

Evaluation of Factors Affecting Hearing Aid Use in Children

Original Investigation

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Abstract

Objective: The purpose of this study was to determine the factors affecting hearing aid use in children and investigate how these factors affected their subjective auditory performance.

Methods: The study was carried out with 34 children aged three to six years who had mild or moderate sensorineural hearing loss and had used a bilateral hearing aid for at least six months. The daily hearing aid usage times of children were collected with the help of data logging software. Parent-child interactions were assessed with the Maternal Behavior Rating Scale (MBRS) and Child Behavior Rating Scale (CBRS) scores. To assess the parents' levels of knowledge about hearing devices, the Hearing Aid Awareness Question Form for Parents, which was prepared by the researchers, was used. Finally, to evaluate the subjective hearing performance of the children, the Parents' Evaluation of Aural/Oral Performance of Children (PEACH) survey was implemented.

Results: Strong and significant correlations were found between the MBRS and CBRS scores, the results obtained from some questions in the Hearing Aid Awareness Question Form for Parents, the overall PEACH score, the QUIET subscale score, and the NOISE subscale score ($p < 0.001$). According to the multivariate linear regression analyses, it was observed that the use of the pediatric clip hearing aids holder (question 17) had a significant effect in decreasing both the overall PEACH score ($\beta = -3.07$, $p = 0.008$) and the PEACH-NOISE subscale score ($\beta = -1.88$, $p = 0.012$). A unit increase in the score given to question 24 of the Hearing Aid Awareness Question Form for Parents (i.e., using the hearing aids longer) caused a 2.35-fold increase in the PEACH-NOISE subscale score, a 1.74-fold increase in the PEACH-QUIET subscale score, and a 4.06-fold increase in the overall PEACH score.

Conclusion: Parent-child interaction and parents' knowledge about hearing aid use are important factors affecting hearing aid use in children. These factors also affect the children's subjective auditory performance. Parents should be given detailed information about hearing aid use and be more sensitive and responsive in their interactions with their children.

Keywords: Hearing loss, hearing aids, parent child relations, pediatrics, hearing impairment, audiology

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Introduction

Hearing loss is a common condition in children and can lead to delays in language skills, as well as to learning problems and social integration disorders (1, 2). These adverse effects can be reduced with appropriate audiological intervention and auditory rehabilitation (2, 3). Hearing aids are one of the audiological intervention options (4).

In most studies that investigate the factors affecting the use of hearing aids, it was emphasized that daily hearing aid use and the parents' educational levels and socioeconomic statuses were effective at daily hearing aid use time (5, 6). In addition to these factors, parents' knowledge about hearing aid use and parent-child interactions were also thought to affect hearing aid use.

As is often mentioned in the literature, one of the factors affecting hearing performance in children is the duration of hearing aid use (7-10). Improved auditory performance and language development are observed in full-time users (8, 11).

Another important factor in hearing aid usage is the interaction between the parents and the child. As this interaction increases, the development in the child's cognitive, social, language and communication areas also increase (12, 13).

Another important factor affecting the use of hearing aids in children is the correct and effective use of these devices. Parents who encountered hearing aids for the first time reported that they had some difficulties in how to integrate new skills into daily life, had little knowledge and had deficiencies (14-16). However, no informative material has been found for parents to overcome these inadequacies.

Factors affecting hearing aid use also affect auditory performance in children (11, 14). There is limited information in the existing studies on how parent-child behaviors and parents' knowledge about hearing aid usage affect the subjective auditory performance of a child (17). Moreover, no study has been found on how parent-child interaction, parents' knowledge about hearing aid use and daily use of hearing aids affect subjective auditory performance. This study aimed to evaluate the factors affecting hearing aid usage of children in regard of the literature. The study further aimed to evaluate the effects of correct hearing aid use, the parent's levels of knowledge about the hearing aid, parent-child interaction and daily hearing aid use have on the subjective auditory performance of children diagnosed with hearing loss.

Methods

The study was approved by Hacettepe University Non-Interventional Clinical Research Ethics Committee on October 9, 2018 (decision no: GO 18/841-29). The research

was carried out on a voluntary basis. As this study was conducted for research purposes, participants and researchers were asked to sign two written informed consent forms, i.e., the audiologist's explanation and the parent's permission statement for the child.

Subjects

The study was carried out with 34 children (20 females, 14 males) aged three to six years (4.31 ± 1.06 years) who had mild or moderate sensorineural hearing loss, had used bilateral hearing aids for at least six months, and showed normal development. Individuals with hearing aids whose free-field hearing thresholds were in the speech banana were recruited. Individuals with unilateral or bilateral severe/profound hearing loss, inner ear anomaly, diagnosed with retrocochlear pathology, developmental delay or auditory neuropathy spectrum disorder were excluded from the study. One participant was excluded from the study because of a Down Syndrome diagnosis and another due to diagnosed developmental delay. Participants were randomly selected, regardless of their social level, and consisted of early diagnosed individuals who regularly received special education. The brands and models of hearing aids and the gender of the subjects were not taken into account.

