Prevalence and Risk Factors for Hyperacusis in Children: a Birth Cohort Study

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Definitions

- **Hyperacusis**: an abnormal lowered tolerance to sound (Baguley and Andersson, 2007)
- **Phonophobia**: the fear of sound
- **Misophonia**: negative reaction to specific types of soft sound
- Often confused: challenging to distinguish between a subjective increase in perceived intensity and the emotional reaction to this
- “Decreased Sound Tolerance” - Jastreboff and Jastreboff, 2013
Proposed mechanism

- Heterogeneous condition
- Increased gain of central auditory system
- May be associated with reduced peripheral auditory sensitivity
- Often comorbid with tinnitus: hyperacusis suggested as a precursor to tinnitus
Associated conditions

- Williams syndrome
  - High frequency HL
  - Recurrent OME
  - Acoustic reflexes deficient
- Autistic Spectrum Disorder
  - Auditory hypervigilance?
  - Oversensitivity to light and touch
- Migraine
- Depression
- Post-Traumatic Stress Disorder
Previous studies of prevalence

- Adults: 8 – 23%
- Coelho et al (2007)
  - Cross-sectional study
  - 506 children (from random selection of 700, one town in Brazil)
  - Age 5 – 12 years

**Hyperacusis**
- “Are you bothered by any kind of noise?” + identify ≥10/20 sounds from a list as being annoying + lowered LDL (5th percentile ≥ 1 frequency)
- Prevalence: 3.2%

**Phonophobia**
- “Are you afraid of sounds?”
- Prevalence: 9%
Other studies

- Sattar (2009)
  - 100 children from a clinic
  - Hyperacusis more common in males 2:1 ratio

- Baguley et al (2013)
  - 88 young persons with tinnitus, 4 specialist European centres
  - 39% had decreased sound tolerance
Study aims

- To estimate the prevalence of hyperacusis in 11 year old children using data from a prospective UK population-based study
- To identify any early life and auditory risk factors for hyperacusis
ALSPAC

- Avon Longitudinal Study of Parents and Children
- Prospective observational study
- www.bristol.ac.uk/alspac/
- Former Avon region: Population about 1 million
- Urban, suburbs, rural, small towns
- All pregnant women in region with expected dates of delivery between April 1\textsuperscript{st} 1991 and December 31\textsuperscript{st} 1992 were invited to participate
- Ethical approval for the study was obtained from the ALSPAC Law and Ethics Committee and the Local Research Ethics Committees.
ALSPAC

- Response rate approx 80%
- N = 13,971 live infants at age 12 mths
- Sample considered to be broadly representative of UK population (slightly higher levels of social advantage and lower levels of ethnic minorities)
- See Boyd et al (2013) for details of cohort
Prospective longitudinal studies: ALSPAC

Selection of participants

Pregnancy

Measurement of other risk factors and confounders

TIME

Age 7

Hearing

Age 9

Hearing

Age 11

Hearing
Hearing assessment session: Age 11

- Pure Tone Audiometry (AC, BC) (BSA recommended procedure)
- Tympanometry
- Questions about sound sensitivity
  - “Do you ever experience over-sensitivity or distress to particular sounds?”
  - Avoidance?
  - Over-sensitivity to light/colours, touch, pain, smell or taste?
  - Ear protection?
- Questions about tinnitus
Non-auditory risk factors

- Prenatal
  - Smoking in pregnancy
- Early life
  - Gestational age (<37 weeks, ≥37 weeks)
  - Birth-weight (≤2500g, >2500g)
  - Gender
  - SCBU
- Socioeconomic
  - Maternal education level (<16yrs, 16yrs, ≥18yrs)
  - Housing tenure (mortgaged/owned, private rented, council/HA)
  - Occupational social class (Registrar General’s Classification)
Results: prevalence

- N=7093
- Study sample socially advantaged compared to remainder of cohort
- 261 reported oversensitivity to sound
- Prevalence of hyperacusis = 3.68% [95% CI 3.25, 4.14]
  - Behavioural avoidance by 112 (42.9% hyperacusis children)
  - 21 (8.0%) used ear protection
Results: other sensory sensitivities

<table>
<thead>
<tr>
<th>Sensory sensitivity</th>
<th>N (% children with hyperacusis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light/colours</td>
<td>22 (8.4)</td>
</tr>
<tr>
<td>Touch</td>
<td>17 (6.5)</td>
</tr>
<tr>
<td>Smell</td>
<td>14 (5.4)</td>
</tr>
<tr>
<td>Taste</td>
<td>10 (3.8)</td>
</tr>
<tr>
<td>Pain</td>
<td>9 (3.4)</td>
</tr>
</tbody>
</table>
Association with socioeconomic factors

Reports of hyperacusis strongly associated with:

