



**PERSONAL AUDIO SYSTEM LISTENING
LEVEL IN THE PRESENCE OF
SIMULATED PUBLIC
TRANSPORTATION SOUND LEVEL
AND
THE RISK OF NOISE-INDUCED
HEARING LOSS (NIHL) IN
ADOLESCENTS IN SINGAPORE**

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Introduction



Personal Audio System (PAS)

Combination of a personal audio device (handphone, MP3) and a listening device (earphone, headphone)



Noise-induced hearing loss (NIHL)

- **Caused by excessive sound exposure** (Ryan et al., 2016; Lin et al., 2011; Kujawa & Liberman, 2006; Liberman & Dodds, 1984)
- **Irreversible & Progressive** (Kujawa & Liberman, 2009)
- **Affects individuals of all ages**
- **Preventable** (Roberts & Neitzel, 2019; Berger, 2010)

In Singapore,

- **Absence** of hearing conservation programs in the **non-occupational settings**
- **High sound exposure from PAS in young population**
 - **~52% of children** (aged 8-9 years old) owned mobile phones (DQ Institute, 2017)
 - **95.8%** of students from Temasek Polytechnic listened to audio on PAS **daily** for approximately 2.3 hours/day (Lee et al., 2014)

Presence of background sound

- **Majority** of people listened to audio on their PAS as they **commute** (National Arts Council, 2020; Muchnik et al., 2012)
- **Average sound level** in public transportation ranges from **73.45 - 80.4 dBA** (Yu et al., 2016; Neitzel et al., 2009)
- **Positive relationship** between listening level on PAS and the intensity of background sound (Jiang, et al., 2016; Portnuff, Fligor & Arehart, 2011)
 - People may increase their listening level in the presence of background noise

AIM: To investigate the sound level adolescents in Singapore were exposed to from listening on their PAS while commuting.

Damage risk criteria:

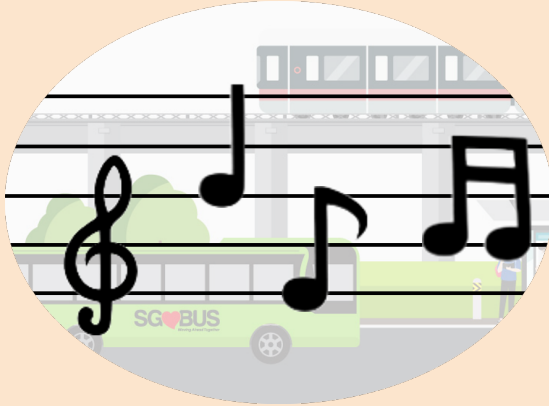
80 dBA for 8 hours with an exchange rate of 3 dB (Roberts & Neitzel, 2019)

02

Methodology

The background features several overlapping, soft-edged circles in muted colors: a large light blue circle on the right, a medium reddish-brown circle in the center, and a large light orange circle at the bottom left. The text is overlaid on these shapes.

2 sections



**Creation of Public
Transportation Noise
(PTN)**



**Measuring PAS
listening level**

Create PTN



Record sound levels in
buses and trains



Recruitment

Inclusion criteria:

- 13-19 years old
- Listened to PAS on public transportation at least once a week
- Uses insert style earphone

Create PTN



Record sound levels in buses and trains

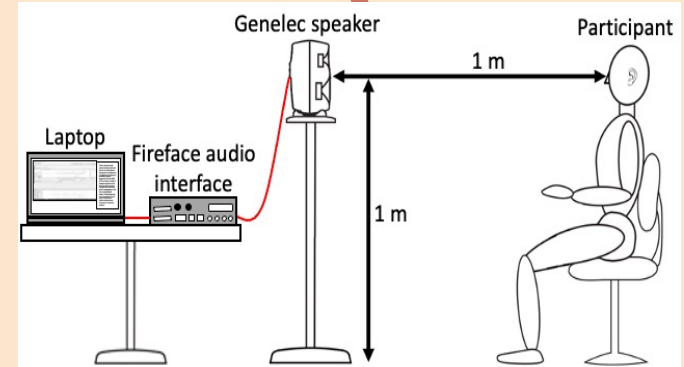


Recruitment

Questionnaire



Hearing level categorisation procedure



PAS listening level measurement

The background features a light blue area on the right and a light orange area on the left, separated by a curved boundary. Several white, organic shapes of varying sizes are scattered across the blue area, creating a layered, abstract effect.

03

Results &
Discussion

Demographics of participants



25 participants (13 male, 12 female)



Age range: 14 to 19 years old (mean = 17.6 years old)



All participants responded reliably to pure tone presented at frequencies 500, 1000, 2000 and 4000 Hz



4/25 used earphones with active noise cancellation features

Results

Mean age started listening on PAS

= 11.4 years old (SD: 2.5)

Average duration spent listening to PAS during commute

= 1.04 hours (6.5%)

Median listening level on PAS during commute

= 72.9 dBA

Median $L_{eq,8h}$ spent listening to PAS during commute

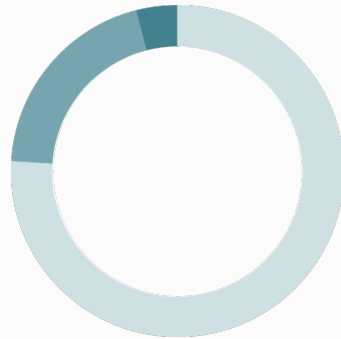
= 62.8 dBA (<80 dBA for 8 hours)

