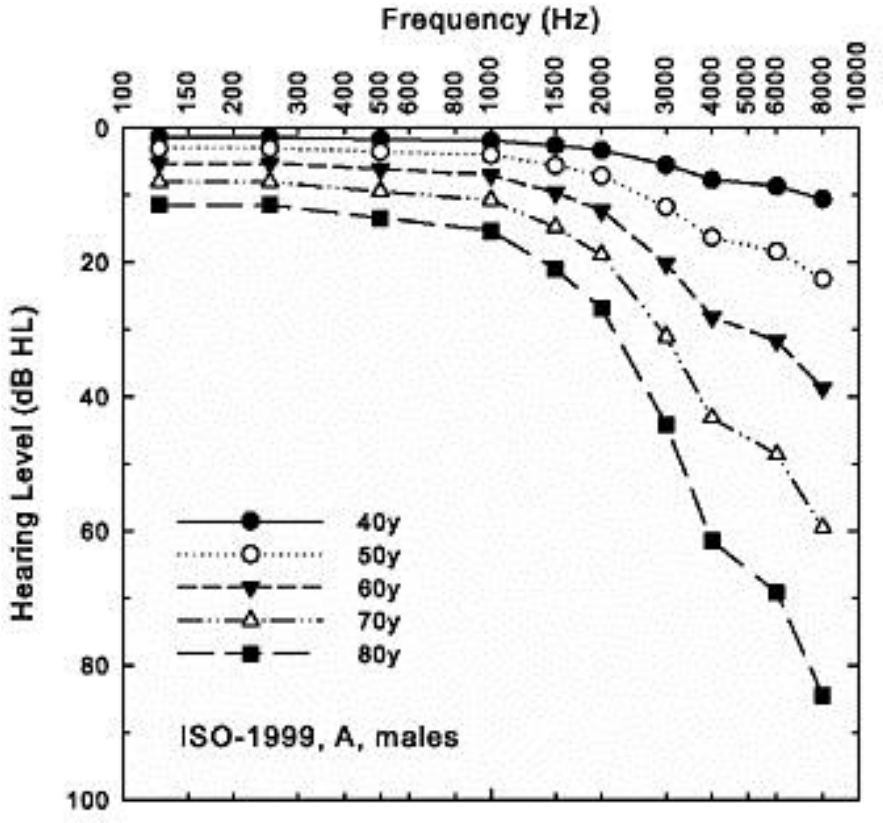
Noise-induced Hearing Loss (NIHL)

- Most common cause of hearing loss after age-related
- 100% preventable and no cure
- Two broad types of NIHL:
  - Acoustic traumatic injury
  - Long-term exposure to high levels of noise

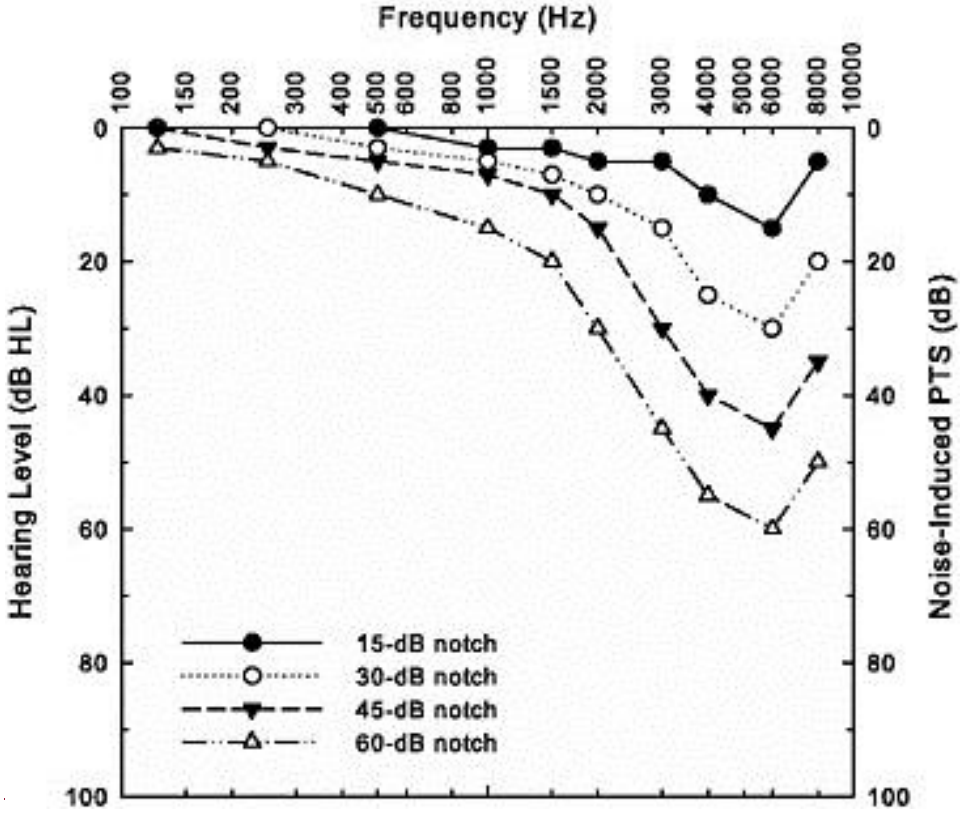
- Hearing losses from different causes are additive and interaction can occur between noise exposure and some solvents/chemicals or antibiotics
- NIHL is often not diagnosed until later in life when it is compounded by age-related hearing loss

