

## Abstract

Detection of hearing loss in the preschool years has been an area of increasing clinical focus in recent years. Reports for referral rates in preschool children vary widely in the literature, however it is well documented that prevalence of hearing loss increases in the preschool years with the advent of middle ear and progressive disease. There is growing evidence that inconsistent acoustic stimulation due to otitis media has long term effects on auditory processing. The project Preschool Hearing Screening in Cyprus investigated the feasibility and efficiency of preschool hearing detection in Cyprus. Four hundred and twenty four children ages 4.5-6.5 years were screened in the schools for hearing and middle ear function. The testing protocol included otoscopy, tympanometry, pure tone audiometry, and play speech audiometry via a tablet application. Children were referred for otoscopy, tympanometry, or pure tone findings. Teachers completed the adapted S.I.F.T.E.R questionnaire for referred children. A total of 25,84% children were referred for audiological or medical evaluation; 15,16% of the children were referred for audiological evaluation, whereas 15,88% were referred for medical evaluation of cerumen or tympanometric findings (there was overlap between the two groups); 0,84% did not cooperate in the screening. Implications of the referral rates, correlations between tone and speech audiometry findings, as well as epidemiological implications will be discussed.

## Introduction

### Why screen hearing in preschool?

- incidence of hearing loss in the preschool years is debatable in literature
- to collect local epidemiological evidence
- to detect and refer children with hearing loss
- to assess language and literacy in detected children
- to assess auditory processing in detected children

## Methods

Randomly selected preschools, 424 preschoolers

### Testing protocol

- Otoscopy
- tympanometry
- behavioral hearing test at 1kHz, 2kHz, 4kHz
- Adaptive Auditory Speech Test (AAST)-Tablet based Play Speech Audiometry
- 3 Fast adaptive sound test – Tablet based Play tone audiometry (filtered animal sounds)
- (Otoacoustic Emissions)
- Language screen

### Referral criteria

- Medical (cerumen, type B tympanogram)
- Audiological (any pure tone threshold >30dBHL)
- Language

Follow up telephone interview to evaluate compliance



### Adaptive Auditory Speech Test



### 3-Fast Adaptive Sound Test

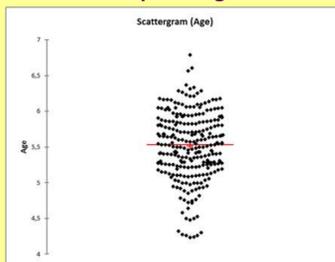


Words/filtered animal sounds presented in increasing signal-to-noise ratio Automated adaptive procedure set to two reversals after piloting

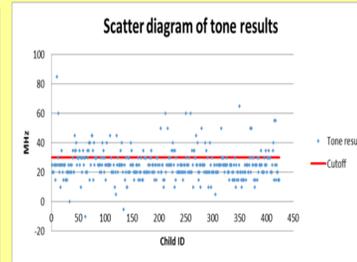
## Results

Transient Evoked Otoacoustic Emissions were removed from the testing protocol due to floor effect: noise levels at the testing sites precluded OAE recording

