

# PHASE-UP (Preschool Hearing And Speech Education - University of Pittsburgh): Comparison of Preschool Hearing Screening Protocols



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## Introduction

Universal newborn hearing screening (UNHS) has drastically reduced the age at which children are diagnosed with congenital hearing loss. However, UNHS does not guarantee early identification and intervention of infants who have mild (i.e., 20-40 dB HL), late-onset, progressive, or fluctuating hearing loss. Also, there will always be a proportion of infants who are lost to follow-up and/or documentation after UNHS.

The prevalence of hearing loss among children increases from 1-3 per 1,000 at birth to 9-10 per 1,000 at school-age. Although a preschool hearing screening program could promote early identification and intervention, no current universal, systematic, screening program has been established to identify these children prior to entering school. As a result, research is needed on the establishment of preschool screening programs to determine the feasibility of identifying late-onset or missed hearing loss.

Current clinical practice guidelines recommend the use of pure-tone audiometry along with tympanometry and/or otoscopy to screen hearing in the preschool population. However, the use of pure-tone audiometry in this population presents many challenges.

Otoacoustic emissions (OAEs) offer many advantages over pure-tone audiometry for preschool hearing screening. However, the sensitivity and specificity of OAEs when applied to hearing screening using a one-criterion pass-fail protocol has been problematic (e.g., high false-negative rate). As a result, OAEs as a standalone measure have not been widely used to screen hearing in the preschool population.

The sensitivity and specificity of OAEs can be enhanced by using **two** pass-fail criteria (Hall 2016). These criteria are (1) distortion-product OAE (DPOAE) signal-to-noise ratio (SNR)  $\geq 6$  dB, and (2) DPOAE absolute amplitude  $\geq 0$  dB SPL.

The goal of this study is to determine the extent to which a two-criteria (Experimental) as opposed to one-criterion (Standard) DPOAE pass-fail protocol would result in more effective hearing screening practices in the preschool population.

## Methods

This study is a retrospective chart review. Six audiology graduate students and two clinical instructors reviewed the hearing screening results and consent forms from children seen in the Preschool Hearing and Speech Education – University of Pittsburgh (PHASE-UP) clinic from September 2018 to April 2022. PHASE-UP is a hearing screening program that partners with the Pittsburgh community to provide no-cost, comprehensive hearing screenings for local preschoolers. At present, physical data sheets and consent forms are used to record hearing screening results and parent consent in the PHASE-UP clinic.

To be included in the review, the following criteria had to be met:

- Child age at testing: 3 – 6 years
- Complete hearing screening results on file (see PHASE-UP Protocol for hearing screening test battery)
- Signed consent form on file

The following steps were completed to prepare data for analysis. All steps were checked for accuracy by no fewer than two students and one clinical instructor prior to commencing statistical analyses.

- Each data sheet was matched to its corresponding consent form
- Raw data from the data sheets were de-identified and entered in an Excel sheet
- Raw data were coded and transferred to a separate Excel sheet to be used for statistical analyses

## PHASE-UP Protocol

Table 1. PHASE-UP Test Battery

Test	Criteria
Tympanometry and/or otoscopy	Pass <ul style="list-style-type: none"> <li>• Tympanometric width (TW) <math>\leq 250</math> daPa, or</li> <li>• Patent pressure equalization (PE) tube, or</li> <li>• Normal tympanic membrane visualized on otoscopy</li> </ul>
One-criterion (Standard) DPOAE protocol	<ul style="list-style-type: none"> <li>• DPOAEs 2-5 kHz are present at a SNR of <math>\geq 6</math> dB at 3 out of the 4 frequencies assessed</li> </ul>
Two-criteria (Experimental) DPOAE Protocol	<ul style="list-style-type: none"> <li>• DPOAEs 2-5 kHz are present at a SNR of <math>\geq 6</math> dB at 3 out of the 4 frequencies assessed, and</li> <li>• DPOAE absolute amplitude <math>\geq 0</math> dB SPL at those frequencies</li> </ul>
Pure-tone audiometry at 1, 2, and 4 kHz	Pass <ul style="list-style-type: none"> <li>• Response obtained at 20 dB HL at all frequencies assessed</li> </ul>

The two-criteria (Experimental) DPOAE protocol was not used to determine if a child passed/failed the screener. Rather, it was performed in addition to the one-criterion (Standard) DPOAE protocol.

## Results

In total, about 2,700 records from 46 different preschools were reviewed. Of these, about 1,500 of them were included in the study, and about 1,100 were excluded for various reasons. The top two reasons for exclusion were no consent form on file, and incomplete data. The total pass rate for the Standard DPOAE protocol was 93% (range = 91%-96%). The total pass rate for the Experimental DPOAE protocol was 86% (range = 84-88%).

