

# THRESHOLD MEASUREMENTS IN PATIENTS WITH TINNITUS COMPARING CONTINUOUS, PULSED, AND WARBLE TONES



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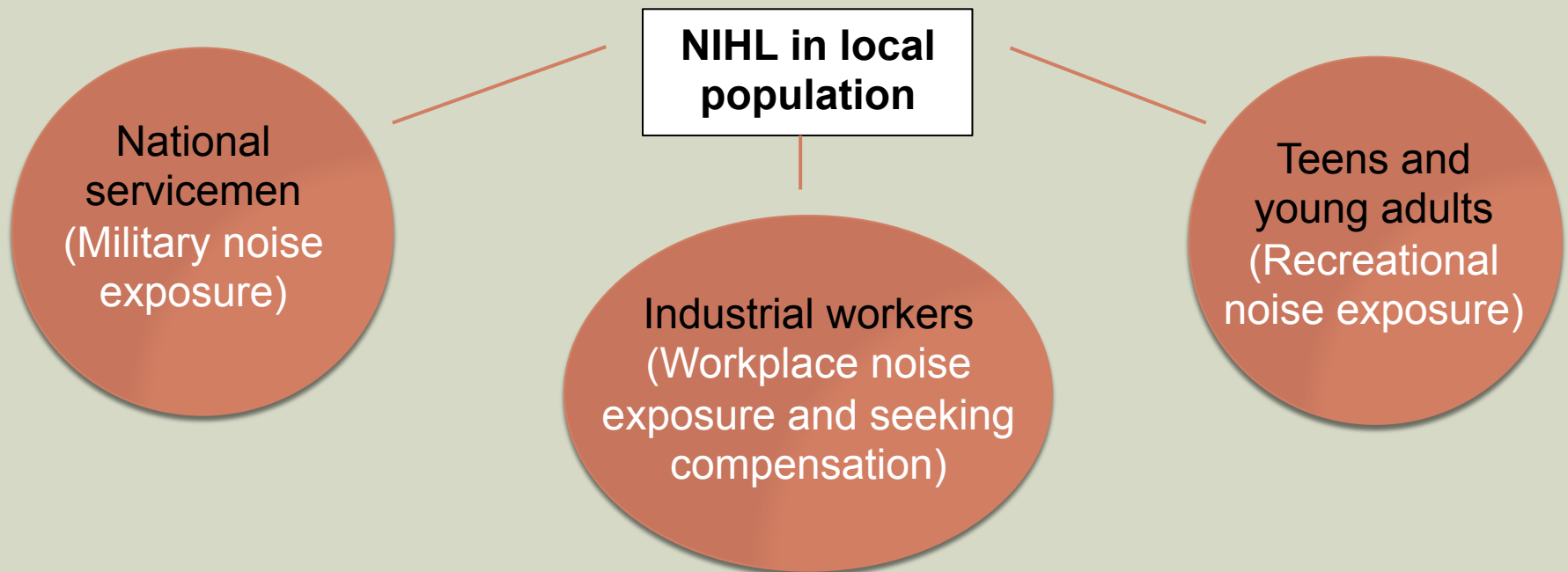
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# BACKGROUND

- Tinnitus is a prevalent condition that audiologists are bound to encounter in clinic
- Most commonly associated with noise-induced hearing loss (NIHL) (Henderson et al., 2011)



# BACKGROUND

- Patients with tinnitus may mistake internal tinnitus sound(s) for the audiometric test stimulus
  - False-positive responses
- ASHA (2005) guidelines recommend the use of pulsed or warble tones for tinnitus patients
- Several studies that compared between the use of pulsed and continuous tones in tonal tinnitus subjects (J. A. Henry & Meikle, 1999; Hochberg & Waltzman, 1972; Mineau & Schlauch, 1997) have reported:
  - No significant differences in threshold measurements
  - Use of pulsed tones → lesser no. of presentations
    - fewer false-positive responses
  - Pulsed tones preferred over continuous tones
- Warble tones?

# STUDY CONCEPT

- Study the use of pulsed tones in various tinnitus types (in addition to tonal tinnitus)
- Study the use of warble tones in individuals with tinnitus
- Compare across the use of continuous, pulsed, and warble tones to identify if there would be a most efficient test stimulus:

Accurate  
hearing  
thresholds

Significantly less  
no. of stimulus  
presentations

Significantly  
less no. false-  
positive  
responses

Preferred  
test  
stimulus by  
subjects

# STUDY PROCEDURES

- Prospective study, 30 subjects enrolled
- Subjects referred by audiologists, through word-of-mouth, or self-referral
- Have subjective tinnitus (present  $\geq 50\%$  of the time) with measurable thresholds:
  - In the ear with tinnitus in unilateral cases,
  - Or in at least one ear in cases of bilateral tinnitus, or tinnitus in the head

