



WIDEBAND TYMPANOMETRY NORMS FOR SINGAPORE POPULATION USING PRESSURE SWEEPS

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Thesis Presentation Outline



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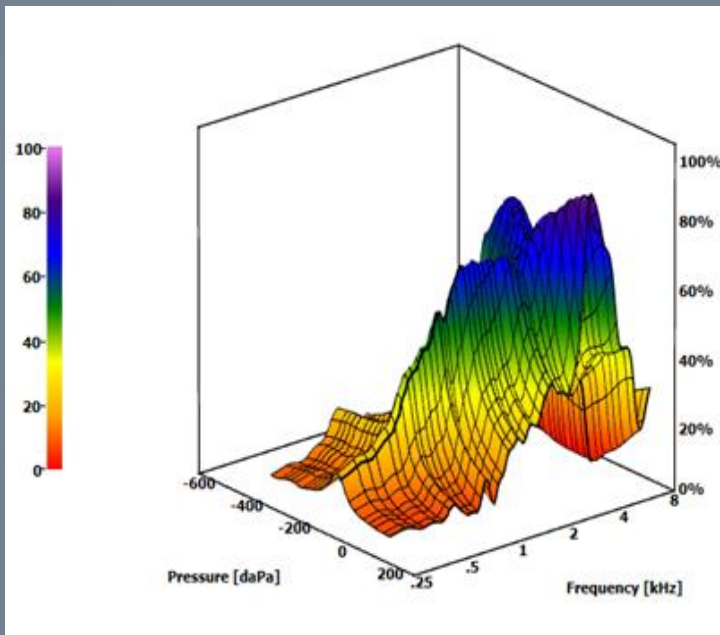
References



	226 Hz Tympanometry	Wideband Tympanometry (WBT)
Current clinical standard for middle ear (ME) testing	✓	✗
Objective	✓	✓
Single protocol for all ages	✗	✓
Allows the extraction of both standard, narrow-band and WBT parameters in just one measurement	✗	✓
Improved differential diagnosis and sensitivity to certain ME pathologies	✗	✓
Stable and robust recordings	✗	✓
Population-specific norms	✓	✗

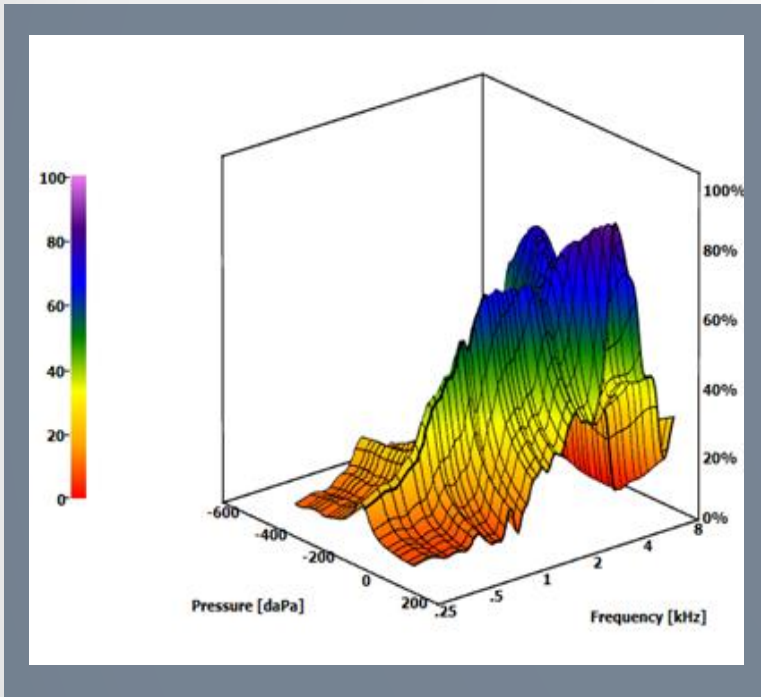
Rationale of this study:

- Tan (2019) conducted a normative study to establish the normative data for wideband energy absorbance at static pressure in the adult Singaporean population
- This research study is an extension of the study by Tan (2019) to establish normative data for WBT measures using pressure sweeps
- Since no studies in Singapore have investigated WBT measures using pressure sweep, it is clinically relevant to gather such data



Specific Aims & Hypothesis:

- i. Establish **WBT normative data** for the **Singaporean adult population** with **normal and healthy ears**
- ii. To **evaluate the effects of gender** on the WBT data
 - There will be a **significant effects of gender** on WBT measures
- iii. To **evaluate the effects of age** on the WBT data
 - There will be **significant differences between the different age groups** in relation to WBT measures