Figure 1.

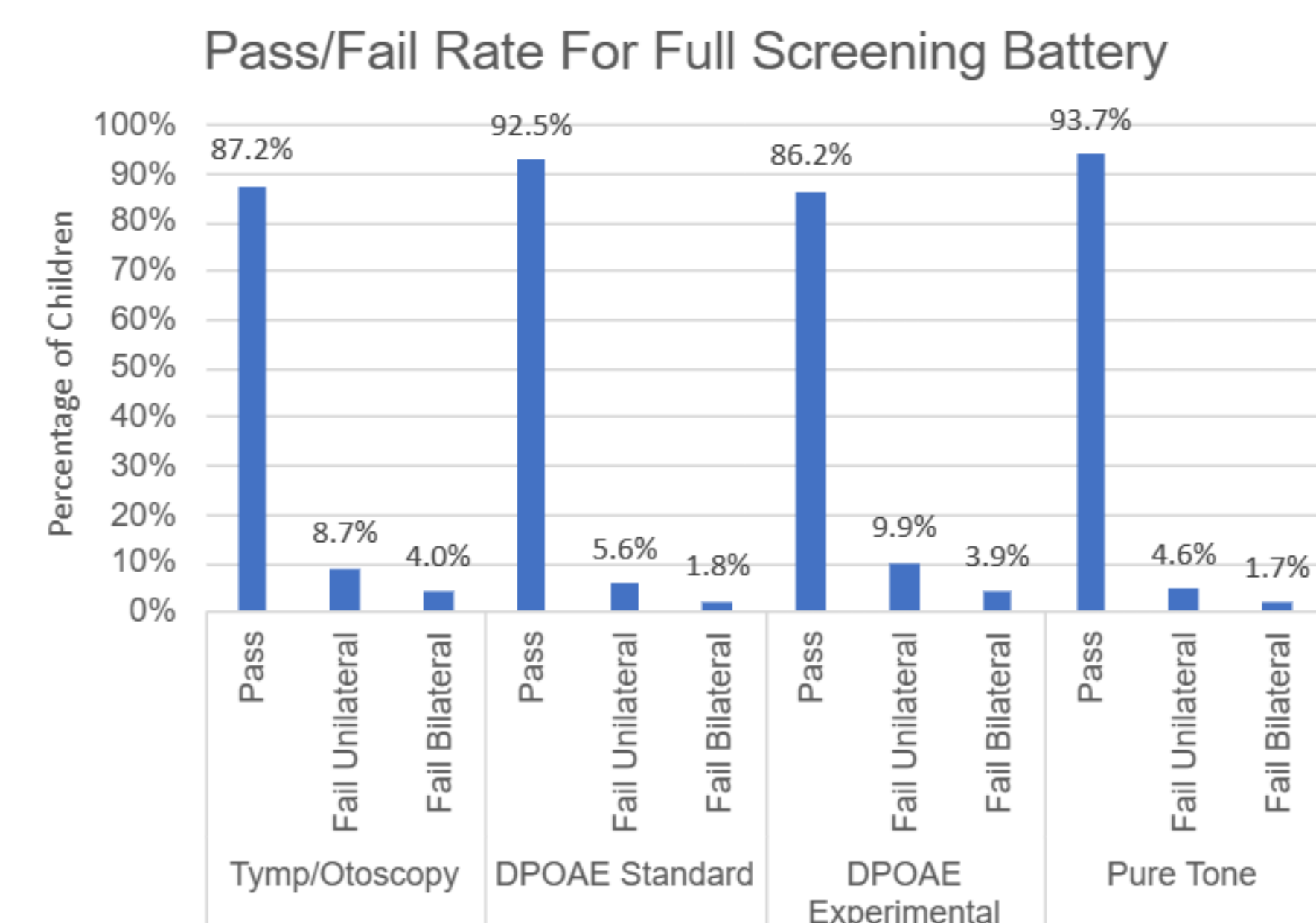


Figure 1 shows the percent of children who passed or failed each measure included in the test battery.

Figure 2.

