SPEECH PERCEPTION OUTCOMES FOR CHILDREN USING COCHLEAR IMPLANTS WHO HAVE A PREMATURE AND/OR LOW BIRTH-WEIGHT HISTORY

Jacinta Pennacchia[1]

Shani Dettman[1,2,3]

Dawn Choo[1,2]

Peter Carew[1]

1. The University of Melbourne

2. The HEARing CRC

3. The Cochlear Implant Clinic
Royal Victorian Eye and Ear Hospital

BACKGROUND: PRETERM DEFINITIONS

- Gestational Age (GA) of less than 37 weeks
  - moderate or late preterm; 32 - < 37 weeks
  - very preterm; 28 - < 32 weeks, and
  - extremely preterm; < 28 weeks (Howson, Kinney, & Lawn, 2012; WHO, 1992)

- Low Birth Weight (LBW) 1500 - 2500 grams (g)
- Very Low Birthweight (VLBW) 1000 – 1499 g, and
- Extremely Low Birthweight (ELBW) <1000 g (WHO, 1992)

THE UNIVERSITY OF MELBOURNE

THE HEARING CRC

BACKGROUND: RISK FACTORS

- Gestation Age and Low Birth Weight are associated
  - ½ of preterm-born children have a Low Birth Weight, and
  - ¾ of Low Birth Weight children are born preterm

- Risk factors associated with both include;
  - indigenous heritage
  - smoking during pregnancy
  - remote residence
  - plurality (twins, triplets etc)
  - age at pregnancy (younger than 20 years *, older than 40 years)

    (* teen pregnancies 14 to 17 years = social deprivation, biological immaturity, underweight, less prenatal care)

THE UNIVERSITY OF MELBOURNE

THE HEARING CRC

PREVALENCE PRETERM BIRTHS

Country	preterm births per 100 births
Malawi	18.1
Comoros	16.7
Congo	16.7
Zimbabwe	16.6
Equatorial Guinea	16.5
Mozambique	16.4
Gabon	16.3
Pakistan	15.8
Indonesia	15.5
Mauritania	15.4

15 million each year

Preterm rates range from 5 to 18% (higher rates in poorer countries)

Of 65 countries with reliable trend data, all but 3 show increases in preterm birth rates over the past 20 years

(WHO, 2012 https://www.who.int/pmnch/media/news/2012/201204_borntoosoon-report.pdf)

THE UNIVERSITY OF MELBOURNE

THE HEARING CRC

PREVALENCE

Country	Premature birth	from	to
Australia (WHO, 2012 https://www.who.int/pmnch/media/news/2012/201204_borntoosoon-report.pdf)	Gestational Age	1995 **6.6%**	2015 **8.1%**
	Low Birth Weight	1995 **5.9%**	2015 **6.5%**

And preterm babies who survive may face

a range of disabilities

a lifetime of disability

Oh, Dettman, Dowell (2013)
N=25 preterm birth history using CIs
(average GA 28.2 weeks)