Measuring Hearing: Audiometric Data

- Audiograms are completed for the right and left ear
- Graph the audible threshold for standardized frequencies

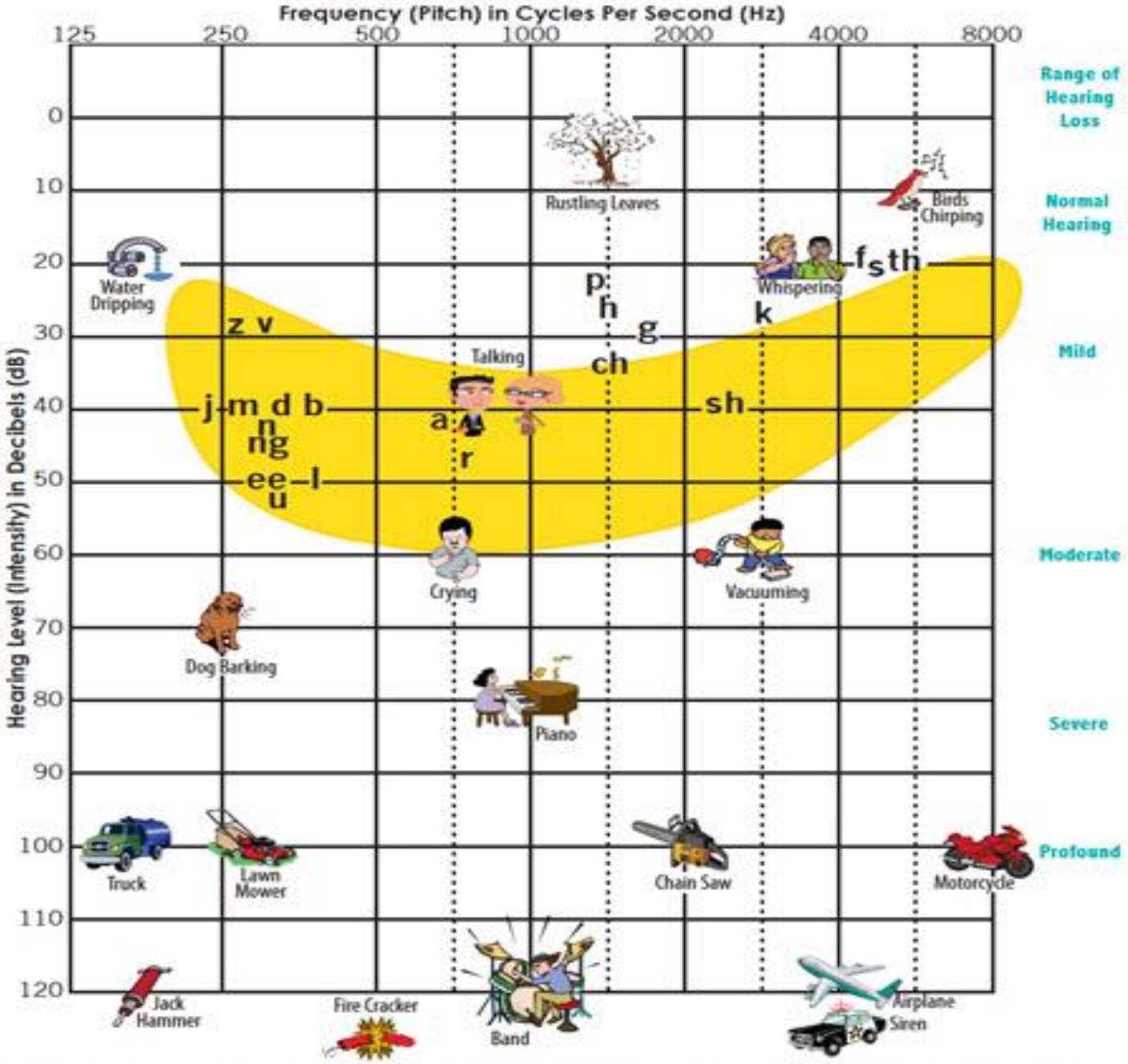


Age-related



Noise-induced

Audiogram of Familiar Sounds



Adapted from: American Academy of Audiology, www.audiology.org and Northern, J.& Downs, M. (2002). Audiogram of familiar sounds; and Ling, D. & Ling, A (1978). Aural Habilitation.

Examples of Approximate Decibel Levels

- 85 - handsaw
- 95 - electric drill, lawn mower
- 100 - factory machinery, music in headphones
- 105 - snow blower
- 110 - power saw, rock concert
- 120 - jet plane (at ramp)
- 130 - jackhammer, percussion section at symphony
- 140 - airplane taking off
- 150 - jet taking off
- 163 - rifle
- 170 - shotgun

Measuring Occupational NIHL

- WHO has identified a gap in information:

  "There is a serious shortage of accurate epidemiological information on prevalence, risk factors and costs of NIHL."

- Many studies are cross-sectional and do not take into account the longitudinal nature of NIHL
- Difficult or impossible to differentiate between occupational and recreational exposures as the cause of NIHL
- Difficult to collect comprehensive exposure along with longitudinal audiometric data

http://www.who.int/pbd/deafness/en/noise.pdf?ua=1

Burden of Occupational Hearing Loss

- 2005 study estimated the proportion of workers world-wide exposed to noise at moderately high (85 – 90 dB) and high (>90 dB) levels, and the relative risks of hearing loss at those exposure levels
- 16% of the disabling hearing loss in adults (over 4 million DALYs) is attributed to occupational noise, ranging from 7% to 21% in the various subregions
- Heavier burden among males (2.8 million DALYs) compared to females (1.4 million DALYs).

(Nelson et al., 2005)

