Risk Factors for Hearing Loss in a Longitudinal Twin Study

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Anatomy of the Ear
Noise levels

<table>
<thead>
<tr>
<th>Sound Level (dB)</th>
<th>Common Sounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>130</td>
<td>Uncomfortable</td>
</tr>
<tr>
<td>120</td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>Very Loud</td>
</tr>
<tr>
<td>100</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>Moderate</td>
</tr>
<tr>
<td>80</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>Quiet</td>
</tr>
<tr>
<td>60</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Library</td>
</tr>
<tr>
<td>30</td>
<td>Bedroom at night</td>
</tr>
<tr>
<td>20</td>
<td>Isolated broadcast study</td>
</tr>
<tr>
<td>10</td>
<td>Leaves rustling</td>
</tr>
<tr>
<td>0</td>
<td>Just Audible</td>
</tr>
<tr>
<td></td>
<td>Threshold of Hearing</td>
</tr>
</tbody>
</table>

Sounds above 85 dB are harmful

Source: Handbook of Environmental Acoustics, James P. Cowan, 1994
The Swedish Twin Registry

The largest twin registry in the world and managed by the Dep. of Medical Epidemiology and Biostatistics at Karolinska Institutet

Contains information about nearly 100 000 twin pairs both identical (monozygotic MZ) and fraternal (dizygotic DZ).

Lichtenstein et al, 2002
http://ki.se/ki/jsp/pollopol.jsp?d=9610&l=sv
Genetic in twins

Monozygotic
MZ
Female – Female
Male – Male

Dizygotic
DZ
Female – Female
Male – Male
Female – Male

Genetic modeling possible
<table>
<thead>
<tr>
<th>Study population in 1991</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n=1624)</td>
</tr>
<tr>
<td>Participants at Time 1 in 1991-1994</td>
</tr>
<tr>
<td>(n=1114)</td>
</tr>
<tr>
<td>Possible participants in 2010</td>
</tr>
<tr>
<td>(n=895)</td>
</tr>
<tr>
<td>Participants at Time 2 in 2010-2013</td>
</tr>
<tr>
<td>TWINHEAR (n=583)</td>
</tr>
</tbody>
</table>
Normal hearing & Hearing loss categories

WHO: PTA4
Pure-tone average
(500, 1000, 2000 and 4000 Hz)

- under 25 Normal
- 26 – 40 Mild
- 41 – 60 Moderate
- 61 – 80 Severe
- 81 and over Profound

Familiar Sounds Audiogram

Loudness (dB)

Degree of Hearing Loss

Pitch (Hz)

PTA4

HPTA4
Environmental risk factors

Methods

- Occupational noise exposure
  - Official Swedish occupational coding for each occupation (NYK-85/90)
  - Individual time in each occupation from questionnaire 1992 and 2010
  - Job exposure matrix (JEM Sjöström et al, 2013) for noise exposure levels (<75 dBA; 75-85 dBA; >85 dBA; 1970-2004) for each occupation
  - Life time and periodic noise exposure and risk categories for each individual used to create exposure estimate

- Occupational solvent exposure
  - Yes/No - and cumulative exposure estimate

- Leisure time and military noise exposure and smoking

*Note: Nordic Occupational Classification system (NYK)*
*Job exposure matrix (JEM)*
Environmental risk factors

Methods

Occupational lifetime noise exposure divided into 4 classes
I. Noise >85 dB for >10 years
II. Noise >85 dB for 5-10 years
III. Noise 75 - 85 dB < 5 years
IV. No noise exposure < 75 dB (reference)

Solvent exposure from questionnaire Yes/ No

Firearm use at leisure time from questionnaire Yes/ No

Statistical analyses: regression analyses, linear quantile mixed models
(twin status – discordant for occupational noise exposure)
Outcome measures

Hearing thresholds between 125 – 8000 Hz in each ear

Pure-tone averages (PTA)
- PTA4 for 500, 1000, 2000 and 4000 Hz
- HPTA4 for 3000, 4000, 6000 and 8000 Hz

Threshold shifts (dB)
- For the two averages
- all frequencies
Environmental risk factors

Results

• Age affected all outcome measures
• Continual exposure to continuous occupational noise was a risk factor for PTA4 and HPTA4 hearing impairment for both BE and WE.
• Noise exposure on PTA4 and HPTA4 was of the same magnitude at both time points.
• Noise exposure between time point one and two affected the threshold shifts of PTA4 and HPTA4 more in participants with a pre-existing hearing loss at time point one.

Note: Better (BE) ; Worse (WE)
Low-frequency averages: 500, 1000, 2000 & 4000 Hz (PTA4)
High-frequency averages: 3000, 4000, 6000 & 8000 Hz (HPTA4)
Environmental risk factors

Results

- Pre-existing hearing loss can increase the risk of hearing impairment due to occupational noise exposure.
- Noise exposure was a risk factor for a greater change of PTA4 at time point one on the BE.
- Impulse noise exposure Class I did affect the HPTA4 on the WE.
- Lifetime occupational noise exposure was a risk factor in both PTA4 and HPTA4 in WE in Class I (>10 yrs).
- Increased risk for NIHL was also seen in the group with exposures below 85 dB(A) Class III in both WE and BE.

Note: Noise-induced hearing loss (NIHL)
Class I: noise >85 dB for >10 yrs
Class III: noise 75-85 dB <5yrs
Conclusions

• Early sign of hearing loss might increase the susceptibility to noise exposure
• Hearing thresholds of the WE were more highly correlated with noise exposure
• The HPTA4 was more sensitive to ageing
• Firearm use (leisure time) was risk factors for hearing impairment
• Smoking was not a risk factor
• PTA4 was more highly associated with NIHL
• Noise exposure 75 – 85 dB(A) increase the risk for NIHL and can affect hearing
The team behind this research

- Ann-Christin Johnson¹ – expert in ototoxic exposures
- Kjell K. Karlsson² – who started the project in 1991
- Renata Bogo¹,² – Audiologist, PhD candidate within the TWINHEAR project
- Åsa Skjönsberg¹,² – Principal Investigator
- Nancy L. Pedersen⁴ – expert in twin research
- Magnus Svartengren⁵ – expert in environmental and occupational medicine
- Per Muhr¹ – expert in noise exposure
- Ahmed Farah³ – statistician

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4. Department of Medical Epidemiology and Biostatistics, Karolinska Institutet, Stockholm,
5. Department of Medical Sciences, Occupational and Environmental Medicine, Uppsala University, Uppsala

All in SWEDEN
Influence of well-known risk factors for hearing loss in a longitudinal twin study

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Noise exposure below 85 dB(A) can affect hearing

For more information please contact renata.bogo@ki.se
1997


Description and primary results from an audiometric study of male twins. 
*Ear Hear*, 18, 114-120.

2015 - 2017


The role of genetic factors for hearing deterioration across 20 years: A twin study. 

Bogo, R., Farah, A., Karlsson, K.K., Pedersen, N.L., Svartengren, M. & Skjönsberg, Å.

Prevalence, incidence proportion, and heritability for tinnitus: A longitudinal twin study. 
*Ear & Hearing*, (Online Dec. 2016)
Kiitos kun jaksoitte kuunnella!
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