

# Audiological testing outcomes for children with developmental disabilities

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## Objective

To better understand whether audiological data obtained during a single behavioral audiological assessment differs based on presence or absence of a developmental disability

## Background

- Behavioral audiological assessments are considered the gold standard for determining hearing status
- Yet children with developmental disabilities (DD) experience barriers with accessing gold standard assessments<sup>1-5</sup>
- In pediatric audiology, behavioral testing techniques assume and rely on the presence of certain developmental skills, for example:
  - Understanding of cause and effect for visual reinforcement audiometry
  - Fine motor skills for conditioned play audiometry
- The completion of behavioral audiological assessments can be impeded by common difficulties for patients with DD, such as:
  - Sensory sensitivities
  - Transitioning between tasks
  - Maintaining joint attention<sup>6</sup>

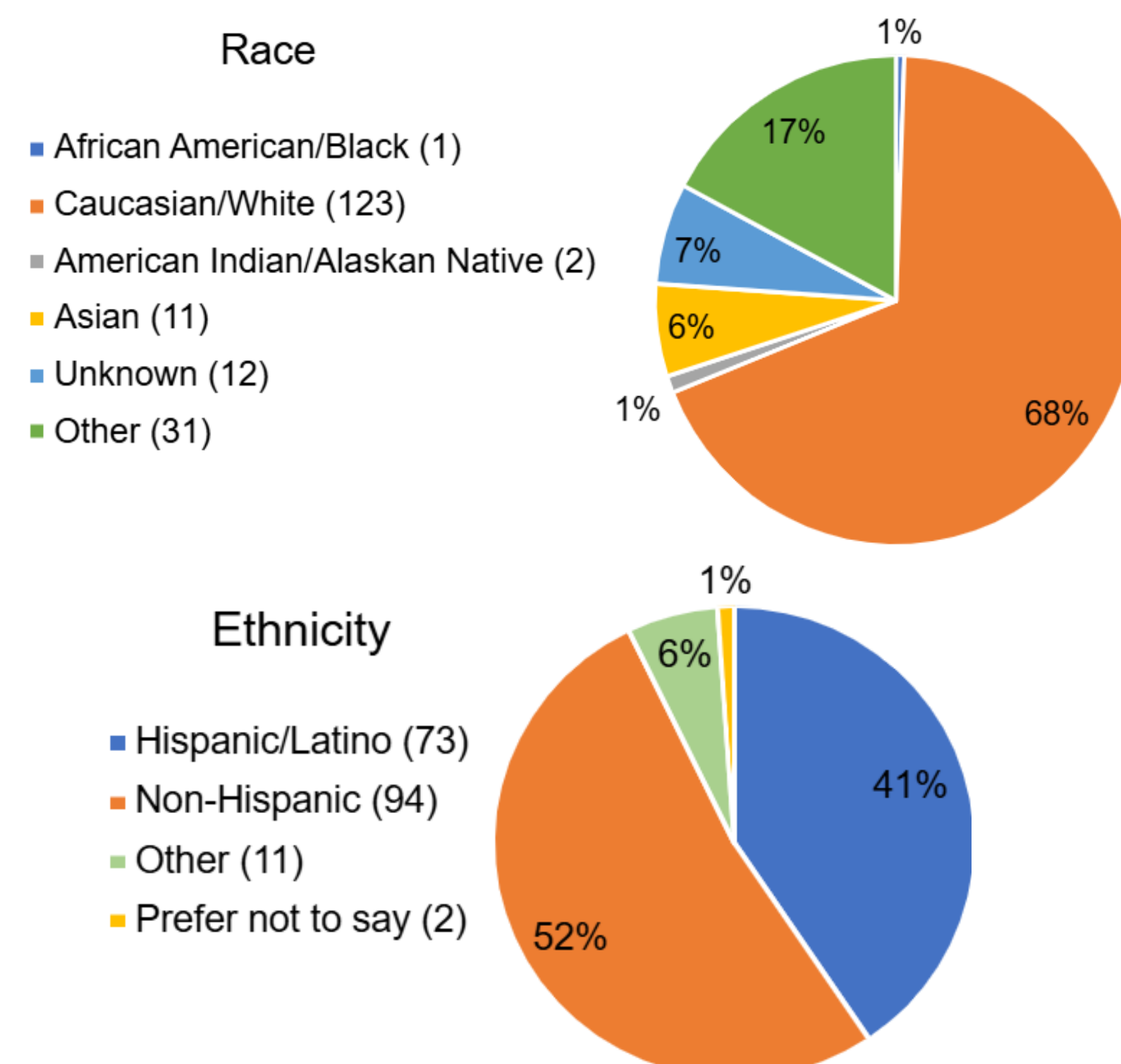
## Methods

- Following approval from the Colorado Multiple Institutional Review Board (COMIRB), 6 pediatric audiologists completed surveys originally intended to screen for possible ASD after 197 behavioral audiological assessments outlining:
  - Audiological data obtained
  - Behaviors observed
  - Demographic variables and DSM diagnoses collected from medical record
- Data was cleaned to eliminate duplicates (14 encounters) and ineligible subjects (8) resulting in 180 unique subjects
- Exclusion criteria influenced by original study included:
  - Outside of the age range (14 months-10 years)
  - In foster care
  - Blind
  - Motor limitations
  - Ability of caregiver/child to take part in English based assessments
- Using a subset of this data, the following dependent variables were analyzed:
  - Number of thresholds obtained
  - Completion of ear-specific testing
  - Completion of age-appropriate testing
- Independent variables:
  - DD status (presence or absence of developmental delay, intellectual disability, autism spectrum disorder, language delay, cerebral palsy, down syndrome)
  - Age
  - Gender
  - Ethnicity (collapsed)
  - Language (English/non-English)
- Statistical analysis was completed using SPSS (version 29). Controlling for the covariates above:
  - Negative binomial linear regression was run for number of thresholds obtained
  - Logistic regressions were run for ear-specific and age-appropriate testing