- Higher maternal education

<table>
<thead>
<tr>
<th>Mat Ed</th>
<th>N (%) hyperacusis</th>
<th>N (%) remainder of sample</th>
<th>Unadj OR [95% CI]</th>
<th>P</th>
<th>Adj OR [95% CI]</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;16yrs</td>
<td>39 (16.3)</td>
<td>1381 (22.1)</td>
<td>Ref</td>
<td></td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>GCSE</td>
<td>79 (32.9)</td>
<td>2217 (35.5)</td>
<td>1.26 [0.85, 1.86]</td>
<td>0.242</td>
<td>1.52 [0.97, 2.40]</td>
<td>0.066</td>
</tr>
<tr>
<td>A level+</td>
<td>122 (50.8)</td>
<td>2644 (42.4)</td>
<td>1.63 [1.13, 2.35]</td>
<td>0.009</td>
<td>1.72 [1.08, 2.72]</td>
<td>0.020</td>
</tr>
</tbody>
</table>
Association with child factors

Reports of hyperacusis strongly associated with:

- Male gender
  - Adj. OR for hyperacusis, if female = 0.64 [0.49, 0.85], p=0.002
- Children re/admitted to hospital in first 4 weeks of life
  - Adj. OR for hyperacusis, if hospital admission = 1.98 [1.20, 3.25], p=0.007
- No strong associations with birth-weight, gestational age, admission to SCBU
## Associations with PTA results

<table>
<thead>
<tr>
<th>Ear</th>
<th>Frequency (Hz)</th>
<th>Mean dBHL without hyperacusis (dBHL) [95% CI]</th>
<th>N</th>
<th>Mean dBHL with hyperacusis [95% CI]</th>
<th>N</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>500</td>
<td>4.81 [4.64, 4.98]</td>
<td>6766</td>
<td>5.45 [4.42, 6.48]</td>
<td>254</td>
<td>0.159</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>3.94 [3.77, 4.11]</td>
<td>6826</td>
<td>4.67 [3.61, 5.72]</td>
<td>260</td>
<td>0.117</td>
</tr>
<tr>
<td></td>
<td>4000</td>
<td>3.37 [3.18, 3.56]</td>
<td>6818</td>
<td>3.44 [2.42, 4.47]</td>
<td>258</td>
<td>0.878</td>
</tr>
<tr>
<td></td>
<td>6000</td>
<td>6.38 [6.16, 6.60]</td>
<td>6759</td>
<td>6.98 [5.74, 8.21]</td>
<td>250</td>
<td>0.316</td>
</tr>
<tr>
<td></td>
<td>8000</td>
<td>7.97 [7.73, 8.20]</td>
<td>6789</td>
<td>8.26 [7.03, 9.49]</td>
<td>248</td>
<td>0.640</td>
</tr>
<tr>
<td>Left</td>
<td>500</td>
<td>5.17 [5.00, 5.35]</td>
<td>6769</td>
<td>5.92 [4.69, 7.16]</td>
<td>253</td>
<td>0.115</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>3.30 [3.13, 3.47]</td>
<td>6827</td>
<td>4.28 [3.08, 5.47]</td>
<td>257</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>8000</td>
<td>7.57 [7.33, 7.81]</td>
<td>6795</td>
<td>9.06 [7.57, 10.56]</td>
<td>247</td>
<td>0.024</td>
</tr>
<tr>
<td>Bone</td>
<td>500</td>
<td>-0.167 [-0.32, -0.01]</td>
<td>6796</td>
<td>0.94 [0.04, 1.84]</td>
<td>249</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>-1.19 [-1.34, -1.04]</td>
<td>6800</td>
<td>-0.79 [-1.64, 0.06]</td>
<td>253</td>
<td>0.315</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>1.91 [1.74, 2.08]</td>
<td>6795</td>
<td>1.85 [0.91, 2.78]</td>
<td>251</td>
<td>0.893</td>
</tr>
</tbody>
</table>

- **Linear regression**
- **Strong associations inconsistent and diminished when adjusted for covariates**
- **Differences only approx. 1dBHL: not clinically significant**
Associations with other audiological outcomes

**Tinnitus**
- 109/260 (41.9%) children reporting hyperacusis also reported tinnitus
  - Chi²=25.3, p<0.0001

**Tympanometry**
- Children were not more likely to have OME (at age 11)
Conclusions: prevalence

- ALSPAC is the largest population-based study to look at hyperacusis in children
- Prevalence of hyperacusis in 11 year old children is estimated at 3.68% [3.25, 4.14]
  - Approx. one child per class affected
- 42.9% of these children showed avoidance behaviours
- Only 8% used ear protection
- A small proportion were sensitive to light / colours
- More common in boys
Conclusions: SES

- Associated with social advantage as measured by maternal education
  - Child more articulate?
  - Greater awareness of health issues?
  - Parents more attentive to health needs?
  - Fewer “life issues” to worry about?
- Unusual as most health conditions are associated with social disadvantage
- Socially advantaged sample so may have over-estimated prevalence
Conclusions: neonatal health

- Hyperacusis more prevalent in children admitted to hospital in first month of life
  
  **Causal:**
  - Adverse effect on auditory neurodevelopment?
  - Adverse effect on brain development which predisposes child to later behavioural / emotional problems?
  
  **Non-causal:**
  - Parents of child with difficult start in life might be hyper-vigilant about child’s health?
Conclusions: auditory outcomes

- Strong association with tinnitus
- No consistent associations with hearing thresholds
- No associations with middle ear function (at age 11)
  - Middle ear history not examined – early OME may be a risk factor
- LDLs not measured: have low sensitivity / specificity for hyperacusis
Acknowledgements

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References