24/25 additional medical conditions
15/25 cognitive delay/disorder

THE UNIVERSITY OF MELBOURNE

THE HEARING CRC

RESEARCH QUESTIONS

1. Prevalence. What percentage of our local population of children receiving CIs have a preterm aetiology?

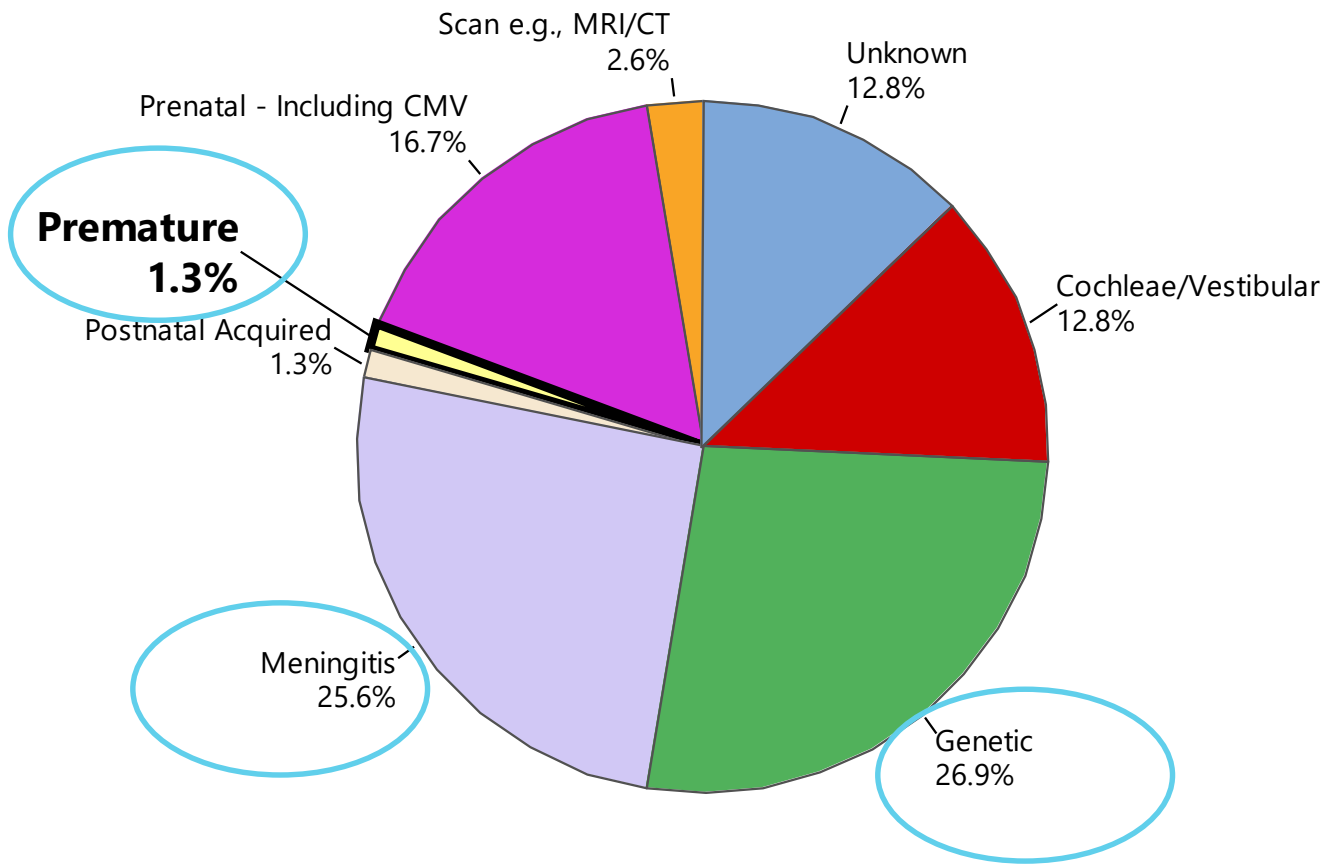
2. For those with a preterm aetiology, describe speech perception outcomes and examine relationships between child and family factors and post-CI speech perception