The demographic characteristics of the participants are given in Table 1.

Procedure

The Denver II Developmental Screening Test was applied to rule out the gross motor, fine motor, and personal/social developmental retardation of the individuals participating in the study. Individuals who were found to have developmental retardation in any area other than language development were excluded from the study. The hearing aid gains were evaluated in the free field and the following steps were applied in the given order to those whose hearing aid thresholds were within the speech banana.

Determination of the Daily Use of Hearing Aids

Data logging is the process of collecting data about the participants' use of the hearing aid with the help of a computer software (Phonak Target version 4.2, Switzerland; Oticon Genie Fitting Software, Denmark) that records the environmental conditions (quiet/noisy) and time used (hours/day) (18).

Evaluation of Parent-Child Interaction

The Maternal Behavior Rating Scale (MBRS) consists of 12 items and three sub-factors aimed to evaluate the behavior of parents during their communication and interaction with their children. The scale was developed by Mahoney et al. (19) to evaluate parent-child interaction and adapted to Turkish by Diken et al. (20) as the Turkish version of the

MBRS, MBRS-TV. The scale consists of three subscales, namely, 'Being Sensitive and Responsive', 'Being Emotionally Expressive', and 'Being Success-oriented and Directive'. Scoring is done on a range of one to five using the five-point Likert-type scoring. For the nine items under the headings Being Sensitive-Responsive and Being Emotionally Exvepressive, a score of '1' indicates no interaction, while '5' indicates ideal interaction. In the three items under the heading Success-Oriented-Directive, 3 was accepted as ideal, and '4' and '5' as extremes.

The Child Behavior Rating Scale (CBRS), developed by Mahoney and Whedeen (21), was adapted to Turkish as

the Turkish version of the CBRS (CBRS-TV) (20). Here, child behavior is assessed with seven items and two factors as 'Attention' and 'Initiation'. The heading 'Attention', addresses the child's attention, continuity, participation, and cooperation. The heading 'Initiation' addresses the child's initiation, joint attention, and emotional state items. In scoring, '1' for each item indicates no behavior and '5' indicates ideal behavior. MBRS-TV and CBRS-TV scales were implemented by the lead author to assess parent-child interaction within the Practical Use Certificate. The sessions were recorded on video for 10–15 minutes with the consents of the parents and the children, in a way that would not

Table 1. Demographics of subjects

| Subject | Gender | Age (months) | Etiology | Degree of hearing loss | Mother's education level |
|---------|--------|--------------|------------|------------------------|-------------------------------|
| S1 | M | 52 | Congenital | Moderate | Bachelor's or master's degree |
| S2 | F | 47 | Congenital | Moderate | High school |
| S3 | F | 50 | Congenital | Moderate | High school |
| S4 | F | 69 | Congenital | Moderate | High school |
| S5 | F | 44 | Congenital | Moderate | Bachelor's or master's degree |
| S6 | F | 42 | Congenital | Moderate | Bachelor's or master's degree |
| S7 | F | 70 | Congenital | Moderate | High school |
| S8 | M | 58 | Congenital | Moderate | Bachelor's or master's degree |
| S9 | M | 67 | Congenital | Moderate | Primary education |
| S10 | M | 36 | Congenital | Moderate | High school |
| S11 | F | 70 | Congenital | Moderate | High school |
| S12 | F | 48 | Congenital | Moderate | Primary education |
| S13 | F | 38 | Congenital | Moderate | High school |
| S14 | M | 42 | Congenital | Moderate | Bachelor's or master's degree |
| S15 | F | 63 | Congenital | Mild | High school |
| S16 | M | 41 | Congenital | Moderate | Primary education |
| S17 | F | 70 | Congenital | Moderate | Primary education |
| S18 | M | 53 | Congenital | Moderate | Bachelor's or master's degree |
| S19 | M | 41 | Congenital | Moderate | Primary education |
| S20 | F | 66 | Congenital | Moderate | Primary education |
| S21 | F | 65 | Congenital | Mild | High school |
| S22 | F | 60 | Congenital | Mild | High school |
| S23 | M | 39 | Congenital | Moderate | Primary education |
| S24 | F | 60 | Congenital | Moderate | Bachelor's or master's degree |
| S25 | M | 46 | Congenital | Moderate | High school |
| S26 | F | 66 | Congenital | Moderate | Bachelor's or master's degree |
| S27 | F | 56 | Congenital | Moderate | Primary education |
| S28 | F | 63 | Congenital | Moderate | Bachelor's or master's degree |
| S29 | M | 53 | Congenital | Mild | High school |
| S30 | M | 45 | Congenital | Moderate | Bachelor's or master's degree |
| S31 | F | 51 | Congenital | Moderate | Bachelor's or master's degree |
| S32 | F | 38 | Congenital | Moderate | High school |

S: Subject, M: Male; F: Female

affect the behavior, and participants who were distracted by the recording process were naturally observed.