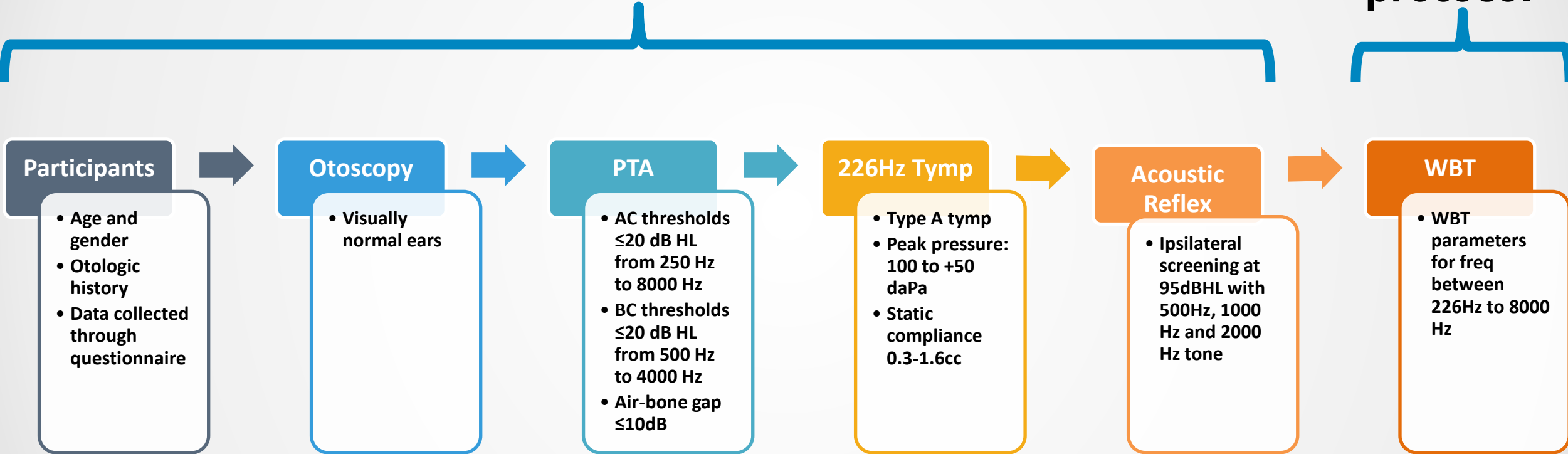
Specific Aims & Hypothesis:

- iv. To compare **effects of ear laterality** on the WBT data
 - **Ear laterality** will have **no significant effect** on the overall WBT response
- v. To assess the **effects of pressure sweep directions** on wideband acoustic immittance parameters
 - There will be a **significant effect of pressure sweep directions** on the WBT parameters
- vi. To examine **within-subject test-retest reliability** of WBT
 - There will be a **good correlation** between WBT measures with no re-insertion of the probe tip during the **8 test-retest trials**

Methodology:

Screening protocol

Experimental protocol





PARTICIPANTS

- Participants (N=50)
- Singaporeans and permanent residents
- 26 females and 24 males
- No. of ears ($N_{\text{ears}}=89$)
- Aged 21-59



INSTRUMENTS

- Screening and experimental procedures conducted in NUS SMART classroom (ambient noise in the room is less than 30 dBA)
- Heine mini3000 otoscope
- Siemens Unity 2 Audiometer
- Interacoustics' Titan system (firmware version 1.10.14)



STATISTICAL ANALYSIS

- Performed with Jamovi (Version 1.2, 2020)
- Parameters not normally distributed ($\alpha < 0.05$) → Mann-Whitney U test
- Parameters normally distributed → Student's t-test
- Effects of age and test-retest reliability → One-way Anova and Tukey Post-Hoc

