Examining Audiometric Screening Outcomes in Non-Native English-Speaking Pediatric Patients

The University of Vermont
LARNER COLLEGE OF MEDICINE

Christopher P Kruglik, MSc, MPH[1]; John L Rustad, BA[1]; Josephine Yalovitser, BA[1]; Jonathan A Chen, BS[1]; Andrea E Green, MD[2]; Daniel A Gerges, MD[3]

Larner College of Medicine at the University of Vermont[1]; Department of Pediatrics, University of Vermont Children's Hospital[2]; Division of Otolaryngology, University of Vermont Medical Center[3] • Burlington, VT

Abstract

Objectives: Hearing loss in childhood can culminate in worse health outcomes if not identified through pure-tone audiometry screening tests, as recommended by the American Academy of Pediatrics (AAP). Non-Native English-Speaking (NNES) pediatric patients and their families often face systemic healthcare barriers, contributing to disparities in chronic conditions and healthcare access. This study is the first in the literature to investigate gaps in audiometric screening adherence and hearing outcomes between NNES and Native English-Speaking (NES) children.

Study Design: Retrospective Cohort Analysis

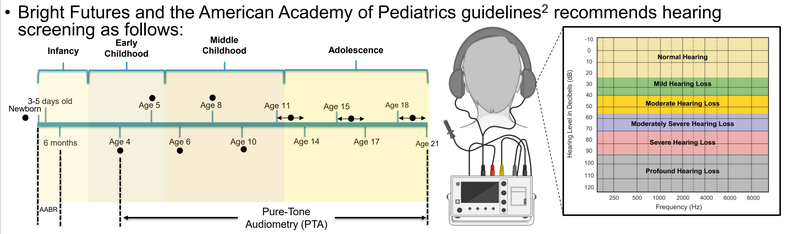
Methods: A cohort of 176 patients (88 NES, 88 NNES) established at an academic-affiliated, pediatric primary care center before age four were evaluated retrospectively during their well-child checks (WCC) at ages 4, 5, 6, and 8. Patient demographics and audiometric screening data were collected to assess compliance with AAP guidelines. Statistical analyses included Pearson's chi-square for compare categorical variables and the Mann-Whitney *U*-test for continuous variables. Exploratory one- and two-way ANOVAs assessed interactions between language preference and hearing thresholds. Statistical significance was defined as p-value<0.05.

Results: Both NNES and NES groups had a mean age of of 10.8 years (p = 0.83), universal state insurance, and balanced sex distribution. Non-English languages included Nepali (40%), Mai-Mai (11%), and Swahili (8%). NNES children had lower audiometric screening rates at age 4 (72.7% vs. 57.5%; χ^2=4.2, p=0.04) and age 6 WCC (87.5% vs. 73.8%; χ^2=3.8, p=0.04). NNES patients exhibited poorer high-frequency (p=0.04) and total-frequency (p=0.02) thresholds at ages 6 and 8. Two-way ANOVA demonstrated a significant interaction between language and frequency on decibel detection (p=0.02), with one-way ANOVA highlighting disparities at 1000 Hz (p=0.009) and 4000 Hz (p=0.04).

Conclusions: This study demonstrates that there are significant disparities in audiometric screening rates in NNES children, and poorer hearing outcomes, likely exacerbated by medical complexity, care coordination challenges, and increased appointment time with interpreter use. Targeted interventions that address implicit biases amongst pediatric providers could improve provider cultural competency and help create care pathways to improve screening rates amongst NNES children. Additionally, inconsistencies in screening practices underscore the need for standardized, universally adopted pediatric hearing loss guidelines across medical organizations.

Introduction

- Prevalence of hearing loss in the United States (U.S.) is one to three per 1,000 live births[1]
- The prevalence doubles during childhood with an additional one to three in every 1,000 children developing deafness or hard-of-hearing conditions[1]
- Bright Futures and the American Academy of Pediatrics guidelines[2] recommends hearing screening as follows:



- 26% of children in the U.S. below age 18 identify as non-native English Speaking and six out of 10 children are defined as being children of immigrant families (at least one parent born outside of U.S.)[3,4]
- Population projection estimates by 2050 suggest NNES children will make up about one-third of the greater than 100 million children in the U.S.[5]
- Immigrant families experience delayed access to healthcare → difficulty navigating new healthcare system, difficulty obtaining insurance, and having limited English proficiency[6]
- About 50% of children with hearing loss from NNES families face stigmatization from their communities[7]
- Given the increase in number of NNES families projected in the future and lack of research dedicated to this population, understanding barriers in accessing healthcare, specifically related to hearing is essential[5,8]

Methodology

Study Design
- Retrospective Cohort Analysis at two academic-affiliated pediatric primary care
- Between January 2020 to December 2021

Patient Demographics
- All patients who received well-child checks (WCC) at ages 4, 5, 6, and 8

Data Collection
- As per the flow chart

Statistical Analysis
- Continuous variables – Mann-Whitney *U*-test
- Categorical variables – Pearson chi-square (χ^2) tests
- Exploratory Analyses – Unbalanced two-way ANOVA and Tukey's multiple comparisons
- p-value<0.05 was statistically significant

