

# Beyond the Fitting Appointment: Patterns of Hearing Aid and FM System Use in the Classroom

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## INTRODUCTION

Although it is well documented that children require more favorable signal-to-noise ratios than adults for optimal listening and learning<sup>3</sup>, classroom noise levels continue to exceed recommended minimum standards<sup>5,6</sup>. Children with hearing loss, even those who wear hearing aids (HAs), generally encounter difficulty learning and understanding speech in the noisy classroom.<sup>1,4</sup> These difficulties often lead to the recommendation of a frequency-modulated (FM) system to improve the signal-to-noise ratio of the teacher's voice.

Device use at school is of particular interest for audiologists, as school age children spend a majority of their time (7-8 hours a day, 5 days a week) in this setting. Unfortunately, if the children are not consistently wearing their HAs and/or using the FM system, they are unable to take advantage of increased audibility for learning in the classroom environment. Furthermore, the shortage of educational audiologists across the US<sup>2</sup> has resulted in teachers and students bearing the responsibility of monitoring hearing aid and FM system use in the classroom so as to ensure that children with hearing loss have adequate access to the auditory signal (e.g. classroom instruction).

Clinical audiologists typically rely on parental report of device use/non-use in the classroom which have the potential to drive technology recommendations and fittings. However, recent reports indicate that parents typically over-estimate device use<sup>7</sup>, leaving the clinical audiologist without an accurate portrayal of the child's hearing assistive technology use at school.

## PURPOSE

- 1) Document parent-reported and researcher-observed patterns of hearing aid(s) and/or FM system(s) use by students in the classroom.
- 2) Identify potential characteristics that may influence device use or non-use to improve fitting and counseling for these specific groups.

## METHODS

Data were obtained as part of a larger ongoing study examining listening effort and fatigue in school-age children (6 to 12 years old) with hearing loss. All participants had bilateral mild-to-moderate hearing loss (MMHL) and were monolingual speakers of English. Children spent at least two hours per school day in a general education classroom. Those with parent-reported diagnoses of cognitive impairment, autism spectrum disorder, and other development disorders were excluded.

HA and FM system use was documented in two ways for each participant:

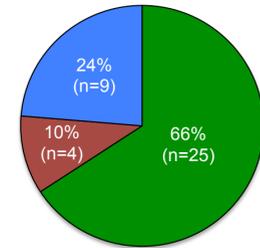
1. Parents reported an estimate of their child's average HA use time during typical school days and indicated whether the child had an FM system available for use in the classroom.
2. Participants' classrooms were visited by a research assistant on two typical school days at 10:00 am and 2:00 pm, for a total of four observations, to document if the child was wearing his/her HAs and/or if an FM system was in use. The following classifications were assigned to each child:
  - **Nonuser** – never observed using the device(s)
  - **Variable user** – observed 1-3 times using the device(s)
  - **Consistent user** – observed all 4 times using the device(s)

Variable	Value
Number of participants with hearing aids	38
Number of participants with FM system	26
Number of males	18
Participants with mothers who attend at least some college	32
Participants who failed at least one grade	6
Average noise level of occupied classroom	63.28 dBA

Table 1. Summary of demographic information and classroom observations for participants.

## RESULTS – Observed Patterns of Hearing Aid & FM System Use

### Classroom Hearing Aid Use



■ Consistent user ■ Variable user ■ Nonuser

Figure 2 - HA use and Degree of Hearing Loss. Hearing threshold levels (in dB HL) reported as a function of frequency (Hz) for the consistent user (left panel) and non-user (right panel) groups. Dotted lines represent each ear of individual participants. Solid lines represent the group average and error bars represent  $\pm 1$  SD in each ear. Asterisks indicate "no response" measured for participants at the limits of the audiometer.

A mixed design analysis of variance (ANOVA) using the better-ear threshold for each frequency showed that **consistent users had poorer thresholds when compared to non-users ( $p < .001$ )**. Post-hoc independent group t-tests showed **these group differences were apparent ( $p < .006$ ) for frequencies 2000-8000 Hz**.

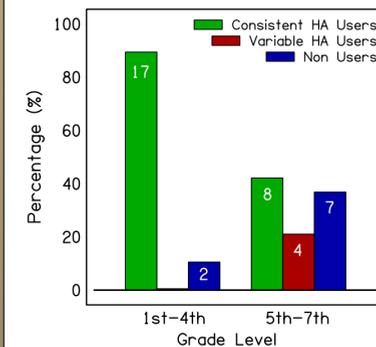
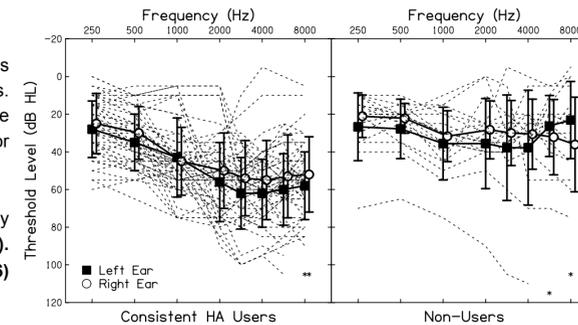


Figure 4 - FM use in the Classroom. Percentages of observed use of an FM system in participants by category: "consistent user", "variable user", or "non-user". Note the total number of children in this figure is less than for previous figures, as only 26 children had parents who reported an FM system was available for use in their child's classroom.