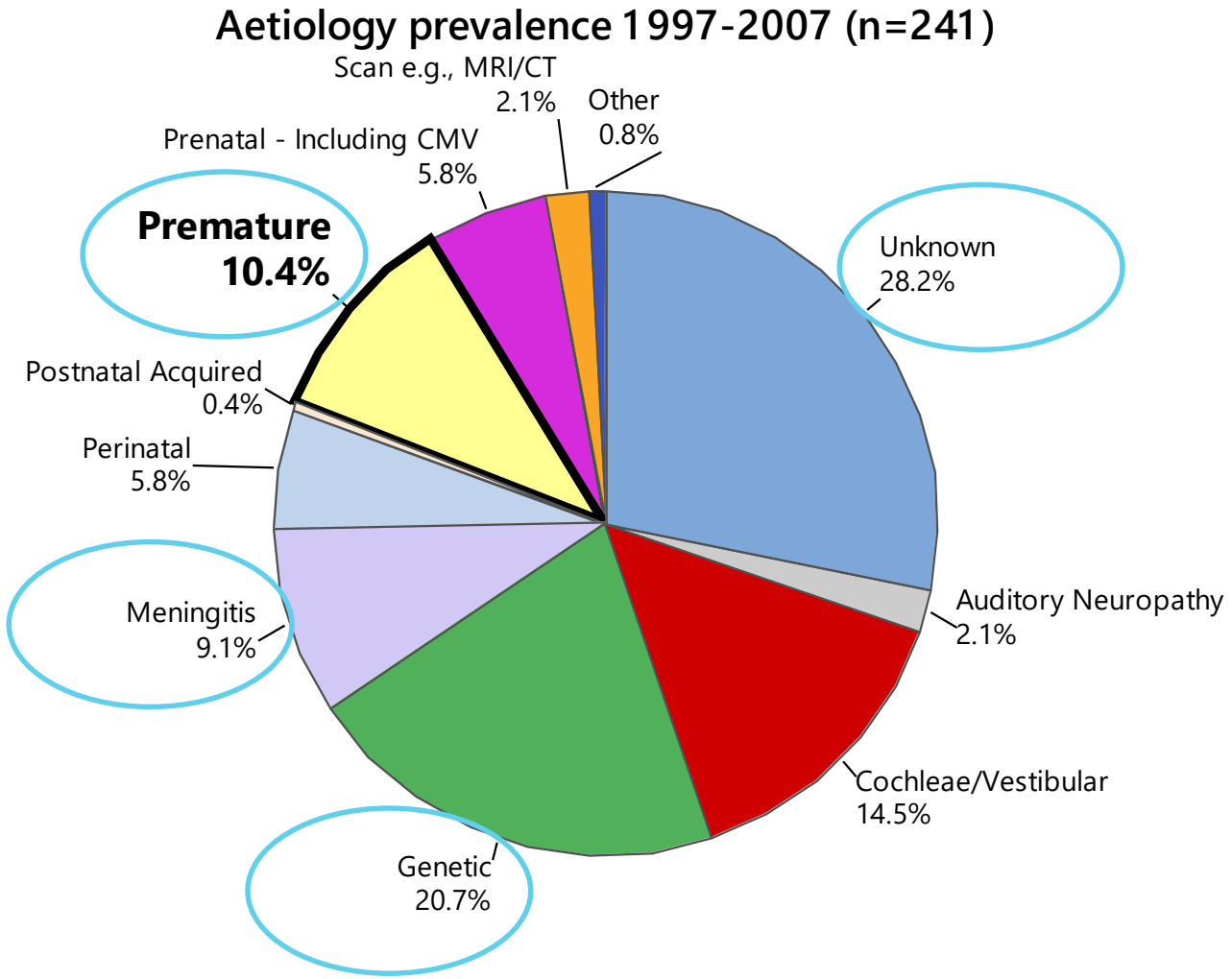
RESEARCH Q1: prevalence

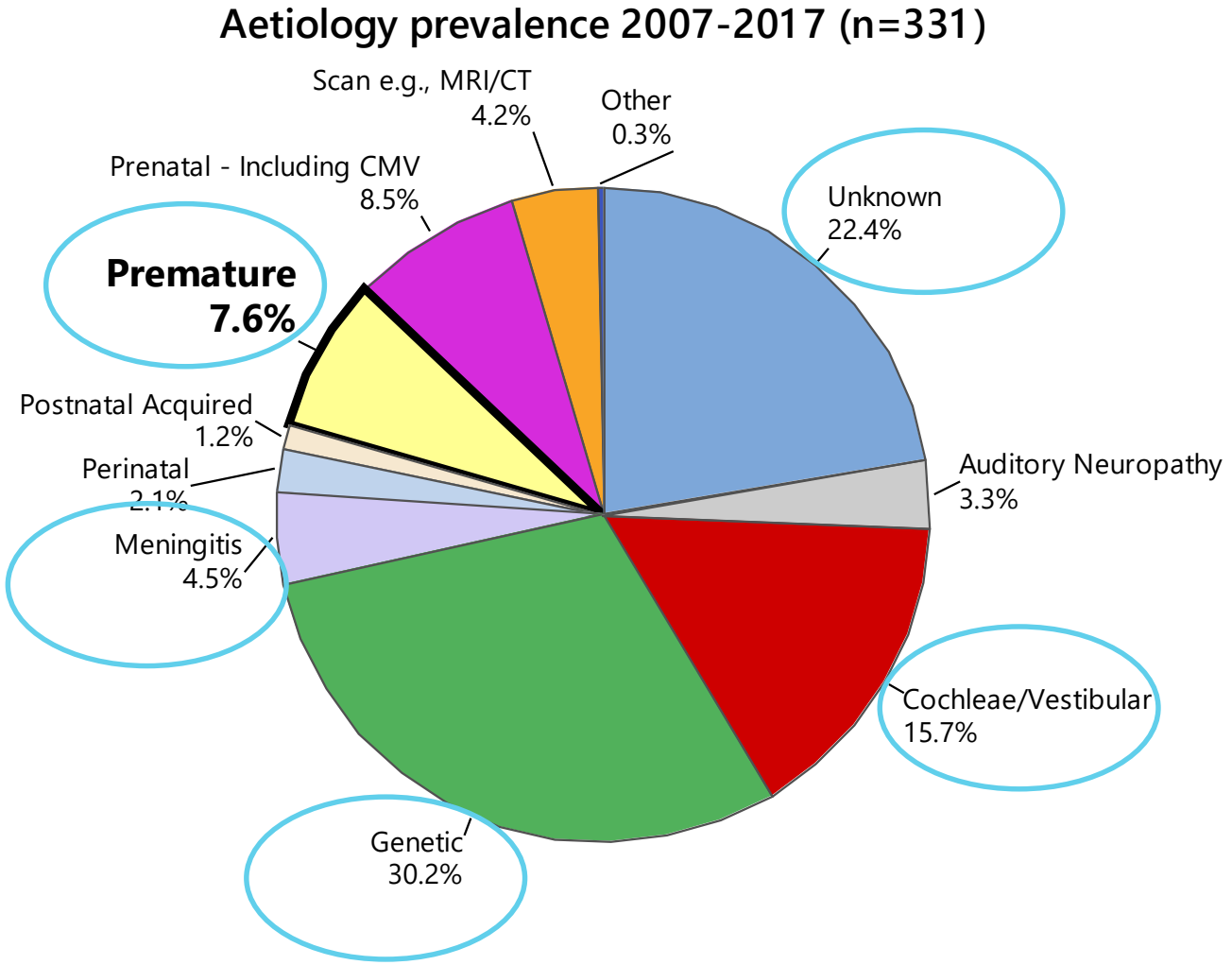
PARTICIPANTS

CIC Paediatric Database N=933

Aetiology prevalence 1987-1997 (n=78)