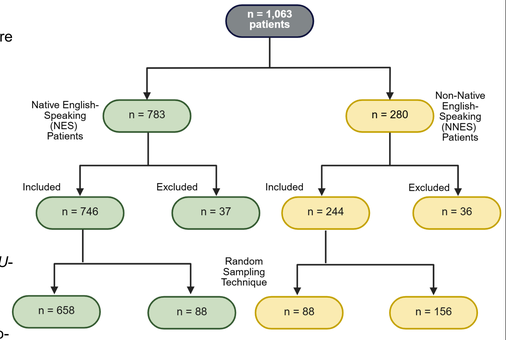


Figure 1. Flow chart depicting selection process for final study population

Study Population Demographics

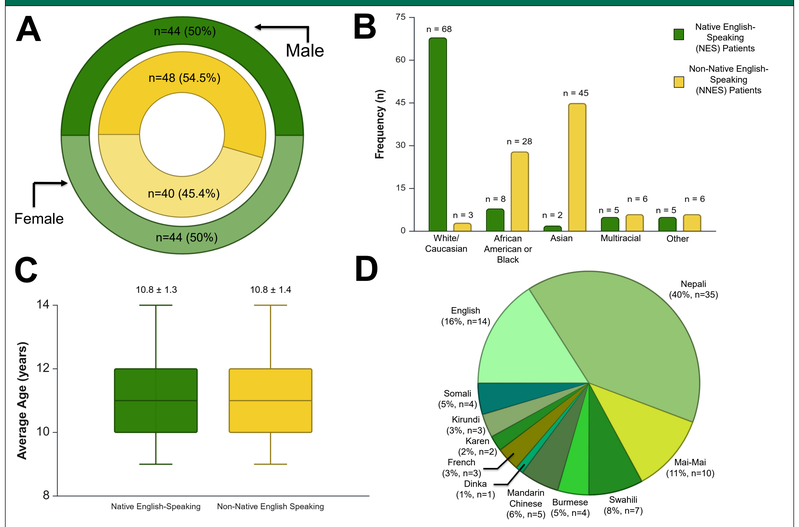


Figure 2. Demographic distributions of Native English-Speaking (NES) and Non-Native English-Speaking (NNES) patient cohorts. **A)** Sex distribution: NES: outer ring; NNES: inner ring) presented as proportions. **B)** Self-reported racial/ethnic composition with categorical legend. **C)** Comparative mean age (± standard deviation) between groups. **D)** Primary language breakdown within the NES cohort (non-exclusive categories).

Non-Native English-Speaking Children had *Fewer* Hearing Screens at Well-Child Checks

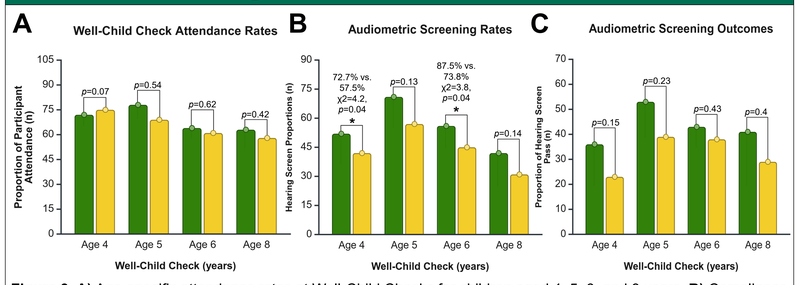


Figure 3. A) Age-specific attendance rates at Well-Child Checks for children aged 4, 5, 6, and 8 years. **B)** Compliance with pure-tone audiometry screening, aligned with American Academy of Pediatrics guidelines, and stratified by populations of interest. **C)** Comparison of audiometry screening outcomes, defined as the proportion of screenings with documented hearing thresholds ≤25 decibels (dB) (pass rate).
All panels illustrate comparative percentage proportions between Native English-Speaking (green) and Non-Native English-Speaking (yellow) patient populations. Categorical variables were analyzed using Pearson's χ2 test of independence; asterisks (*) denote statistically significant differences (p<0.05).

Mid- and *High*-Frequency Gaps in NNES Children Emerge by Age 5, Persist Through Age 8