## Participants

### Demographics of Sample (n=180)

- Average age of sample was 4.69 years with a range of 1.17 to 10.75 years
- Sample was 66.5% male



### Developmental Disabilities in Sample (n=180)

Disability	N (%)
Any Developmental Disability	98 (54.4%)
Language Delay	57 (31.7%)
Global Developmental Delay	39 (14.4%)
Autism Spectrum Disorder	26 (14.4%)
Down Syndrome	23 (12.8%)
Intellectual Disability	1 (0.6%)
Cerebral Palsy	0 (0.0%)

Due to distribution among racial identities and disability diagnoses, race and specific disability could not be used as independent variables while maintaining the integrity of the models. Ethnicity of participants was able to be used but had to be collapsed (Hispanic/Non-Hispanic).

## Discussion

- When compared to participants without DD, participants with DD:
  - Had **31% lower threshold** counts
  - Were **80% less likely** to complete ear-specific testing
  - Were **96.1% less likely** to complete age-appropriate testing
- Audiological assessment results differed based on the presence or absence of DD
- Behavioral audiological assessment, although considered the gold standard, was less accessible for participants with DD
- Children with DD had fewer thresholds obtained, were less likely to complete the behavioral assessment method usually considered age-appropriate, and were less likely to obtain ear-specific results in a single behavioral audiological assessment

## Implications

- Due to increased likelihood of poor audiological testing outcomes, children with DD are more likely to encounter:
  - Follow-up appointments
  - Evaluations requiring sedation
  - Delays in hearing status determination
- Poor audiological testing outcomes for children with DD may result in
  - Excessive use of resources (time and money) for both parties
  - Greater likelihood of loss to follow up
  - Further developmental consequences due to late identification of hearing loss
- Equitable behavioral assessment methods must be developed and implemented to ensure accurate and timely results for all patients, regardless of disability status

## Limitations

- Exclusionary criteria of original sample limited participation of non-English speaking subjects and subjects with significant motor impairment (resulting in no children with CP in this sample)
- Racial and ethnic diversity in this sample is not representative of the region (likely due to sampling of original study), reducing generalization of results
- Audiological data obtained by providers with common employment, possibly impacting training or protocols. Results not nested by provider due to nature of original data collection.