Aetiology prevalence 1997-2007 (n=241)
Scan e.g., MRI/CT
2.1%
Other
0.8%
Prenatal - Including CMV
5.8%
Premature
10.4%
Unknown
28.2%
Postnatal Acquired
0.4%
Perinatal
5.8%
Meningitis
9.1%
Auditory Neuropathy
2.1%
Cochleae/Vestibular
14.5%
Genetic
20.7%


Aetiology prevalence 2007-2017 (n=331)
Scan e.g., MRI/CT
4.2%
Other
0.3%
Prenatal - Including CMV
8.5%
Unknown
22.4%
Premature
7.6%
Postnatal Acquired
1.2%
Perinatal
2.1%
Auditory Neuropathy
3.3%
Meningitis
4.5%
Cochleae/Vestibular
15.7%
Genetic
30.2%

RESEARCH Q2: speech perception

PARTICIPANTS

CIC Paediatric Database N=933

CAPI-Revised (Dettman et al., 2018)

8. open-set understanding in +10dB signal/noise > or = 75%
7. open-set understanding in +20dB signal/noise > or = 75%
6. open-set understanding in quiet > or = 75% (phoneme score 75-100%, word 44-100%, sentence 71-100%)
5. open-set understanding in quiet 50 to 75% (phoneme score 50-74%, word 14-43%, sentence 27-70%)
4. open-set understanding in quiet < or = to 50% (phoneme score 0-49%, word 0-13%, sentence 0-26%)
3. closed-set understanding > or = 75% & functional indicators of audition; understands what, where Qs, comprehends 1/2/3 step instructions
2. limited closed-set understanding < 75% (e.g., modified versions/ ½ lists) & functional indicators of audition; responds to name consistently, imitates LING sounds
1. some sound awareness & functional indicators of audition; attempts to localise, change in vocalisation when device 'on'
0. limited or no awareness of sound

MATERIALS: CAPI-R

CAP (Archbold et al., 1995)

CAP-II (Gilmour, 2010

CAPI (Black et al., 2014)

Dettman, S., Choo. D., & Dowell, R. (2018, May). CAPI-Revised and CLIP: Two practical tools to measure outcomes for children with hearing loss which can facilitate multi-centre research collaboration. Poster presented at the Audiology Australia National Conference, Sydney, New South Wales.

THE UNIVERSITY OF MELBOURNE

THE HEARING CRC

RESULTS: speech perception

RESULTS: SPEECH PERCEPTION

- median CAPI-R score for all participants was 5 (*N* = 35)

- this corresponds to open-set phoneme understanding of 50-74%, word understanding of 14-43%, and sentence understanding of 27-70%, in a quiet environment