Normative Data for Singapore population

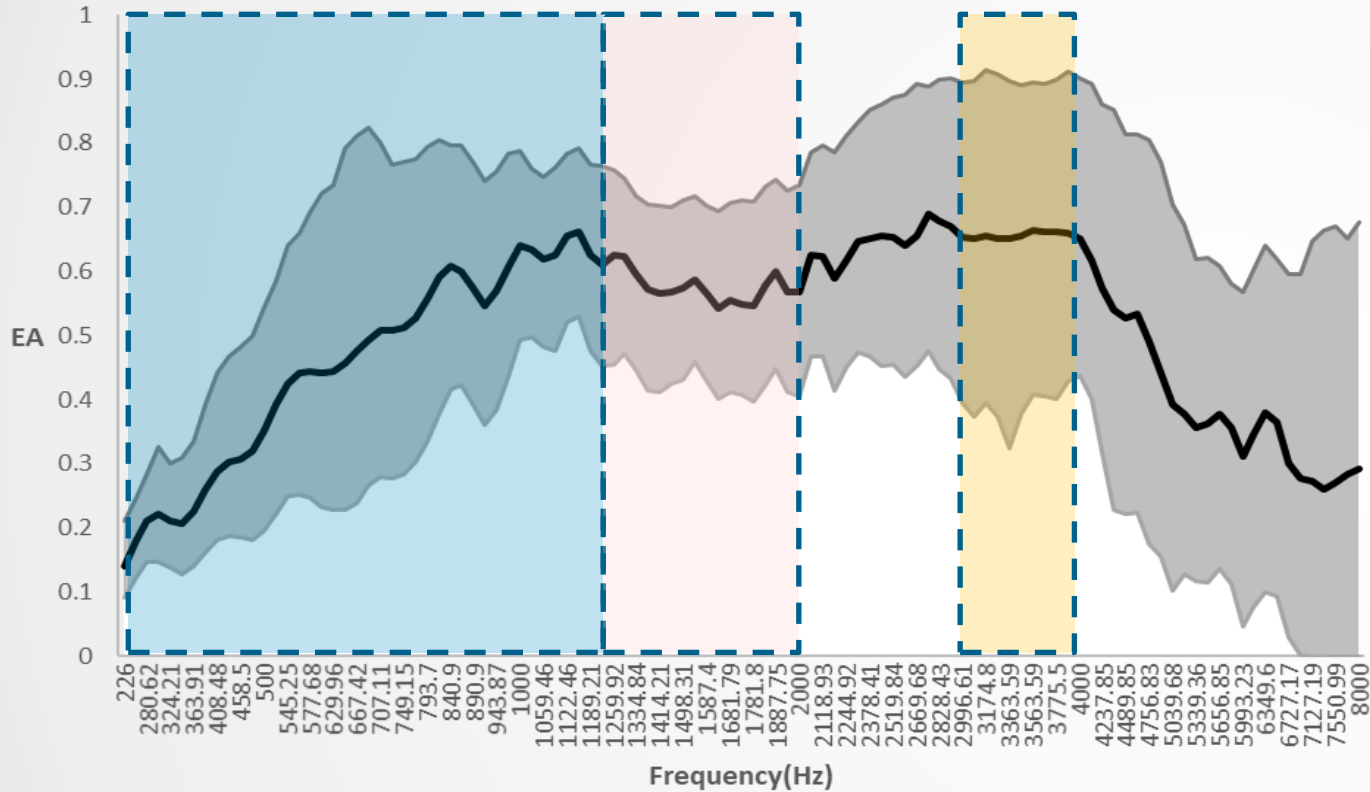


Figure 1: Mean energy absorbance (EA_{TPP}) responses for 89 normal Singaporean adult ears obtained at tympanometric peak pressure at 107 frequencies between 226Hz to 8000Hz using 8 descending sweeps. The grey shaded area represents the 90% range