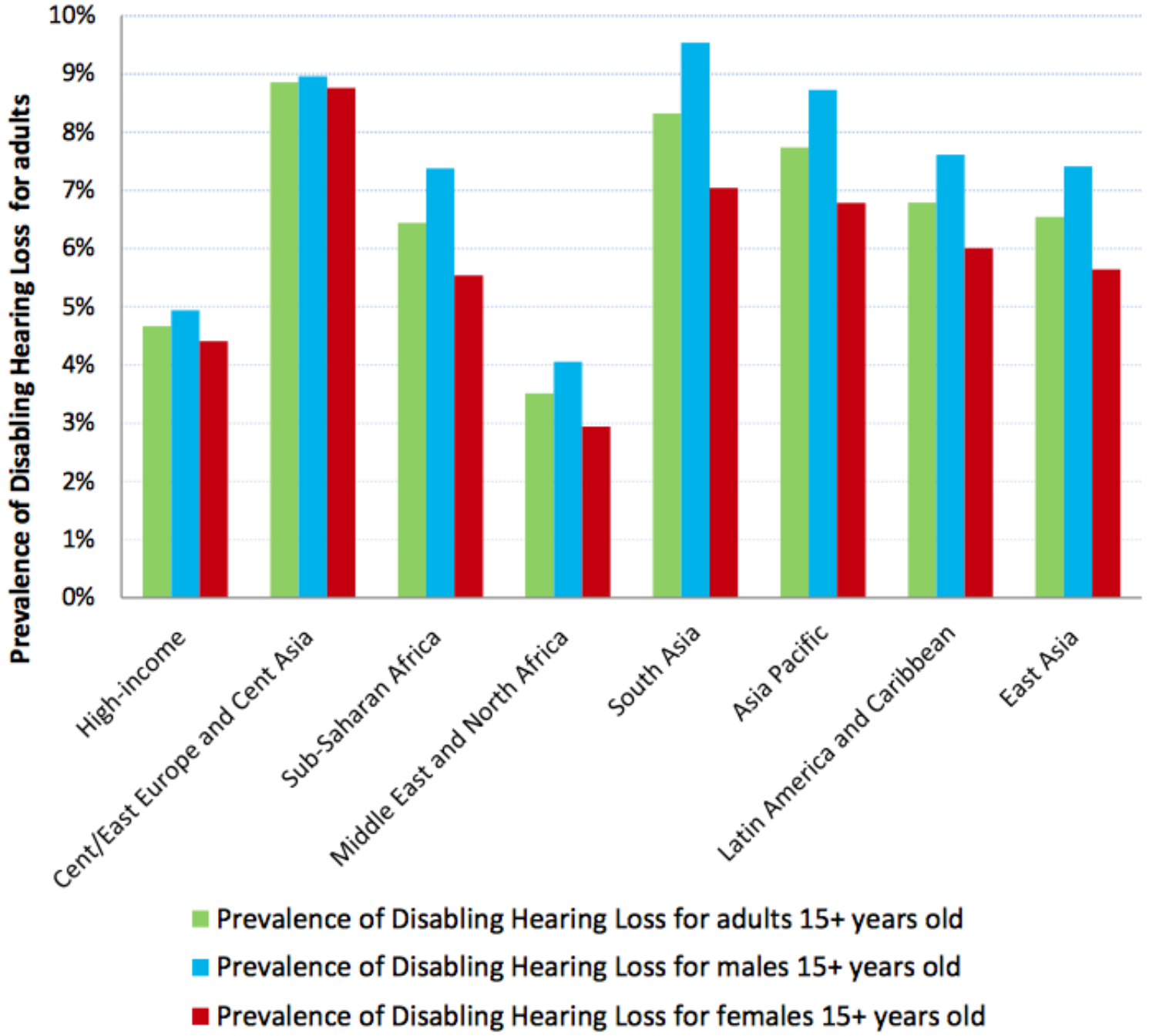
Global Burden of Hearing Loss

- In 2012, WHO released new estimates (based on 42 population-based studies) on the magnitude of disabling hearing loss:
  - There are 360 million persons in the world with disabling hearing loss (5.3% of the world's population).
  - 328 million (91%) of these are adults (183 million males, 145 million females)
- Approximately one-third of persons over 65 years are affected by disabling hearing loss.
- In developing nations an estimated 40% of workers are exposed to hazardous levels of noise

WHO Disabling Hearing Loss Estimates

Selected Regions	DHL in adults			
	Males		Females	
	millions	prevalence (%)	millions	prevalence (%)
High-income	19	4.9	18	4.4
Central/Eastern Europe and Central Asia	14	9.0	16	8.8
Sub-Saharan Africa	17	7.4	13	5.5
Middle East and North Africa	6	4.1	4	2.9
South Asia	52	9.5	36	7.0
Asia Pacific	19	8.7	15	6.8
Latin America and Caribbean	15	7.6	13	6.0
East Asia	41	7.4	30	5.6
World	183	7.5	145	5.9

MBD, WHO, 2012 DHL estimates



*MBD, WHO , 2012, DHL estimates, where DHL adult threshold is ≥41 dB HL

Cross-sectional Canadian Hearing Loss Data

- CCHS 1.1 (2000-2001):
  - Hearing difficulty in adults
    - 4% reported a "hearing problem" (deafness or hearing loss)