THE UNIVERSITY OF MELBOURNE

THE HEARING CRC

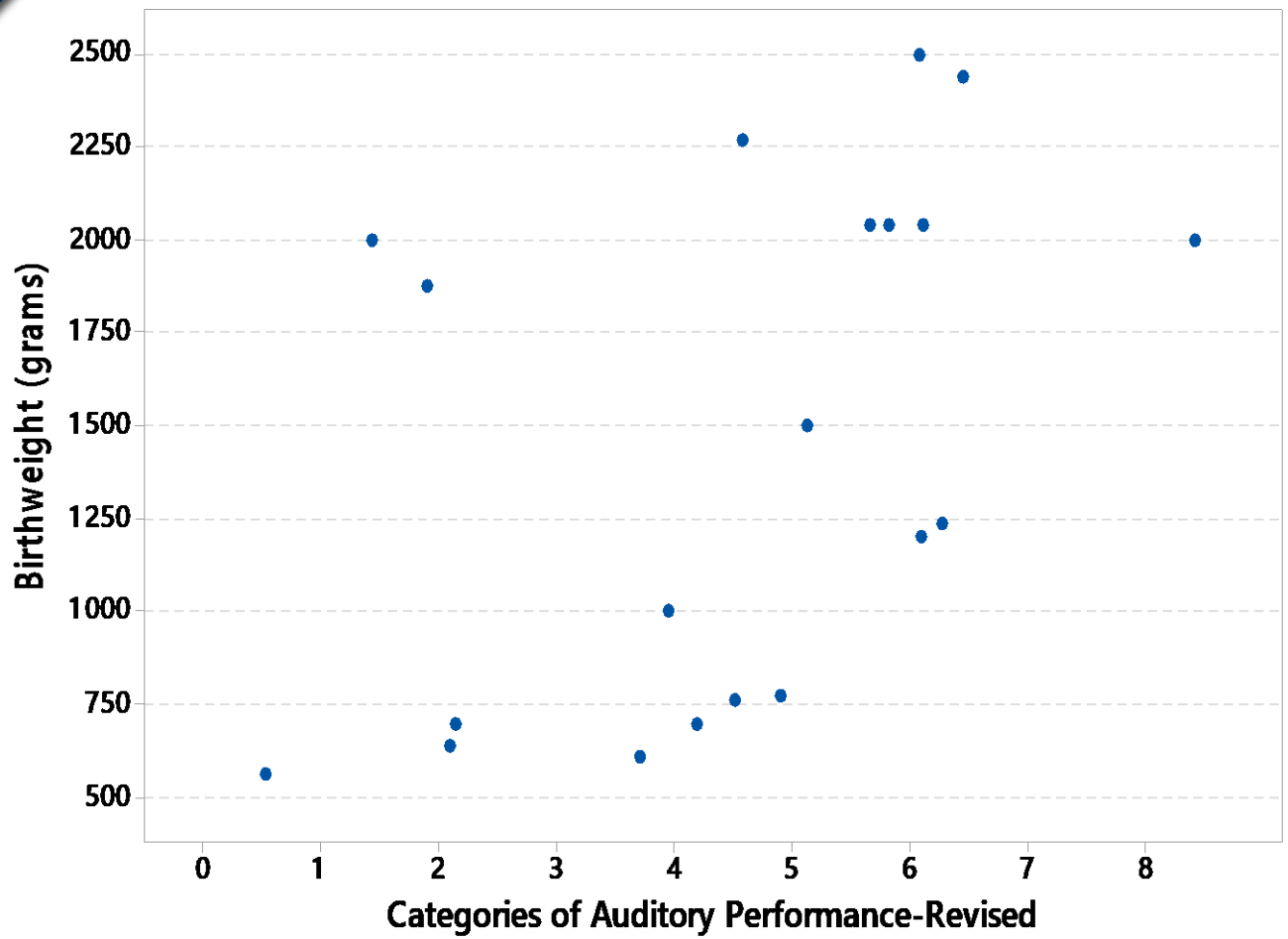
RESULTS: SPEECH PERCEPTION

- median CAPI-R score for all participants was 5 (*N* = 35)

- this corresponds to open-set phoneme understanding of 50-74%, word understanding of 14-43%, and sentence understanding of 27-70%, in a quiet environment
  - **Child Factors** - Gestational Age, Birthweight, pre-CI residual hearing (pure tone average =PTA), duration of hearing loss, Age-at-First-Implant, Age-at-Test, duration of CI experience
  - **Family Factors** - Measure of relative socio-economic advantage using postcode = Socio-Economic Indexes for Areas (SEIFA)