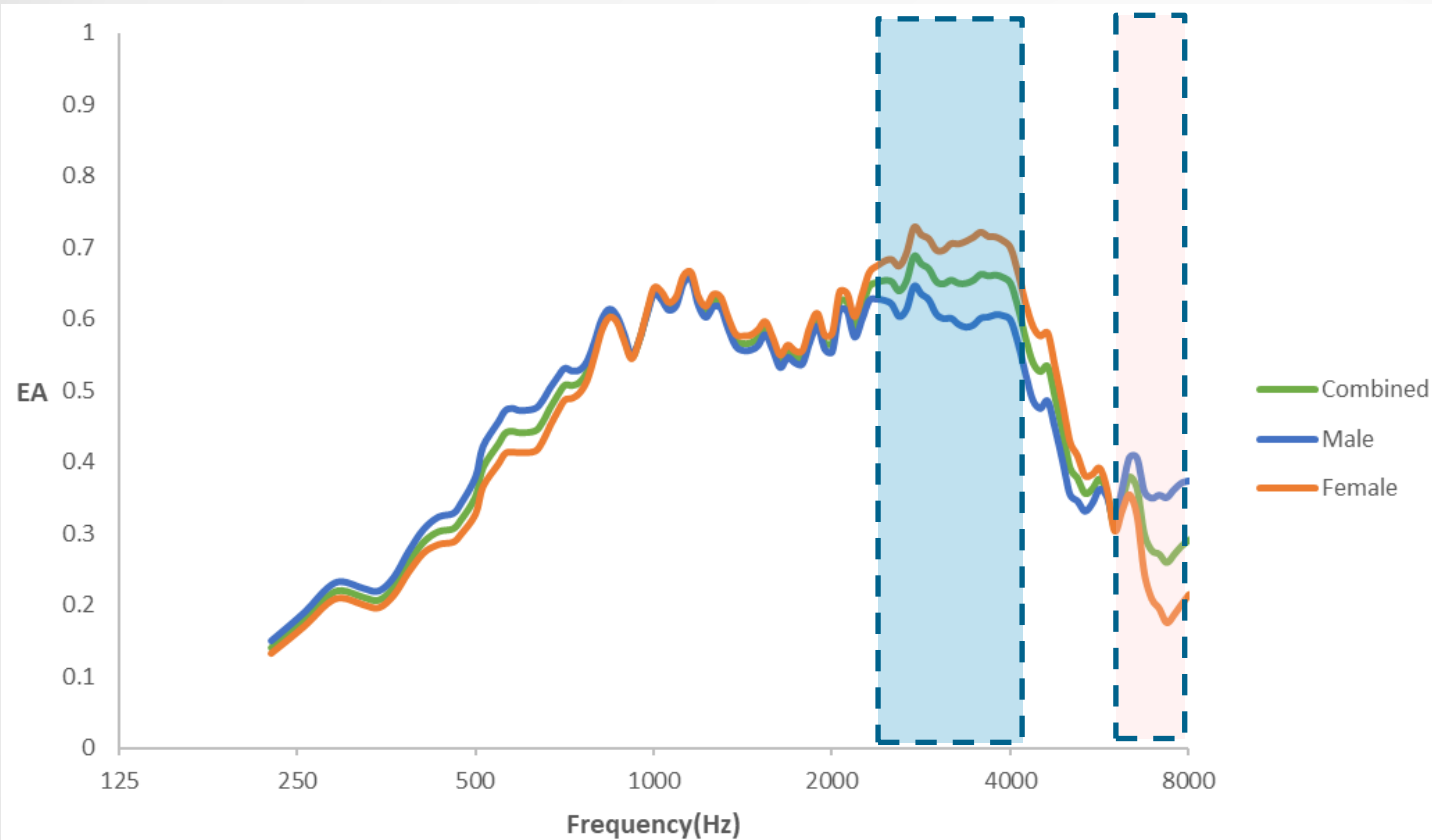
General trend of EA_{TPP}:

- Mean EA_{TPP} lowest at 226Hz
- Mean EA_{TPP} increases from 226Hz to the mid-freq around 1250Hz
- Dips between 1250Hz and 2000Hz
- Reaches a **second maxima peak** between 3000 Hz to 4000 Hz

Normative Data for Singapore population

- Two peaks (1250 Hz and between 3000-4000Hz)
- Corresponds to ME and EAC resonant frequencies respectively
- Pattern in EA spectrum in this study is closely similar to that observed by other studies (Sun, 2016) & (Tan, 2019)

Effects of gender



Significant differences ($p < 0.05$)
between gender and mean EA_{TPP}
was found for **two frequency**
bands:

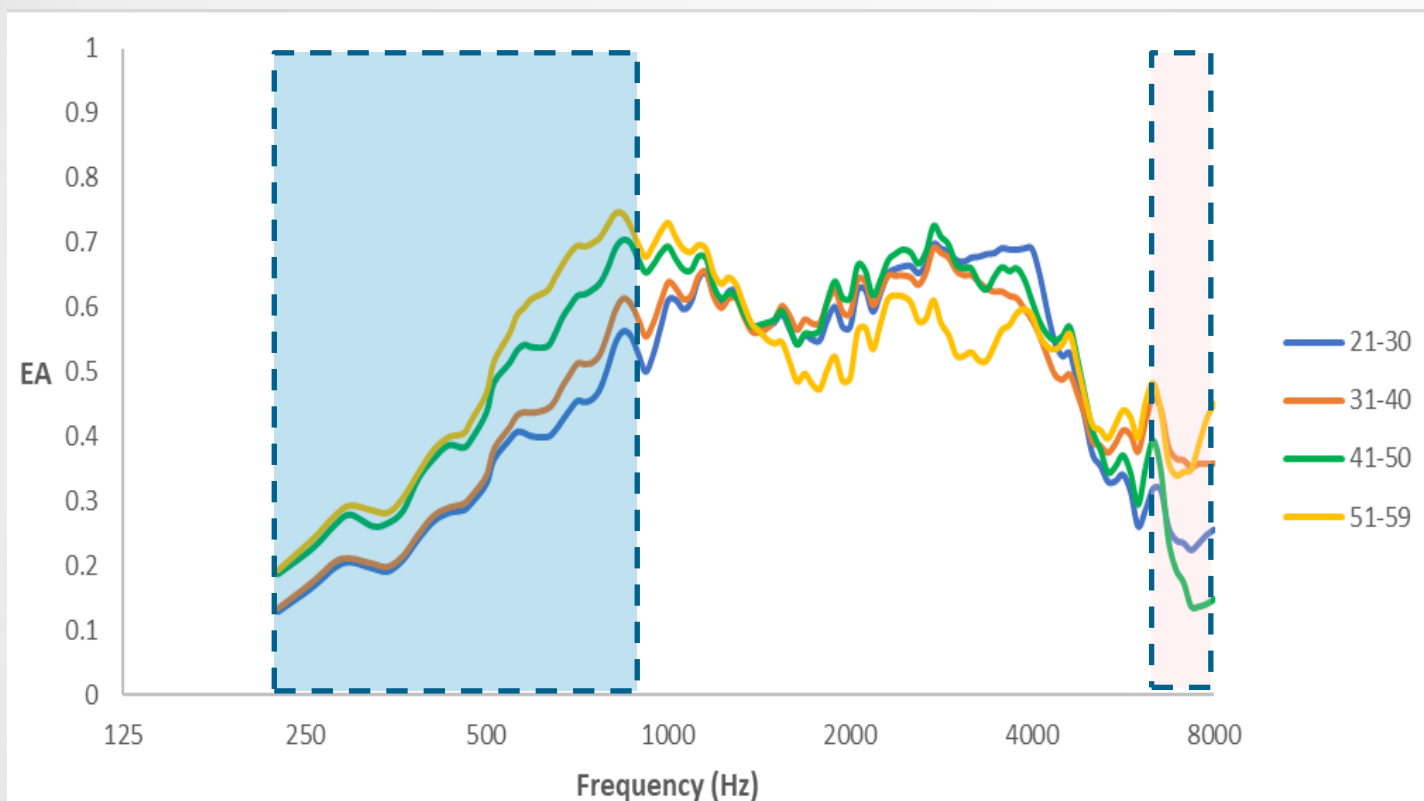
- 1) 2593 Hz to 4621 Hz
- 2) 6727 Hz to 8000 Hz

Figure 2 : Mean absorbance values (EA_{TPP}) of male and female participants obtained at tympanometric peak pressure at 107 frequencies between 226Hz to 8000Hz, averaged across 8 WBT runs using descending pressure sweeps

Effects of gender

- Mean EA_{TPP} significantly higher for females than males for frequency band between 2593 Hz to 4621 Hz
 - Polat et al. (2015) observed this trend between 3100 Hz and 6900 Hz
 - Shahnaz et al. (2013) observed higher absorbances in Chinese females than Chinese males at 4000 Hz and 5000 Hz
- In this study, between 6727 Hz to 8000 Hz, mean EA_{TPP} is significantly higher for males than females
 - This trend has not been reported by previous studies

Effects of age



Mean EA_{TPP} responses were **most significantly different** between the (21-30) and (51-59) age groups, followed by (21-30) and (41-50) age groups

Figure : Mean EA_{TPP} responses across four age groups of participants at 107 frequencies between 226Hz to 8000Hz, averaged across 8 WBT runs using descending pressure sweeps