Median signal-to-noise difference

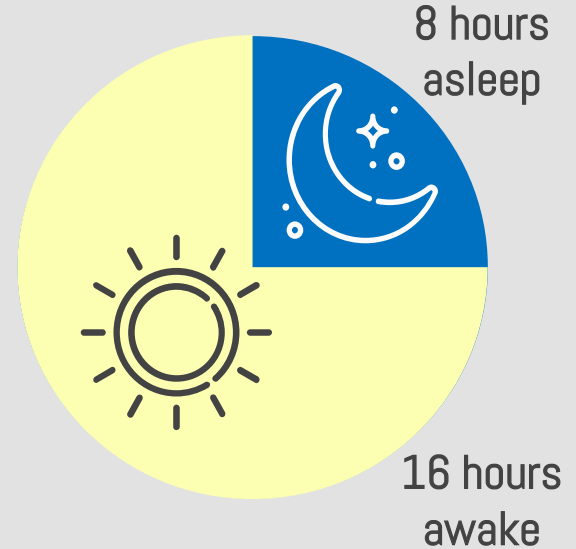
= 0.4 dB

Results

Percentage of daily noise dose incurred by listening on PAS during commute



- 76% No/Less risk (<6.5%)
- 20% High risk (6.5% - 100%)
- 4% Very high risk (>100%)



(Paruthi et al., 2016)

Discussion



24% of participants exceeded the daily noise dose of 6.5% from listening to PAS during commute, out of which 1 exceeded 100% daily noise dose

Discussion



Listening level measured is lower compared to other studies conducted in the presence of similar level of background noise, and $L_{eq.8h}$ measured in this study is lower due to shorter duration.

Studies	Country	Age (years old)	Sound level of test environment (dBA)	Average listening level (dBA)
Muchnik, Amir, Shabtai, & Kaplan-Neeman (2012) n = 74	Israel	14-16	61.0-70.0	89.0
Portnuff, Fligor, & Arehart (2011) n = 29	Colorado	13-17	70.0 (Bus and pink noise)	79.1
			75.0 (Plane noise)	81.3
This study n = 25	Singapore	14-19	72.5 (PTN)	72.9

Discussion



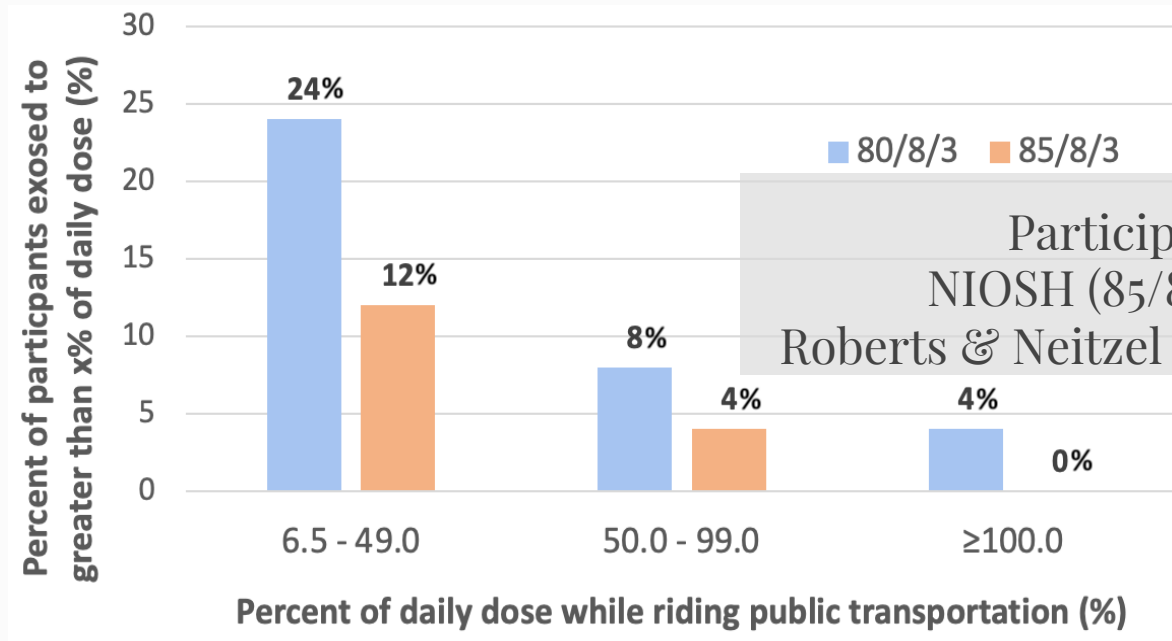
Most participants started listening to PAS in primary school age (11.4 years old)



Insert earphone is good passive sound isolator (SND = 0.4 dB)

Portnuff, Fligor, & Arehart (2011) :
SND = 12.2 dB

Discussion



Participant 1:
NIOSH (85/8/3) – 57%
Roberts & Neitzel (80/8/3) – 179.1%

Huge difference between results calculated using different damage risk criteria, more appropriate to use conservative Roberts & Neitzel criteria for adolescents

Limitations



Small and convenient sample size (n=25)

Investigated only one style of listening devices

Results **may not be representative** of all adolescents in Singapore



Small sample of users with active noise cancellation (ANC) earphone (n= 4)

No definitive conclusion on the effect of use of earphone with ANC



Self-reported duration spent listening to PAS on public transportation in a week were obtained

May be **under/over estimation** of actual exposure duration

In conclusion,



In conclusion,

A **small but significant** proportion of young Singaporeans were over-exposed to loud sound from PAS during a commute

This study only analyzed sound exposure from PAS during commute hours, not total PAS use



More research on a bigger scale should be conducted on investigating sound exposure from total PAS use to determine if sound regulation in non-occupational settings for adolescents is **justified** in Singapore

Thank you!

Do you have any questions?

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