## 1) Pre-audiometry

Type of tinnitus  
Location of tinnitus  
Presence of tinnitus  
Select test ear  
Pre-assigned stimulus presentation sequence

## 2) Familiarisation Task

Thresholds at 1kHz and 4kHz (minimised learning effect)

## 3) Study audiometry

Thresholds obtained at 250Hz – 8kHz (including 3kHz and 6kHz)  
No. of presentations recorded for each stimulus at each frequency  
Likewise for no. of false-positive responses

## 4) Post-audiometry

Each subject's preferred stimulus (if any) was recorded (easiest to distinguish)

# STUDY DATA

# MEAN HEARING THRESHOLDS (dBHL) OBTAINED ACROSS STIMULUS TYPES

	Continuous tone		Pulsed tone		Warble tone	
Frequency (Hz)	Mean (SD)					
250	18.5	(12.9)	18.8	(12.4)	19.2	(13.4)
500	20.2	(12.0)	20.5	(12.0)	19.7	(12.1)
1000	18.7	(12.8)	18.7	(12.0)	18.7	(12.2)
2000	19.5	(12.4)	19.3	(12.5)	19.5	(13.5)
3000	24.0	(17.7)	23.3	(16.3)	23.8	(17.7)
4000	25.8	(18.5)	26.2	(18.3)	25.8	(19.3)
6000	26.8	(19.6)	27.0	(18.4)	26.5	(18.5)
8000	27.5	(21.8)	27.8	(21.0)	27.0	(21.6)

# MEAN NUMBER OF TEST STIMULUS PRESENTATIONS REQUIRED ACROSS STIMULUS TYPES

	Continuous tone		Pulsed tone		Warble tone	
Frequency (Hz)	Mean (SD)					
<b>250</b>	<b>8.6</b>	(2.0)	<b>8.6</b>	(2.1)	<b>8.7</b>	(2.0)
<b>500</b>	<b>9.2</b>	(1.7)	<b>9.6</b>	(2.0)	<b>9.2</b>	(2.0)
<b>1000</b>	<b>9.1</b>	(1.8)	<b>9.7</b>	(2.1)	<b>9.6</b>	(2.4)
<b>2000</b>	<b>8.9</b>	(1.9)	<b>9.2</b>	(2.9)	<b>9.1</b>	(2.5)
<b>3000</b>	<b>9.6</b>	(2.4)	<b>8.9</b>	(2.1)	<b>8.9</b>	(1.8)
<b>4000</b>	<b>8.9</b>	(1.9)	<b>8.8</b>	(1.9)	<b>9.0</b>	(3.1)
<b>6000</b>	<b>9.9</b>	(2.6)	<b>9.3</b>	(2.4)	<b>9.1</b>	(2.4)
<b>8000</b>	<b>9.3</b>	(2.6)	<b>9.3</b>	(1.9)	<b>8.2</b>	(2.3)