    - Self-report

(Woodcock & Pole, 2007)

- CHMS Cycle 3 (2012-2013):
  - Hearing loss in adults
    - 20% of adults19 to 79 years had at least mild hearing loss in at least one ear
    - Measured

(StatsCan, 2015)

Cross-sectional American Hearing Loss Data

- NHANES III:
  - Hearing difficulty in adults 18–65
    - 11% reported hearing difficulty
    - 24% of this hearing loss attributed to occupational noise
    - Self-report

(Tak & Calvert, 2008)

- US Current Population Survey 2010:
  - Severe hearing impairment among ≥17 years
    - 2.5% (2.3-2.6) non-veterans
    - 10.4% (9.8-11.0) of veterans (all service periods)
    - Measured

(Groenewold, CDC MMWR, 2011)

NIHL in High-Risk Occupational Groups

- Musicians
- Industrial workers
- Miners
- Construction workers
- Military personnel

Occupation-specific Hearing Loss

- Audiometric data of 1,122,722 US Workers (2000-2008):
  - 18% of workers 18-69 years had hearing loss
    - Mining, Manufacturing, and Construction industries need better engineering controls for noise and stronger hearing conservation strategies
    - Unexpectedly high risk of hearing loss among real estate workers
    - NIOSH Occupational Hearing Loss (OHL) Surveillance Project