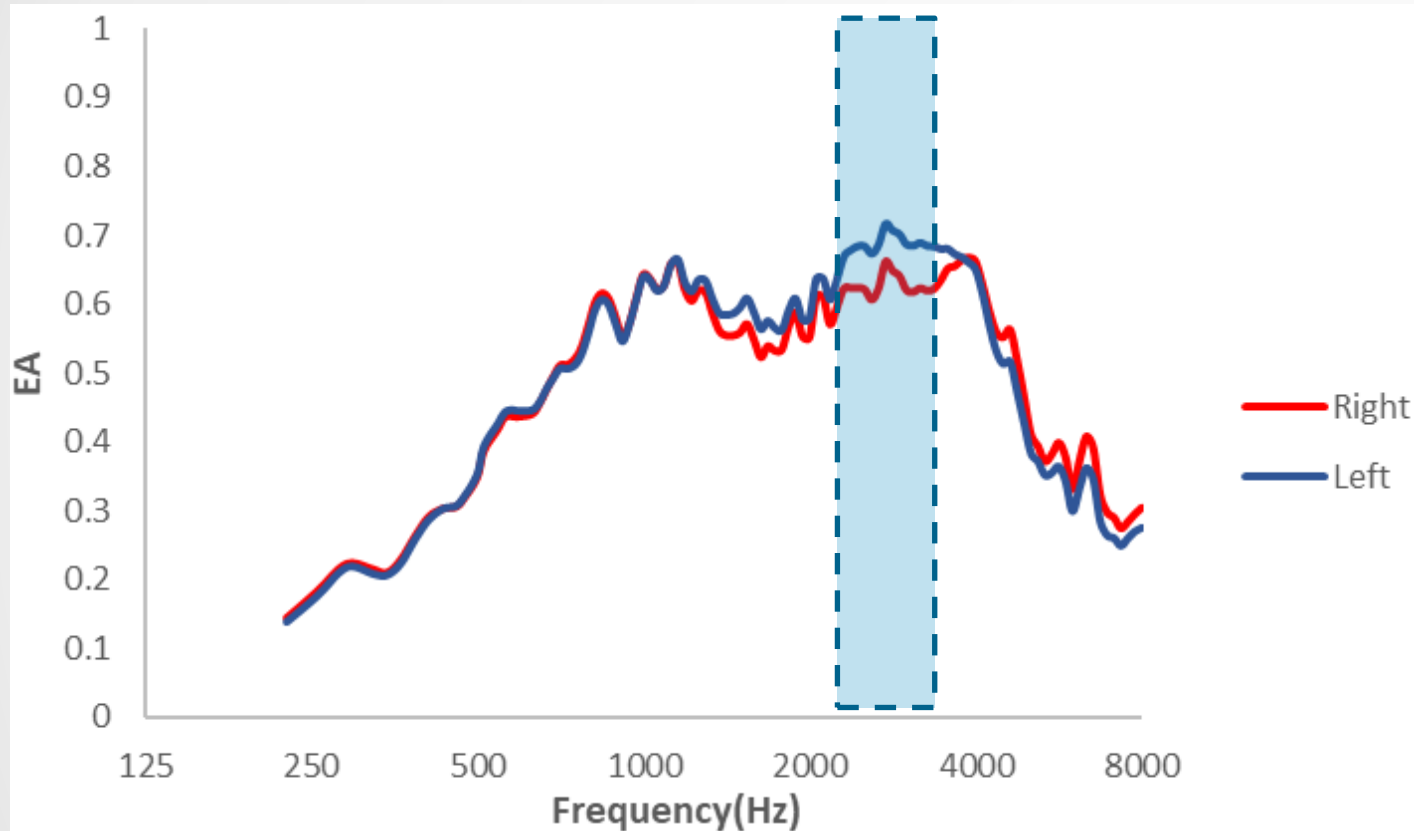
Effects of Age

- Feeney et al. (2004) and Mazlan et al. (2015) suggested changes in the middle ear due to aging could potentially start around 42 years of age
- (21-30) and (51-59) age groups:
 - differences at center frequencies of 250 Hz, 315 Hz, 630 Hz, 800 Hz, 6300 Hz and 8000 Hz
- (21-30) and (41-50) age groups:
 - differences at center frequencies of 250 Hz, 315 Hz and 800 Hz

Limitations:

- Mean age of participants in this study was 31.9 years
- Number of ears in the younger age group (21-30) was much higher than the number of ears in the other age groups

Variability due to ear laterality



No overall significant differences between mean EA_{TPP} responses of right ears and left ears across all center frequencies **except between 2239-3548 Hz**

Figure : Mean EA_{TPP} responses for left ears (n=39) and right ears (n=39) obtained at 107 frequencies between 226Hz to 8000Hz, averaged across 8 WBT runs using descending pressure sweeps

Variability due to ear laterality

- Effects of ear laterality on wideband EA responses by comparing right ears and left ears within a single participant
- In the current study, only slight variations in mean EA_{TPP} were seen as a result of ear laterality at two centre frequencies 2500 Hz and 3150Hz (between 2239 Hz and 3548 Hz)
- Two studies found that there were no significant differences (Özgür et al., 2016; Shahnaz et al., 2006) whereas Tan (2019) found significant differences

Limitations:

- Attributed to procedural effects as the testing sequence was not randomized

Variability due to pressure sweep directions

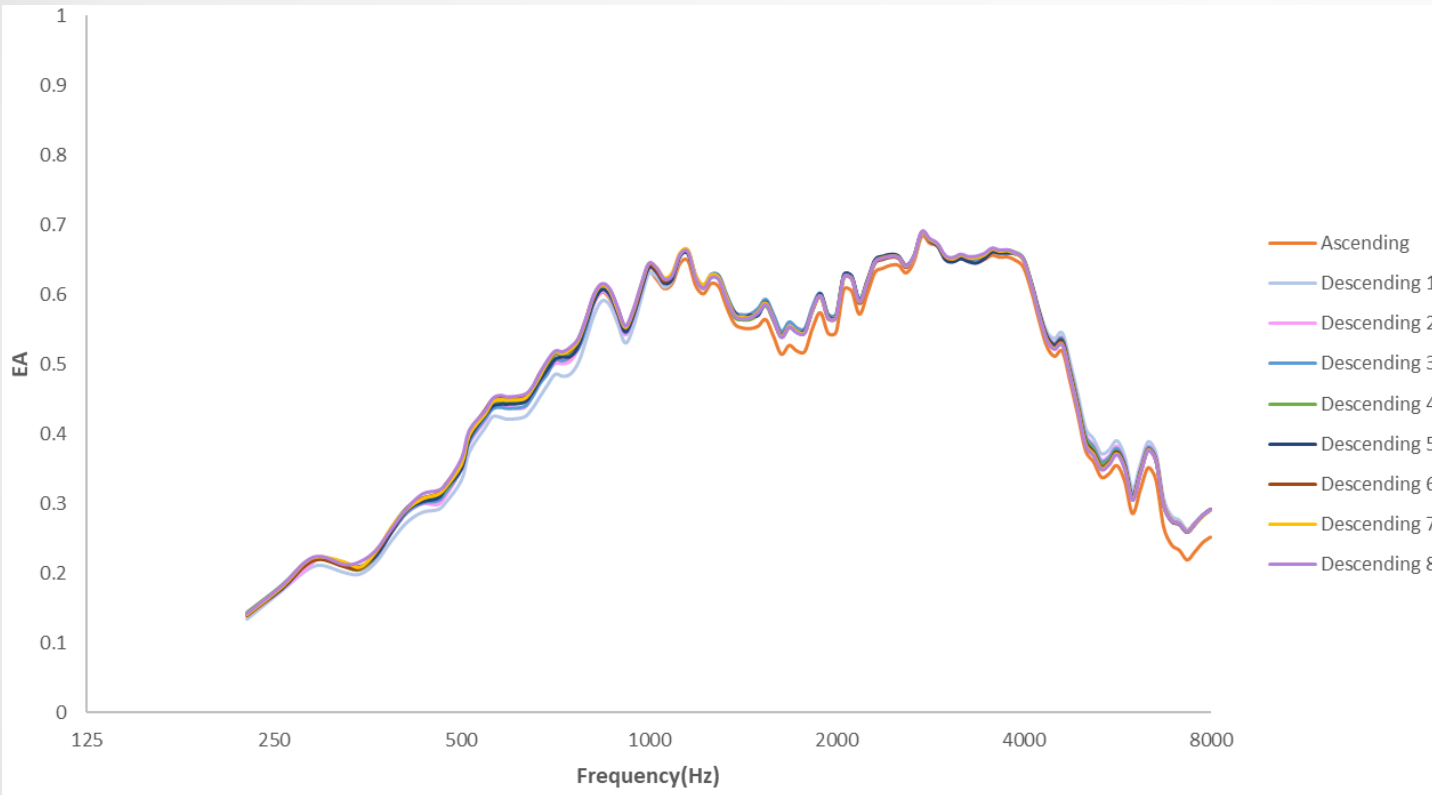


Figure : Mean EA_{TPP} responses for ascending and descending pressure sweeps for 89 ears

No significant differences between between the mean EA_{TPP} obtained at 16 center frequencies in the ascending pressure sweep compared to any of the eight descending pressure sweeps

Variability due to pressure sweep directions

- Descending pressure sweep more commonly used since multiple notches can occur in tympanograms using ascending pressure sweep (Margolis et al., 1985; Wilson et al., 1984)
- Liu et al. (2008) compared peak EA between ascending and descending sweeps and found that pressure sweep direction had effect on peak EA
- However, no significant effect of pressure sweep direction on mean EA_{TPP} was observed in this study