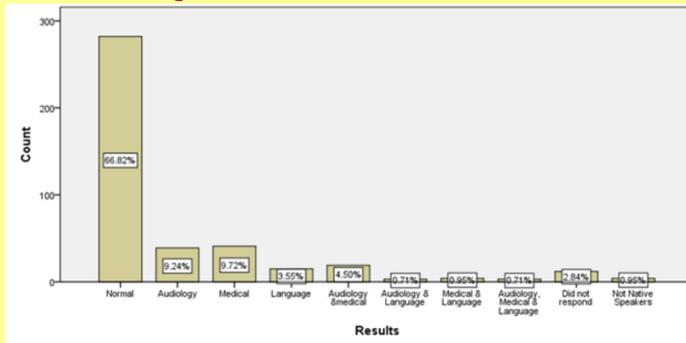
### Participant age



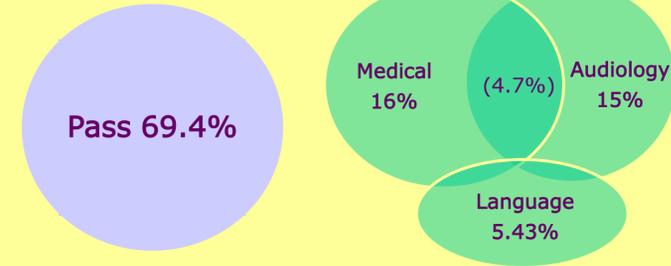
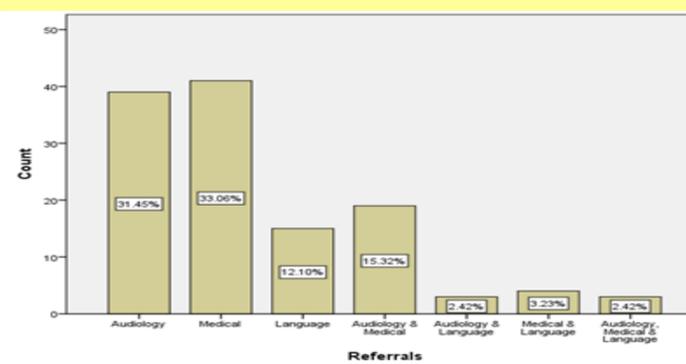
### Pure tone results



### Screening outcomes



### Referral distribution



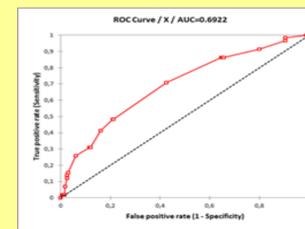
Pass 69.4%



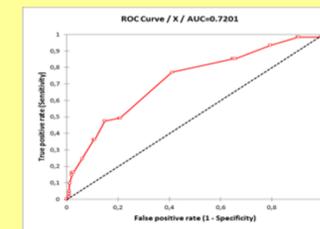
**Audiological follow-up:** twenty children of the 63 referred for diagnostic audiology complied (3.4%) all had normal hearing.

**Medical follow-up:** compliance reports based on parent interviews was over 90%

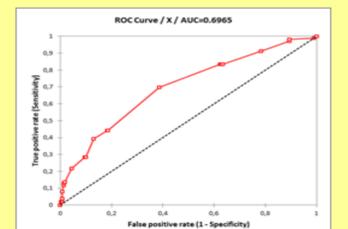
### ROC AAST - pure tone referrals



### ROC AAST - medical referrals



### ROC AAST - combination of pure tone and medical referrals



AAST had 69.61% sensitivity and 61.38% specificity for hearing loss detection based on concurrent pure tone measurements (30dBHL and above response in either ear at any of 1,2,4KHZ)

## Discussion

Hearing loss incidence doubles between newborn detection and school age: over 50% of permanent hearing losses are identified by post-neonatal procedures (Prievé, 2015, Watkin, 2011). Referral rates for the present study were high, (audiology-15%, medical- 16%), consistent with testing in the noisy environments. Referral and identification rates as reported in several studies are shown in the following table.

### Preschool-school hearing screening referral rates

Study	Referral rate (hearing loss)
China, Wenjin et al., 2014- tones	9.3%(1.91%)
Saudi Arabia, Al-Humaid I. Humaid et al., 2014	(5% hearing loss, 7.5% OME)
China, Hubei, Chen et al., 2013 - OAE	1.9% (0.77‰)
China, Shanghai, Lu et al., 2011 - PT/(+) NHS	2.8%(0.75‰)
USA, Serpanos, Jarmel, 2007	18%(1.8%)
UK, Bamford et al., 2007	8% (3.47‰)

### Reasons for not detecting permanent hearing loss in the present study

- low incidence of permanent hearing loss in the preschool population
- low compliance to follow up evaluation
- relatively small sample

## Conclusions

Hearing loss in the early years has been proven to cause severe developmental and academic delays. Even transient hearing loss may alter auditory processing patterns and permanently disrupt efficient neuronal function (Maruth and Mannarukrishnaiah 2008; Borges, Paschoal, Colella-Santos, 2013). Our findings suggest that:

- Preschool hearing screening is feasible and acceptable in the Cyprus preschool population
- The protocol established with otoscopy, play audiometry, and tympanometry identifies all sources of preschool hearing loss, transient or permanent
- A more extensive investigation needs to be undertaken to establish local epidemiological hearing data
- Correlation of hearing screening to language outcomes is necessary to establish the need for widespread preschool hearing screening.