(Masterson, et al, 2012)

- NHANES (2001-2002) and US Army personnel (2003-2005):
  - 1,872 general population compared to Army Active Duty (AD) (n = 9,096), National Guard (n = 3,842), and Reservists (n = 2,025) and by gender
    - No difference between hearing thresholds of civilian and military females
    - No difference between hearing thresholds of civilian and Army Active Duty males
    - Poorer hearing among male National Guard and Reservists compared to civilians

(Sobieraj, et al, 2009)

Hearing Loss: A Public Health Issue

- WHO has identified NIHL as a public health priority:

  "…as populations live longer and industrialization spreads, NIHL will add substantially to the global burden of disability."

- Whose responsible for prevention?
  - Regulatory bodies
  - Industry
  - Workplaces
  - Workers
  - Individuals during leisure time

http://www.who.int/pbd/deafness/en/noise.pdf?ua=1

Workplace Noise Regulations

- In Canada, there are provincial/territorial variations (85-90 dB; some regions have max. peak of 140; some regions have max. number of impacts (90-100).
- Federally
  - Noise limit is 87 dB over an 8-hour work period
- Ontario
  - Noise limit is 85 dB over an 8-hour work period
- In the United States
  - Noise limit is 90 dB over an 8-hour work period

Public Health Implications

- Potential for population-level increase of health issues
  - Isolation, frustration, depression
- Potential increase of workplace accidents
  - Reduced awareness and ability to monitor environment

- Potential Occupational Implications:
  - Reduced communication among workers
  - Lost productivity
  - Increased absenteeism
  - Reduced employability

Hearing Loss in the Canadian Military

- For my dissertation, I am examining the epidemiology of hearing loss among Canadian Armed Forces personnel
- No comprehensive data on noise exposure in Canadian military environments
- There are electronic audiometric data and matched self-report questionnaires since 2010
  - Tested at least at recruitment, and every 5 years for those under age 40 and every 2 years for those aged 40 and over
- My proposed research will examine occurrence and severity of hearing loss, and will identify high-risk occupational subgroups and key risk factors for NIHL

Hearing Loss in the Canadian Military

- Although there is no current information on the burden of hearing loss in the Canadian military, it is one of the most commonly compensated service-related conditions
- Top five service-related conditions for which compensation is paid by VAC (FY 2012/2013):
  - Tinnitus 29%
  - Hearing loss 21%
  - PTSD 7%
  - Osteoarthritis - knee 2%
  - Lumbar disk disease 2%

Hearing Loss in the American Military

- Hearing loss is the most common injury of war
- Hearing loss is the most common service-related disability among veterans
- Roughly 30% of all claims to Veteran Affairs are for hearing loss
- Veteran Affairs buys one in five hearing aids sold annually in the U.S.

Looking Forward

- Need for more comprehensive exposure and audiometric data from occupational subgroups and non-exposed counterparts
- Need to focus on prevention – hearing conservation programs in workplaces
  - Noise assessments
  - Noise controls (administrative, engineered, PPE)
  - Audiometric monitoring of workers' hearing
  - Worker education
  - Record keeping
  - Program evaluation

Happy (Belated) World Hearing Day!

- March 3rd - annual advocacy event which aims to raise awareness and promote ear and hearing care across the world. Previously 'International Ear Care Day'.
- However…Occupational NIHL not yet identified as a priority:
  - 2016: 'Childhood Hearing Loss: Act now, here is how!'
  - 2015: 'Make Listening Safe'
  - 2014: 'Ear Care Can Avoid Hearing Loss'
  - 2013: 'Health Hearing, Happy Life – Hearing Health Care for Ageing People'

Final Remarks

- Take responsibility for your own hearing
  - Reduce exposure to loud environments and wear protection
  - Seek medical advice if you experience changes in your hearing
- How can you tell if you are exposed to hazardous noise?
  - If you have to raise your voice to talk to someone who is an arm's length away
  - If your ears are ringing or sounds seem dull or flat after leaving a noisy place

Thank you! Questions? laura.bogaert@mail.utoronto.ca

Prevalence of disabling hearing loss for all population by selected regions*

(threshold >=41 dB for adults 15 years of age or more, and threshold >=31 dB children under 15 years of age, WHO 2011 estimates)

Disabling hearing loss prevalence per 100 population

- 2.72% – 4.41%
- 4.42% – 6.13%
- 6.14% – 7.58%
- Data not available
- Not applicable