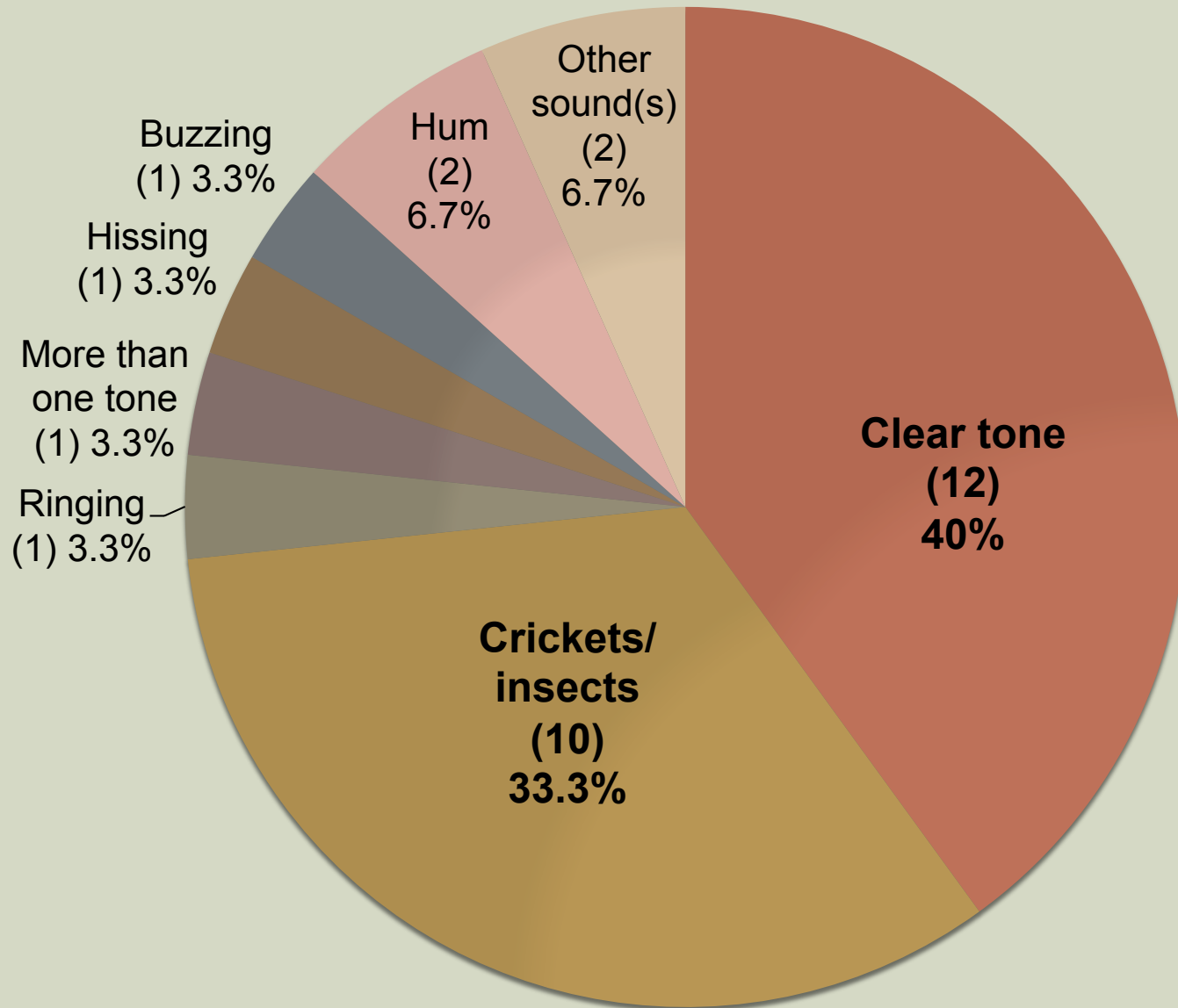
# NUMBER OF SUBJECTS PRESENTING A GIVEN NUMBER OF FALSE-POSITIVE RESPONSES ACROSS STIMULUS TYPES

No. of false-positive responses										
	0	1	2	3	4	5	6	9	11	20
Continuous tone	20	4	3	0	0	1	0	1	0	1
Pulsed tone	19	7	1	2	0	0	0	0	1	0
Warble tone	18	5	1	2	2	1	1	0	0	0

# SUBJECT PREFERENCES FOR ANY STIMULUS USED

<b>Preferred stimulus</b>	<b>No. of subjects</b>	<b>% of total subjects</b>
<b>Continuous tone</b>	10	<b>33.3</b>
<b>Pulsed tone</b>	11	<b>36.7</b>
<b>Warble tone</b>	5	<b>16.7</b>
<b>No preference</b>	4	<b>13.3</b>
<b>Total</b>	30	<b>100</b>

# Subject-reported Tinnitus Types



# SUBJECT PREFERENCES FOR ANY STIMULUS USED BASED ON TYPE OF TINNITUS SOUND(S) EXPERIENCED

Type of tinnitus sound(s)	n	Preferred stimulus	No. of subjects
<b>Clear tone</b>	12	Continuous tone	3
		<b>Pulsed tone</b>	<b>6</b>
		Warble tone	1
		No preference	2
<b>Crickets/insects</b>	10	<b>Continuous tone</b>	<b>5</b>
		Pulsed tone	2
		Warble tone	2
		No preference	1

## Subpopulation analyses in these two subject groups

No significant differences reported between the three test tones for:

- Hearing thresholds obtained
- No. of stimulus presentations required
- No. of false-positive responses that occurred

# CONCLUSION

- No significant differences noted in:
  - Mean hearing thresholds obtained
  - Mean no. of stimulus presentations required
  - Total no. of false-positive responses
- Suggests that continuous, pulsed and warble tones were equally efficient test stimuli
- Subjects with clear tone tinnitus → **pulsed tone preferred**
- Subjects with crickets/insects-sounding tinnitus → **continuous tone preferred**
- A larger study sample is needed to reach more definitive conclusions

# FUTURE

- Survey the most common types of tinnitus sounds experienced by patients here in Singapore
- Larger population of subjects for each of these specific tinnitus types can be recruited and studied for their responses in audiometry
- Significant differences may be present in larger study populations
- Subject preferences may support the pattern of findings seen in this study for subjects with clear tone tinnitus or crickets/insects-sounding tinnitus

**THANK YOU**

Thank God.

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