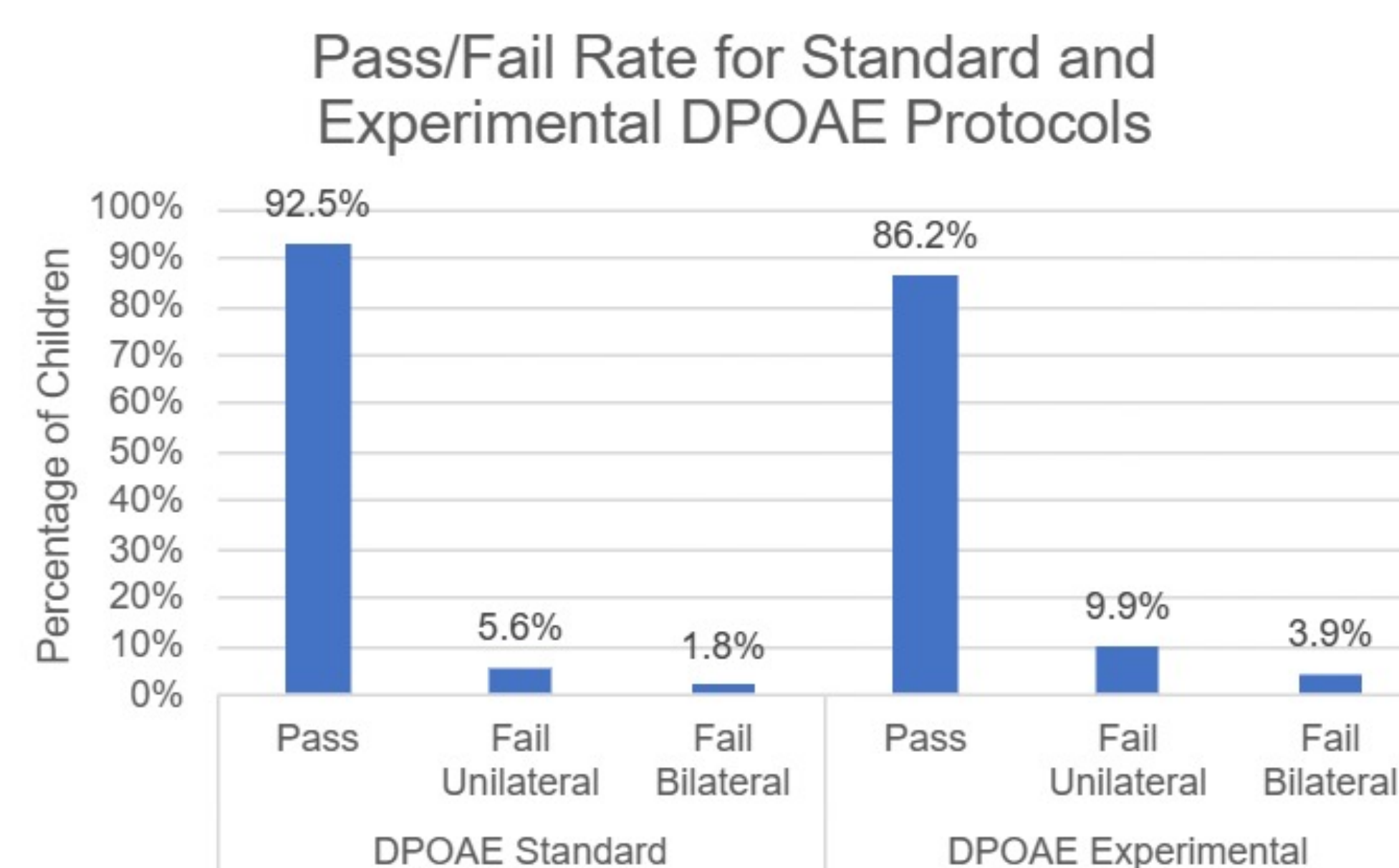


Figure 2 shows the percent of children who passed or failed the Standard (one-criterion) versus Experimental (two-criteria) DPOAE protocol.