Test-retest reliability of WBT

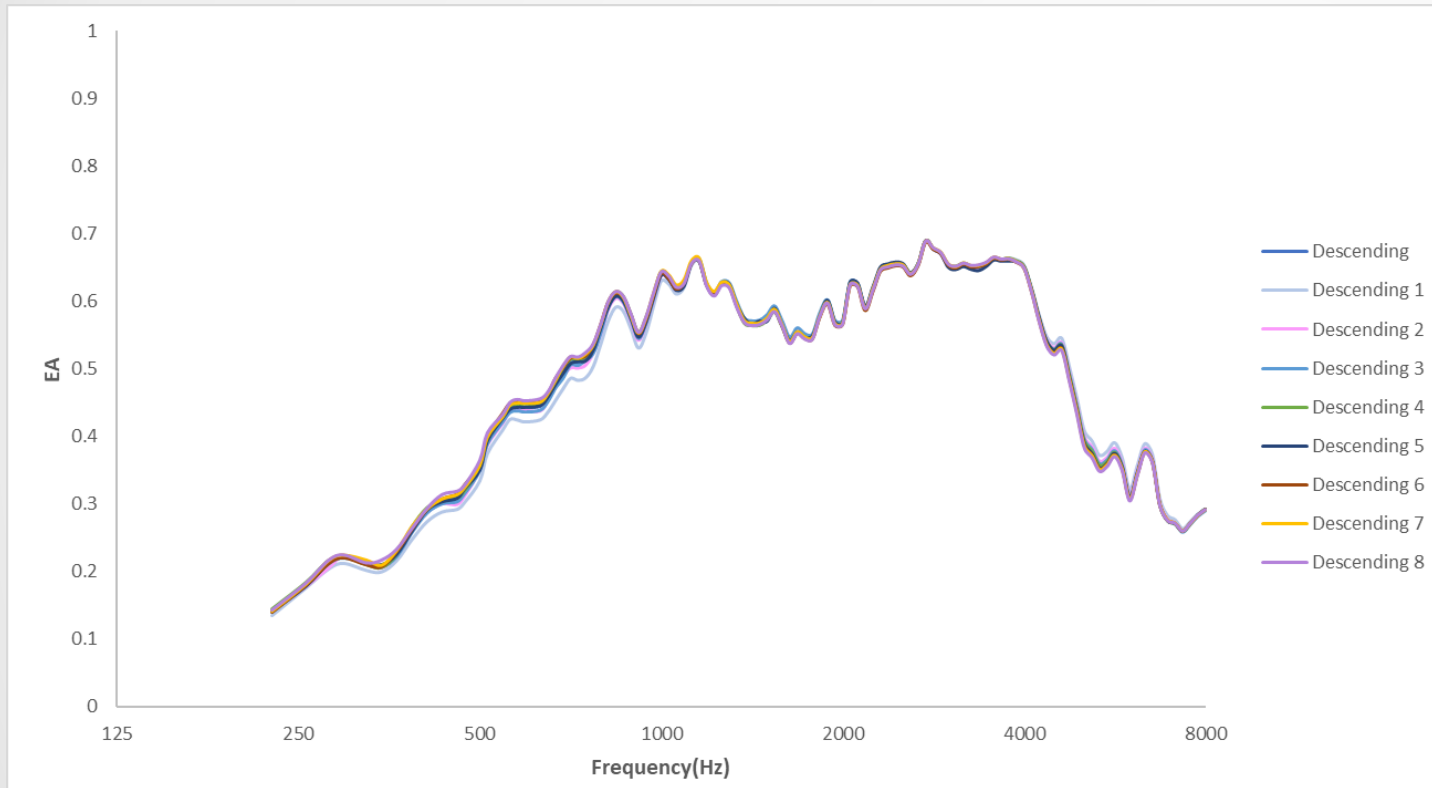


Figure : Mean EA_{TPP} responses for 8 descending pressure sweeps for 89 ears

No significant differences between between the mean EA_{TPP} obtained at 16 center frequencies in the eight descending pressure sweeps

Test-retest reliability of WBT

- Eight consecutive trials were performed without reinsertion of the probe so as to look at the immediate test-retest reliability
- No significant differences between the mean EA_{TPP} of any of the eight consecutive WBT trials at 16 center frequencies
- Immediate test-retest reliability was found to be good (p-value ≈ 1.0)

Conclusion

- WBT normative data for Singaporean adult population established
- Significant effects for the co-variables, gender and age on the WBT EA responses
- Only slight variations in mean EA_{TPP} as a result of ear laterality
- No significant differences between ascending and descending pressure sweep directions
- Good test-retest reliability for wideband tympanometry demonstrated
- Normative data in this study can provide a baseline to compare WBT measures in adult ears with middle ear pathology

Future Work

- Wideband data for neonates and pathological ears can be established

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Acknowledgements