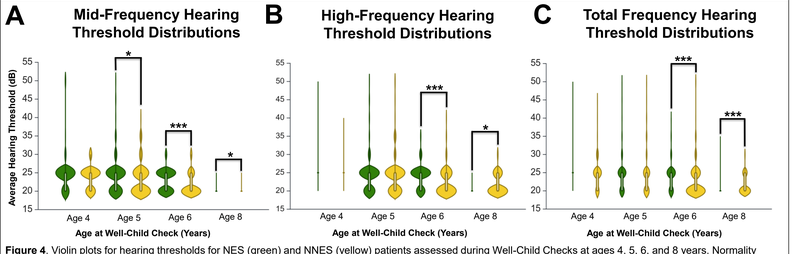
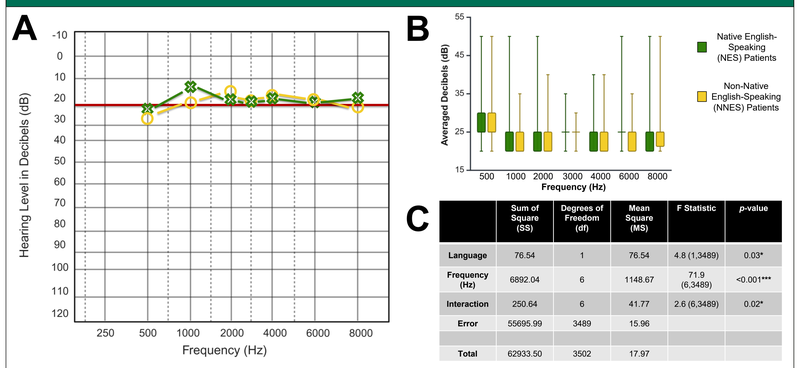


Figure 4. Violin plots for hearing thresholds for NES (green) and NNES (yellow) patients assessed during Well-Child Checks at ages 4, 5, 6, and 8 years. Normality assumptions were evaluated using Shapiro-Wilk tests; non-normally distributed data were analyzed via Mann-Whitney U tests. Asterisks denote significance levels: *p<0.05, ***p<0.001. **A)** Mid-frequency thresholds (500-2000 Hertz (Hz)): NNES patients exhibited significantly higher thresholds than NES patients at ages 5 (21.2±2.1 dB vs. 20.7±1.8 dB), 6, and 8. **B)** High-frequency thresholds (3000-8000Hz): Thresholds differed significantly between NNES and NES groups at ages 6 and 8, with NNES demonstrating elevated, or poorer, thresholds. **C)** Composite Thresholds (all frequencies): NNES patients displayed statistically significant higher average thresholds than NES patients at ages 6 and 8.

Language and Frequency Levels Tested Predicted dB hearing thresholds



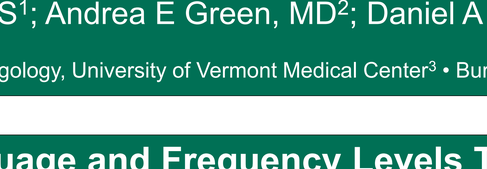
C

	Sum of Square (SS)	Degrees of Freedom (df)	Mean Square (MS)	F Statistic	*p*-value
Language	76.54	1	76.54	4.8 (1,3489)	0.03*
Frequency (Hz)	6892.04	6	1148.67	71.9 (6,3489)	<0.001***
Interaction	250.64	6	41.77	2.6 (6,3489)	0.02*
Error	55695.99	3489	15.96		
Total	62933.50	3502	17.97		

Figure 5. **A)** Average hearing thresholds for each frequency tested across all age groups and stratified by language cohort (Green = NES; Yellow = NNES). **B)** Boxplot demonstrating average hearing threshold for each frequency tested across all age groups, separated by language cohort (Green = NES; Yellow = NNES). **C)** Unbalanced two-way ANOVA and Tukey's multiple comparisons were performed to assess whether language (NNES and NES) and frequency levels predicted decibel hearing thresholds. *=p<0.05; ***=p<0.001.

Equity *Gaps* in Pediatric Hearing Care: Why do NNES Children *Fall* Through?

- This is the first study to examine age-appropriate audiometric screening practices and hearing threshold outcomes among Non-Native English-Speaking (NNES) children and Native English-Speaking (NES) children
- We found that there was significant delays in receiving age-appropriate hearing screening for NNES children
- Other studies have found differences in screening rates for NNES children for:



Developmental Surveillance[9] | Vision Screening[10] | Behavioral Health Screening[11] | Oral Health/Dental Hygiene Screening[12]

- Studies have shown that parents of NNES children have reported worse physical health compared to parents of NES children[13]
- Furthermore, providers spend more time with patients when they require the use of an interpreter[14]
- Therefore, our study findings could be attributed to increased medical complexity and length of appointment times for NNES pediatric patients

Future Directions

- Establish standardized, universally adopted pediatric hearing loss diagnostic and screening guidelines through collaboration across medical organizations
- Develop targeted interventions centered on mitigating implicit bias and expanding culturally competent provider education initiatives to promote equitable access to hearing healthcare services
- Future research should investigate systemic and current factors influencing hearing screening outcomes among NNES populations to improve accessibility and quality of care for linguistically diverse communities

References

Contact

Christopher P. Kruglik, MPH

Email: ckruglik@med.uvm.edu
Twitter: @ChrisKruglik
LinkedIn: Christopher-Kruglik

Senior Authors:
Daniel A. Gerges, MD
Division of Otolaryngology
University of Vermont Medical Center
Email: daniel.gerges@uvmhealth.org

Andrea E. Green, MD
Department of Pediatrics
University of Vermont Children's Hospital
Email: andrea.green@uvmhealth.org