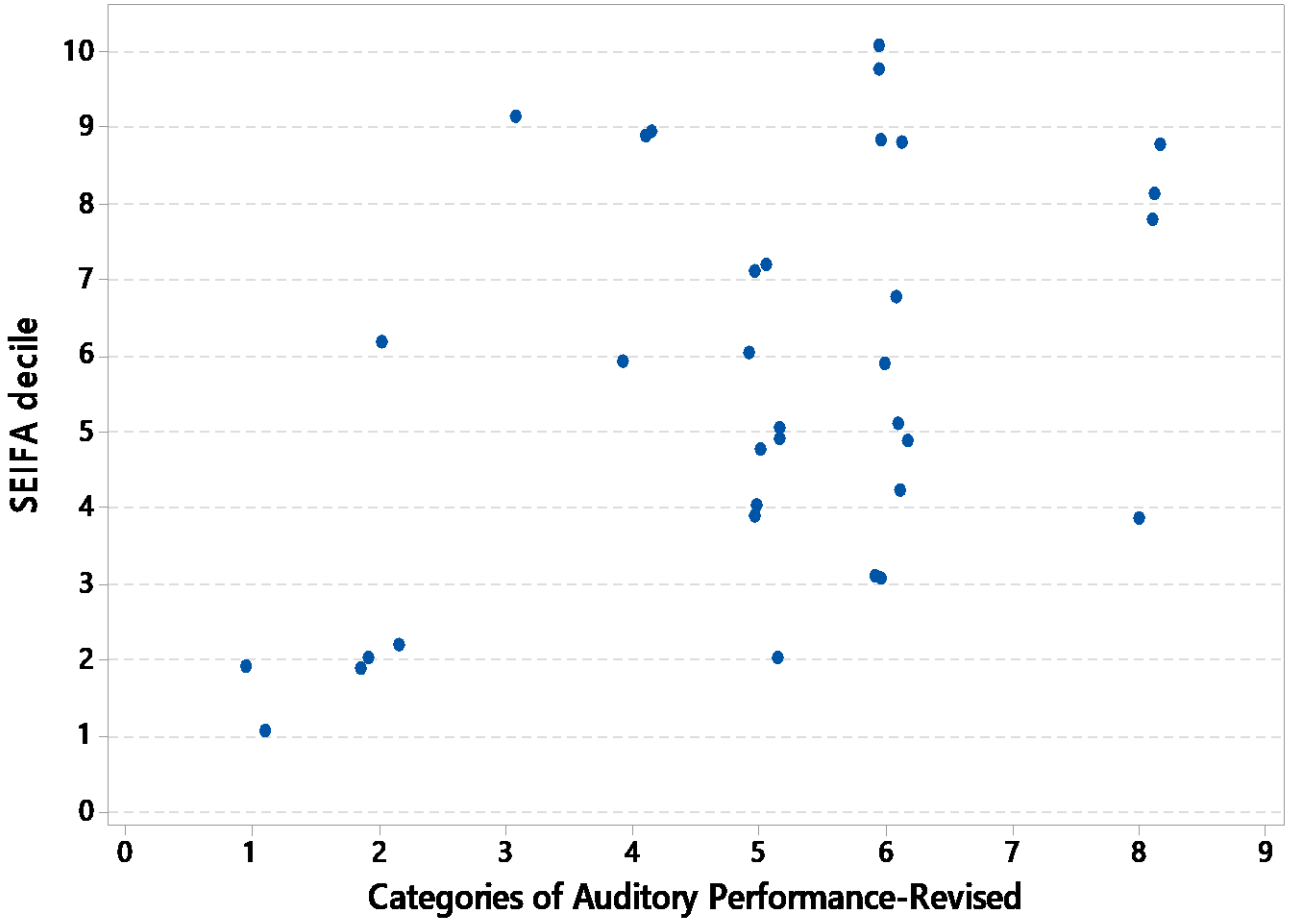
THE UNIVERSITY OF MELBOURNE

THE HEARING CRC



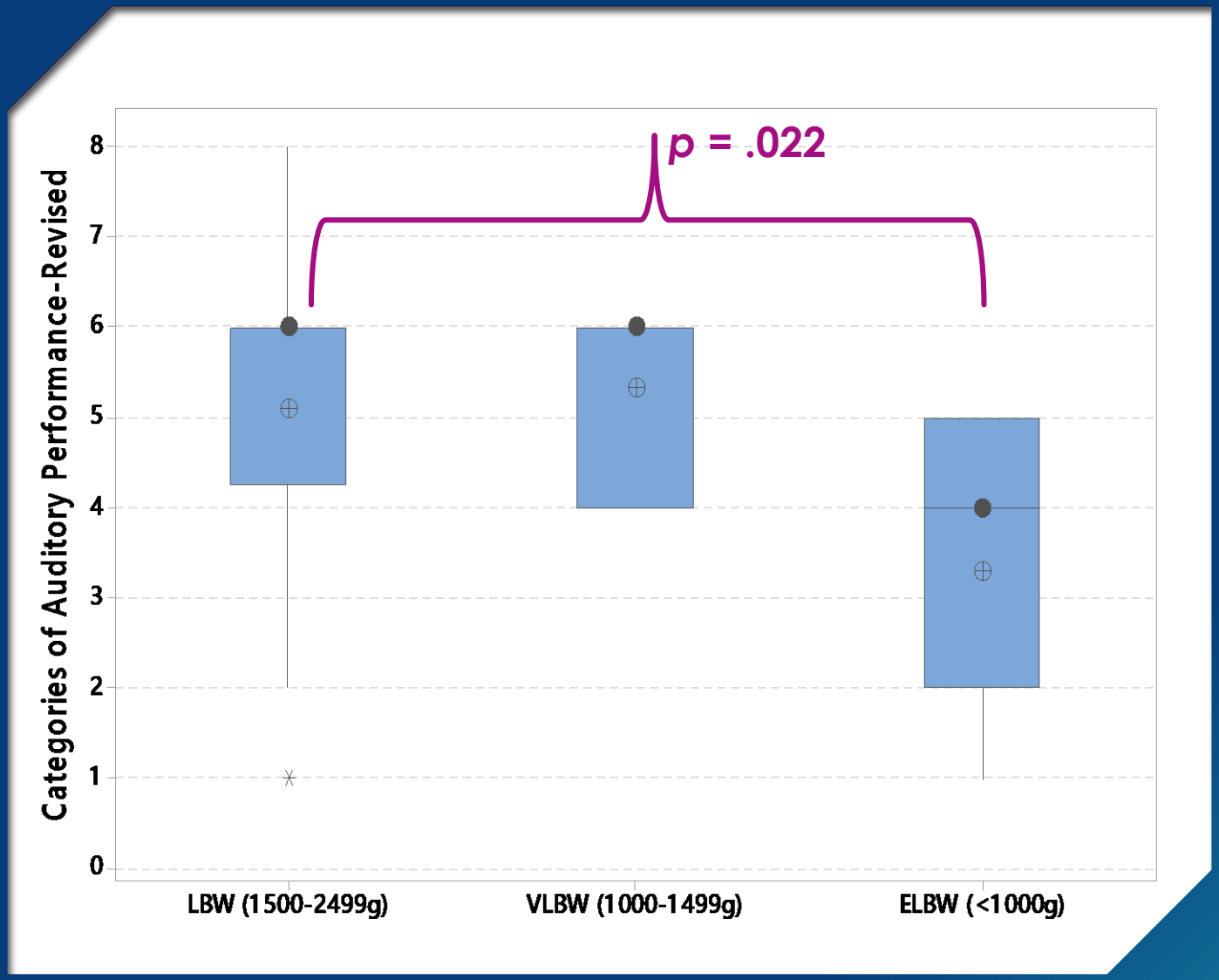
RESULTS: CHILD AND FAMILY FACTORS

- no significant correlation between Gestational Age, Age-at-implant and CAPI-R
- significant positive correlation between Birthweight and CAPI-R (ρ = .622, p = .003)



RESULTS: CHILD AND FAMILY FACTORS

- no significant correlation between Gestational Age, Age-at-Implant and CAPI-R
- significant positive correlation between Birthweight and CAPI-R (ρ = .622, p = .003)