## References

- <sup>1</sup>Basonbul, R. A., Ronner, E. A., Rong, A., Rong, G., & Cohen, M. S. (2020). Audiologic testing in children with Down syndrome: Are current guidelines optimal? *International Journal of Pediatric Otorhinolaryngology*, 134, 110017.
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- <sup>6</sup>Autism spectrum disorder. (2024, May 16). CDC. <https://www.cdc.gov/autism/signs-symptoms/index.html> <https://doi.org/10.1097/010803-024-06461-9>

## Acknowledgements

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## Results

### Number of Thresholds

Negative Binomial Linear Regression

P-value	X <sup>2</sup> (5)
<.001	62.58

- The model is statistically significant

### Completion of Ear-Specific Testing

Logistic Regression

P-value	X <sup>2</sup> (5)	Nagelkerke R <sup>2</sup>	Accuracy
<.001	70.25	.456	79.9%

- The model is statistically significant and a good fit
- The model accounts for 45.6% of the variance and is 79.9% accurate in predicting likelihood of completion

### Completion of Age-Appropriate Testing

Logistic Regression

P-value	X <sup>2</sup> (5)	Nagelkerke R <sup>2</sup>	Accuracy
<.001	49.58	.372	80%

- The model is statistically significant and a good fit
- The model accounts for 37.2% of the variance and is 80% accurate in predicting likelihood of completion

### Number of Thresholds Findings

Predictor	P-value	Exp (B) [IRR]*	95% Confidence Interval for Exp (B)
Age (years)	<.001	1.21	1.13-1.29
DD Status	.003	1.69	1.19-2.40
Gender	0.119	0.76	0.54-1.07
Ethnicity	0.815	0.96	0.66-1.39
Language	0.917	0.97	0.59-1.62

\*IRR=Incidence Rate Ratio

### Age and DD status are statistically significant predictors for the number of thresholds obtained.

- Each additional year of age increased the number of thresholds obtained by 21%
- Children without DD have 69% higher count of thresholds than children with DD
- Other variables (gender, ethnicity, and language) were not significant predictors

### Ear-Specific Testing Findings

Predictor	P-value	Exp (B) [OR]*	95% Confidence Interval for Exp (B)
Age (years)	<.001	1.70	1.37-2.11
DD Status	<.001	0.20	0.08-0.50
Gender	0.517	1.32	0.57-3.06
Ethnicity	0.065	0.44	0.18-1.05
Language	0.211	2.21	0.64-7.68

\*Odds Ratio

### Age and DD status are statistically significant predictors for the completion of ear-specific testing.

- Each additional year of age increases odds of completing ear specific testing by 70%
- Presence of DD decreased odds of completing ear-specific testing by 80%
- Ethnicity was found to be borderline significant with Hispanic participants having 56% lower odds of completing ear-specific testing
- Other variables (gender and language) were not significant predictors

### Age-Appropriate Testing Findings

Predictor	P-value	Exp (B) [OR]*	95% Confidence Interval for Exp (B)
Age (years)	0.002	0.77	0.65-0.91
DD Status	<.001	0.04	0.01-0.14
Gender	.020	3.26	1.21-8.80
Ethnicity	0.869	1.08	0.43-2.70
Language	0.725	1.27	0.34-4.76

\*Odds Ratio

### Age, DD status, and gender are statistically significant predictors of successful completion of age-appropriate testing.

- Presence of DD decreased odds of completing age-appropriate testing by 96.1%
- Each additional year of age decreased the odds of completing age-appropriate testing by 23%
- Female participants had higher odds of completing age-appropriate testing
- Other variables (ethnicity and language) were not significant predictors