### FM and HA Use Group:

- Of the 26 children with reportedly available FM, 22 were observed to be consistent HA users.
- **8/22 (36%) of these consistent HA users were never observed using an FM system.**

### Variation in FM Technology:

- Of the children with observed variable or consistent FM system use (n=15), 7 had sound-field systems, 6 had personal FM, and 2 had both sound-field and personal.

Figure 1 - HA use in the Classroom. Percentages of observed hearing aid use in participants by category: "consistent user", "variable user", or "non-user".

- The majority of participants (63%) were observed wearing their hearing aids during all four classroom visits; however, nine participants were never observed wearing their prescribed HAs.
  - All of the variable users were in grades 5-7. One child was a typically consistent user who had a dead battery at one visit and the remaining three children were inconsistent users.
- Of the six children who had failed at least one grade, half were consistent hearing aid users and half were variable or non-users.
- There was no significant effect of gender on HA use category ( $p > .05$ ). In fact, 67% of males and 65% of females were noted to be consistent hearing aid users.

Figure 3 - HA use and Grade Level. Percentage of observed device use in participants by category and grade level.

- Most consistent HA use was observed in children in grades 1-4.
  - Of children in this grade level range, 89.5% were found to be consistent users.
  - Conversely, only 42% of participants in grades 5-7 were observed wearing HAs consistently.
- Of the nine children considered "non-users", seven (78%) were in grades 5-7.

A one-way analysis of covariance (ANCOVA) was completed with HA use group as the dependent variable and grade-group as the independent variable. The four-frequency (500, 1000, 2000, 4000 Hz) pure-tone average (PTA) of the better-hearing ear was found to be a significant covariate ( $F=17.401$ ,  $p < .001$ ), showing that children with milder hearing loss were more often observed to be "non-users". A significant main effect of grade-group ( $F=4.882$ ,  $p < .05$ ) suggests that **children in grades 1-4 have different HA use patterns than those in grades 5-7, regardless of the severity of hearing loss**.

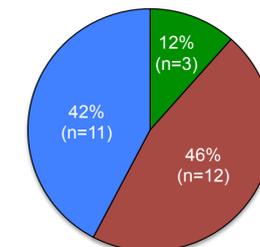
### FM and Grade Level:

- The majority of children (65%) with reportedly available FM systems were between 1-4<sup>th</sup> grade.
- 50% of children between 5-7<sup>th</sup> grades did not have an FM system or their parents didn't know if they had one.

### FM Use and Degree of Hearing Loss:

- Better-ear 4-PTA was not significantly related to FM system use/non-use ( $p = .222$ ).

### Classroom FM System Use



■ Consistent user ■ Variable user ■ Nonuser

## RESULTS – Parent Estimation of Use

### HA Report Accuracy & Grade Level:

Parental reports of HA use in the classroom were consistent with 95% of observations of children in grades 1-4; however, parents were less accurate for children in grades 5-7

Table 2. Parent report and observed pattern of HA use in the classroom.

HA Use	Consistent	Variable	Non-Use
Reported	32	1	5
Observed	25	4	9

with only 63% accurately reporting use/non-use.

- 33% of parents with children who were not wearing hearing aids during any of the observations (n=9) reported consistent device use at school.

### FM System Report Accuracy:

- Of the 26 parents who reported that their child had an FM system available in the classroom, only two correctly reported that their child did not use that device.
- 11/26 (42%) of parents who reported that there was an available FM system in the classroom had children who were not observed wearing the device during any of the four classroom visits.
- Three parents were unaware that their child was using an FM system in the classroom.

## SUMMARY & CONCLUSIONS

The following factors were observed to potentially influence HA use in the classroom:

- **Degree of hearing loss:** Consistent HA users had significantly more hearing loss than variable and non-users.
- **Grade level of the student:** Children in grades 1-4 were more likely to be consistent users than children in grades 5-7.

Despite available FM systems, the majority of children with MMHL and/or their teachers were observed to use these devices inconsistently or not at all. The pattern of available FM system use does not appear to be influenced by grade level, degree of hearing loss, or gender. However, half of the 5-7<sup>th</sup> grade children were not reported to have an available FM system.

Collaboration between audiologists and school personnel to accurately determine device use for school-age children is key, as **parents are not always aware of their child's device use and/or if the child has an FM system for use at school**. Clinical audiologists should increase parental support to help families advocate and understand what services and equipment their child has available at school.

Limitations of this study include a small sample size and limited observation times. Additional information, including datalogging results and longer observation periods are needed. Future studies are needed to determine potential psycho-social barriers to device use, rates of malfunction of devices being worn throughout the school day, and the knowledge of teachers and school staff related to hearing assistive technologies.

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