- significant positive correlation between SEIFA and CAPI-R (ρ = .393, p = .022)

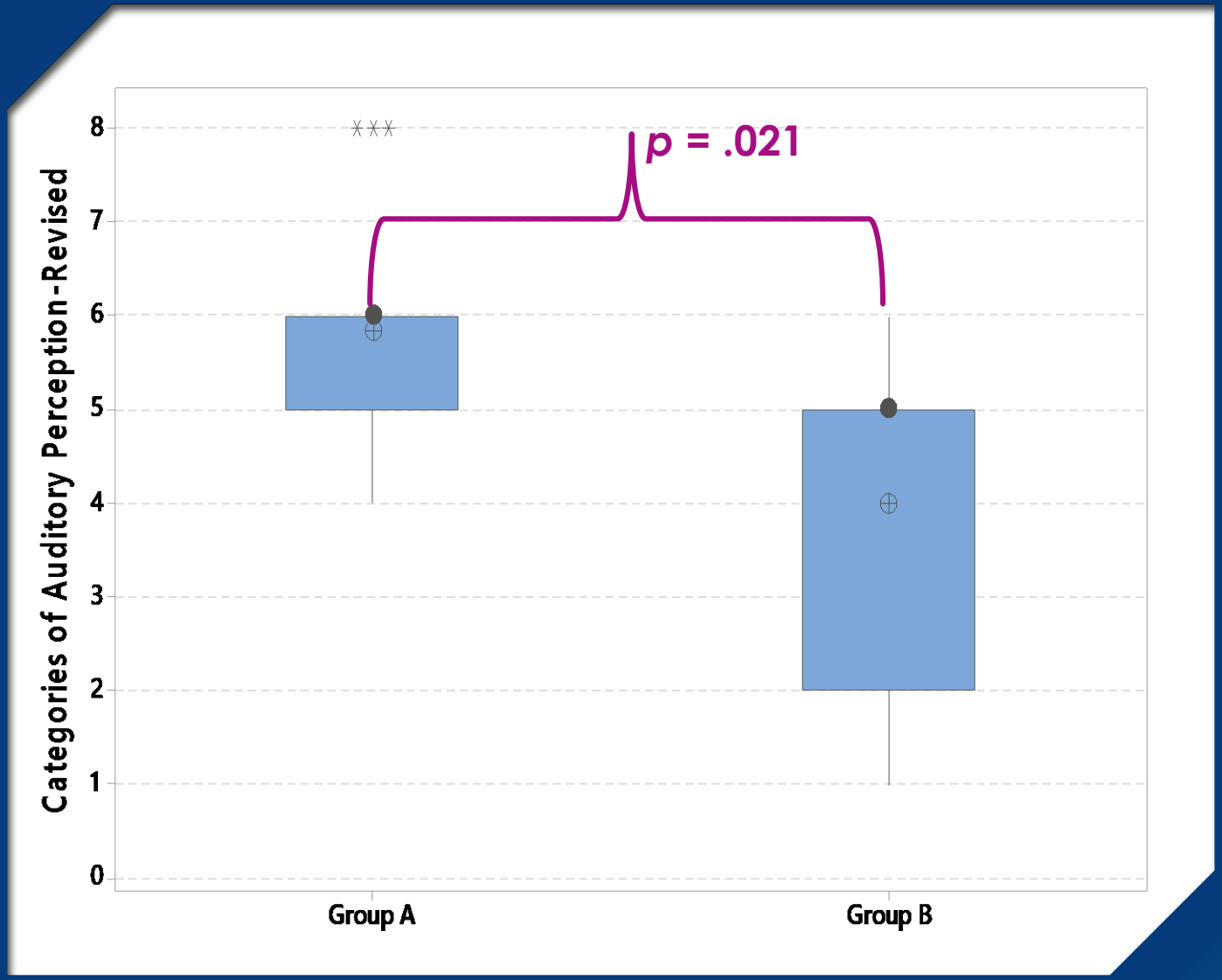


RESULTS: CHILD AND FAMILY FACTORS

Whilst

- LBW 1500-2499g (n = 10),
- VLBW 1000-1499g (n = 3), and
- ELBW <1000g (n = 7) groups did not differ in
  - pre-CI PTA,
  - duration of hearing loss,
  - Age-at-Implant,
  - duration of CI experience

there was a significant difference in median CAPI-R between LBW and ELBW



RESULTS: CHILD AND FAMILY FACTORS

Data were collapsed into two groups;

