The Sound of Freedom: Chronic Aircraft Noise Exposure and Children’s Health

Ms. Samantha Serrano, MS
Dr. Catherine Karr, MD, PhD
Ms. Nancy Beaudet, MS, CIH

Pediatric Environmental Health Specialty Unit (PEHSU)
Outline

• Introduction to noise
• Vulnerability of children
• Health effects of noise exposure
• Comparison to Whidbey Island situation
• Prevention strategies
• Resources
Introduction - Noise

- Noise – Unwanted or disagreeable sound
- Interferes with normal activities
  - Sleeping, conversation
- Disrupts or decreases quality of life
How do we measure noise?

- Measured by sound level decibel (dB)
- A-weighting (dBA) – accounts for human ear’s lower sensitivities to very high & very low frequencies (pitches)

- Maximum sound over a fraction of a second
  - $L_{A_{\text{max}}}$
- Average noise level over a defined time period
  - $L_{A_{\text{eq}}}$
Washington & National Noise Standards

- **Washington State** (Chapter 70.107 RCW NOISE CONTROL/WAC 173-60)
  - Max noise in a residential setting from a residential area: **55dBA**
  - 10pm-7am max noise is reduced by 10dBA: **45dBA**

- EPA sets community noise standards as:
  - 70-dBA 24 hour (Leq)

- Occupational settings: $L_{A\text{max}} = 115$ dBA

https://fortress.wa.gov/ecy/publications/SummaryPages/17360.html
http://www.epa.gov/air/noise.html
Vulnerability of Children

- Developmental toxicity
- Dependency on adults for safe environments
- May be more exposed due to behavior and settings
- Origin for adult onset of disease
Health Effects Studied

• Most consistent evidence
  ▫ Learning
  ▫ Annoyance
  ▫ Motivation

• Less consistent evidence
  ▫ Memory & Attention
  ▫ Perceived stress
  ▫ Stress hormone changes
  ▫ Cardiovascular effects
  ▫ Hearing loss
  ▫ Behavioral disorders

• No studies in children
  ▫ Sleep disturbance
Jet Noise Levels near Coupeville, WA on Whidbey Island
JGL Acoustics Report

- Jet noise on May 7, 2013
  - 4 outdoor measurements during 4 jet practice sessions
  - 1 indoor measurement in private residence
Maximum Noise Levels by Location in dBA

- Rosehip Farm: 115.7 dB
- Rhododendron Park Baseball Field: 114.3 dB
- Empty Lot (corner of Lockwood & Stark): 119.2 dB
- Inside Private Residence: 81.1 dB
- Bird watching platform at beach near ferry dock: 113.4 dB
Predicted Average Noise Levels over Loudest 16 hrs and 24 hours in dBA

- **Bird watching platform at beach near ferry dock**
  - 16 hr: 71.6
  - 24 hr: 69.9

- **Rosehip Farm**
  - 16 hr: 69.8
  - 24 hr: 64.1

- **Rhodadendron Park Baseball Field**
  - 16 hr: 74.8
  - 24 hr: 73.0

- **Empty Lot (corner of Lockwood & Stark)**
  - 16 hr: 76.7
  - 24 hr: 75.0
Impaired Reading Comprehension in Children
Coupeville Noise Measurement Comparison w/Research Data

Annoyance in Children
Coupeville Noise Measurement Comparison w/Research Data

- **Max (dBA)**
- **24-hr Leq (dBA)**

- **Empty Lot**
  - Max (dBA): 120
  - 24-hr Leq (dBA): 80

- **Bird Watching Platform**
  - Max (dBA): 110
  - 24-hr Leq (dBA): 70

- **Rosehip Farm**
  - Max (dBA): 120
  - 24-hr Leq (dBA): 80

- **Rhododendron Park**
  - Max (dBA): 130
  - 24-hr Leq (dBA): 90

- **Inside Residence**
  - Max (dBA): 110
  - 24-hr Leq (dBA): 70

Decreased Motivation in Children

- **95 max (dBA)**
- **62 24-hr Leq (dBA)**
Coupeville Noise Measurement Comparison w/Reference Values

Max (dBA)

Empty Lot  Bird Watching Platform  Rosehip Farm  Rhodadendron Park  Inside Residence

WHO Annoyance

50 max (dBA)
Coupville Noise Measurement Comparison w/Reference Values

Max (dBA)

80 max (dBA)

WHO Decreased Motivation/Increased Helplessness
Coupeville Noise Measurement Comparison w/Reference Values

Max (dBA)

<table>
<thead>
<tr>
<th>Location</th>
<th>Max (dBA)</th>
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<tbody>
<tr>
<td>Empty Lot</td>
<td>120</td>
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<tr>
<td>Bird Watching Platform</td>
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<tr>
<td>Rosehip Farm</td>
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<td>Rhododendron Park</td>
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<tr>
<td>Inside Residence</td>
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</table>