Figure 3

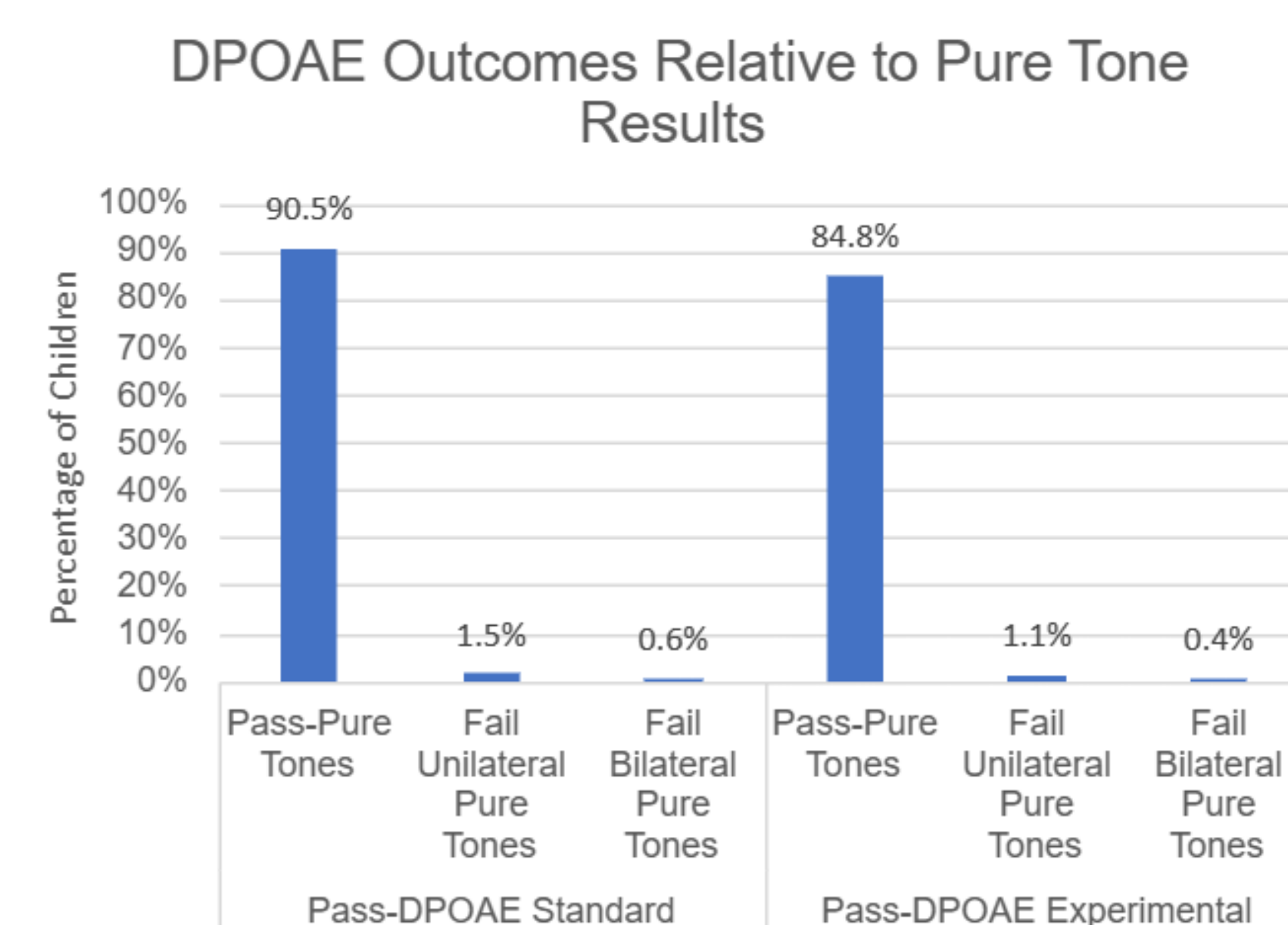


Figure 3 shows pure-tone screening results for children who passed the Standard and Experimental DPOAE protocols.

## Results Continued

With results scaled in order of pass, unilateral refer, and bilateral refer, the weighted Kappa statistics were .59 for agreement between the one-criterion DPOAE protocol and pure-tone audiometric screening, and .43 for agreement between two-criteria DPOAE protocol and pure-tone audiometric screening.

Consistent with the recommendation made by Hall (2016), there were fewer false negatives with the two-criteria DPOAE protocol than with one-criterion DPOAE protocol; the sensitivity was .77 for the two-criteria DPOAE protocol and .68 for the one-criterion DPOAE protocol. Conversely, test specificity was .90 for the two-criteria DPOAE protocol and .97 for the one-criterion DPOAE protocol.

## Conclusions & Future Directions

Preschool hearing screening programs are feasible and effective.

The sensitivity of DPOAE screening for preschoolers is greatest when utilizing the Experimental protocol. However, this comes at a cost of less specificity relative to the Standard protocol.

Replicate this study using equipment with the two-criteria DPOAE protocol built-in to eliminate effects of possible human error in recording responses.

We hope to validate these findings by examining the feasibility and utility of the Experimental DPOAE protocol in a primary care physician's (PCP) office when conducted by nursing staff. Towards this end, we aim to establish a relationship with the University of Pittsburgh School of Nursing to share our findings and advocate for an increased awareness of hearing loss and use of appropriate screening protocols in this population.

## References

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