- Group A with no additional cognitive delay/disorder
- Group B with cognitive delay/disorder

Groups did not differ in *

- pre-CI PTA,
- duration of hearing loss,
- Age-at-Implant,
- duration of CI experience,
- Age at Test

there was a significant difference in median CAPI-R

*note groups did differ in SEIFA
Group A median SEIFA 7
Group B median SEIFA 3

CONCLUSIONS: GESTATIONAL AGE AND BIRTHWEIGHT

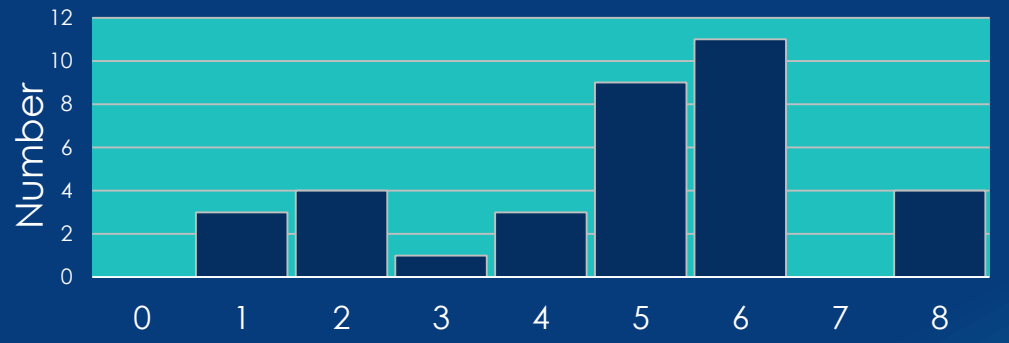
- significant positive correlation between Birthweight and speech perception,
  but not Gestational Age and speech perception

- there may have been differences in prevalence and severity of Cognitive delay/disorder across the LBW, VLBW and ELBW groups (but this was not measured statistically due to small numbers in groups)

THE UNIVERSITY OF MELBOURNE

THE HEARING CRC

CONCLUSIONS: COGNITION



- Cognitive delay/disorder was associated with poorer speech perception scores

- many participants experienced perinatal complications known to be associated with lower cognitive function
  (Botting et al., 1998; Taylor et al., 1998; Whitaker et al., 2006)
  - e.gs., Cases 2 & 5 lung disease; Cases 2, 5 & 33 prolonged supplemental oxygen use; Case 33 necrotising enterocolitis; Case 25 scans indicated abnormal white matter

THE UNIVERSITY OF MELBOURNE

THE HEARING CRC

CONCLUSIONS: COGNITION

- presence of Cognitive delay/disorder should not preclude child receiving CI (Eze et al., 2013; Pyman et al., 2000; Wakil et al., 2014; Waltzman et al., 2000) as children with cognitive impairments can progress on speech perception tasks (albeit more slowly than their peers with typical cognition), and

- these children may demonstrate benefits from CIs in other ways, e.g., quality of life.

THE UNIVERSITY OF MELBOURNE

THE HEARING CRC

CONCLUSIONS: AGE AT IMPLANT

- did not find a relationship between Age-at-Implant and CAPI-R in this group
  - but 12 out of 35 received first CIs before 24 months of age
  - inherent difficulties isolating Age-at-Implant from duration of CI experience, age-at-test etc

THE UNIVERSITY OF MELBOURNE

THE HEARING CRC

CLINICAL IMPLICATIONS

- use of the CAPI-R may facilitate future pooling of data from a range of centres
  - to examine factors in more detail, and
  - describe outcomes for rare conditions

- recommend all centres record Gestational Age and Birthweight, and measure cognitive function as part of their standard protocols

THE UNIVERSITY OF MELBOURNE

THE HEARING CRC

THANK YOU

dettmans@unimelb.edu.au

REASONS FOR INCREASES IN PREM BIRTHS (IF ASKED)

Possible reasons from the literature suggest;

- better measurement
- changes in health such as increased maternal age
- underlying maternal health problems such as diabetes and high blood pressure
- greater use of infertility treatments leading to increased rates of multiple pregnancies
- changes in obstetric practices such as more caesarean births before term

THE UNIVERSITY OF MELBOURNE

THE HEARING CRC