30 max (dBA)

WHO Sleep Disturbance
Coupville Noise Measurement Comparison w/Reference Values

<table>
<thead>
<tr>
<th>Location</th>
<th>Peak (dB)</th>
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<td>100</td>
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<tr>
<td>Inside Residence</td>
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</table>

WHO/EPA Hearing Loss

- 120 peak (dB) Children (WHO)
- 70 max (dBA) EPA
Coupville Noise Measurement Comparison w/Reference Values

Max (dBA)

School Sites
75 max (dBA)

Inside Classroom
45 max (dBA)

Washington State DOH - Schools
Coupeville Noise Measurement Comparison w/Reference Values

- Max (dBA)
  - Empty Lot: 120
  - Bird Watching Platform: 110
  - Rosehip Farm: 120
  - Rhododendron Park: 120
  - Inside Residence: 80

- Washington State Ecology - Residential

- Industrial: 60 max (dBA)
- Commercial: 57 max (dBA)
- Residential: 55 max (dBA)
Summary of Findings
Summary of Findings

• Child Health Impacts with Conclusive Evidence
  ▫ Learning
  ▫ Annoyance
  ▫ Motivation

• Whidbey Island measurements exceed levels that protect human health
Recommendations and Resources
Hierarchy of Hazard Control

- Eliminate the hazard
  - Relocate touch and go training activity
- Administrative controls
  - Schedule touch and go training when children are not in school
- Disrupt the pathway
  - Relocate outdoor child play/study areas to quiet settings
  - Engineering controls in schools, daycares and homes to reduce indoor noise exposure
    - Acoustic insulation
  - Community design policy for new buildings
    - Prioritize low exposure (siting and building design)
- Personal protection
  - Ensure that child wears child-sized hearing protection such as earplugs during touch and go training
  - Guard against additional noise exposure, musical devices, etc

Educate: instruct child to walk away from sources of loud noises
Health Impact Assessment (HIA)

- Used to assess the potential health effects of a project or policy prior to implementation
- Focus on child health
- Health impacts (i.e. noise, jet fuel combustion products)
Noise and Its Effects on Children

INFORMATION FOR PARENTS, TEACHERS, AND CHILDCARE PROVIDERS

Children often participate in recreational activities that can harm their hearing.

What Is Noise?
Noise is defined as any unwanted or disagreeable sound and is often dismissed simply as a “nuisance.” However, noise can become harmful when it interferes with a child’s normal activities, such as sleeping or talking, or disrupts or diminishes a child’s health or quality of life.

Measurement of Noise
Noise, like all sounds, is measured by the intensity and frequency of the sound waves that hit the ear. The unit used to measure the volume of sound is the decibel (dB). The greater the number of decibels, the louder the noise and the more harmful it is to your ears.

How the Ear Works
The ear is divided into three parts - the outer, middle, and inner ear.
Questions?

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Reading Comprehension & Academic Performance

• ↑ aircraft noise dose ↓ reading comprehension (most difficult questions)
• Noisy school reading comprehension < Quiet school
• ↓ failure rates on standardized tests after noise reduction
Annoyance

- Annoyance: triggers feelings of irritation, discomfort, distress, frustration, and offence
- ↑ aircraft noise dose ↑ annoyance
  - Netherlands
  - Spain
  - UK
- Annoyance in noisy schools/homes > Quiet schools/homes
  - China
  - Germany
  - UK
  - South Africa
Motivation

- Motivation impacted by aircraft noise
- Motivation of noisy school < Quiet school
Less consistent evidence
Memory and Attention

• Sustained Attention
  ▫ 3 studies

• Memory
  ▫ 4 studies

• Inconsistent effects, no effects, small effect size
Perceived Stress/Well-Being/Health

• 3 studies
  ▫ Tendency toward higher quality of life in quiet group
  ▫ No difference in perceived stress between noise and quiet groups
## Stress Hormones

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<th>Exposure ($L_{eq}$)</th>
<th>N</th>
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Hypertension

- Tendency toward positive association between aircraft noise exposure and children’s blood pressure
- Uncertainty based on methodological differences between studies
- Future research needed
Hearing Loss

- Three studies published in 1990s
  - Two negative
  - One with mild hearing loss for students near airport
- Standards to protect hearing loss
  - Occupational settings: $L_{A_{max}} = 115$ dBA
  - Indoor and outdoor educational/residential areas: $L_{eq, 24\ hr} = 70$ dBA
No field studies in children
Sleep Disturbance

• Sleep is important for learning, memory and behavior
• No recent studies identified directly addressing this question in children
• Federal Aviation Administration (FAA) has identified research on noise-induced sleep disturbance as high priority