Assessment of Parents' Levels of Knowledge About Hearing Aid Use

The Hearing Aid Awareness Question Form for Parents is a form created by the researchers for this study. In this form, parents were asked about their children's hearing aid use, hearing aid care, time used, battery tracking, mold tracking, etc. (Appendix A).

The Hearing Aid Awareness Question Form for Parents, which aims to evaluate hearing aid use, care and control information for parents, was filled. The clinician asked the questions and the form was completed by explaining the parts which the parent did not understand.

Assesment of Subjective Auditory Performance

The Parents' Evaluation of Aural/Oral Performance of Children (PEACH) scale was developed by Ching and Hill (22), and the Turkish validity/reliability studies were done by Eroğlu et al. (23). The scale aimed to assess the subjective hearing performance of children based on the observations of the parents. The PEACH scale consists of 13 items related to situations in quiet and noisy environments. A 4-point Likert scale is used for scoring. Three different scores were obtained as quiet environment, noisy environment and total score, and these scores were recorded as raw scores. During the interview, the parents were asked to answer the questions in the questionnaire, taking into account their child's behavior in the past week.

Statistical Analysis

The descriptive measures used were frequency and percentage values for categorical variables and mean and standard

deviation for normally distributed numerical variables, median and quartiles for measurements that did not fit to the normal distribution. The normality assumption of the data was studied with the Shapiro–Wilk's test and a histogram. Relationships between the non-normally distributed numerical variables were examined with Spearman's correlation coefficient (partial with age-adjusted), and the relationship between the dichotomous variables (0 or 1) and the numerical variables were examined with the point biserial correlation coefficient. The relationship between the ordered factors (taking values 0, 1, and 2) and the numerical variables was analyzed with the polyserial correlation coefficient. Some questions in the Hearing Aid Awareness Question Form for Parents, which were found to be significant in correlation analysis, data logging, MBRS-TV score, CBRS-TV score, and the effect of age on PEACH score were examined with a multivariate linear regression with backward variable selection. Correlation (r) value; 0.00–0.19 were taken as 'very weak', 0.20–0.39 as 'weak', 0.40–0.59 as 'medium', 0.60–0.79 as 'strong', and 0.80–1.00 as 'very strong' positive correlation. The significance level was accepted as <0.05. IBM SPSS Statistics version 22 (Armonk, NY: IBM Corp.) and R statistical programming language (version 3.4.3) were used in the analysis of the data.

Results

The demographic information and hearing aid daily use statistics of all participants are given in Table 2. No significant difference was observed between men and women in terms of age (p=0.117), data logging score (p=0.404), MBRS-TV (p=0.880), CBRS-TV (p=0.970), PEACH-QUIET score (p=0.287), PEACH-NOISE score (p=0.084) AND overall PEACH score (p=0.117) distribution.

Table 2. Demographic characteristics and summary statistics of participants

| | Male | Female | All participants | p-value |
|---|--------------------|--------------------|--------------------|---------|
| Age, mean ± SD (median) | 3.85±1.07 (3.00) | 4.63±0.96 (5.00) | 4.31±1.06 (4.00) | 0.117 |
| Maternal education | | | | |
| Primary education | 4 (30.8) | 4 (21.1) | 8 (25.0) | 0.627 |
| High school | 4 (30.8) | 9 (47.4) | 13 (40.6) | |
| Bachelor's or master's degree | 5 (38.5) | 6 (31.6) | 11 (34.4) | |
| Data logging, mean ± SD (median) | 9.50±3.90 (10.80) | 10.64±3.35 (11.20) | 10.18±3.57 (10.95) | 0.404 |
| MBRS-TV, mean ± SD (median) | 44.07±7.80 (46.00) | 43.78±7.53 (46.00) | 43.90±7.52 (46.00) | 0.880 |
| CBRS-TV, mean ± SD (median) | 28.15±5.99 (29.00) | 28.21±6.42 (28.00) | 28.18±6.15 (28.50) | 0.970 |
| PEACH-QUIET score, mean ± SD (median) | 22.07±3.66 (24.00) | 21.78±2.34 (22.00) | 21.90±2.90 (23.00) | 0.287 |
| PEACH-NOISE score, mean ± SD (median) | 16.69±4.17 (18.00) | 15.63±2.58 (15.00) | 16.06±3.30 (16.50) | 0.084 |
| Overall PEACH score, mean ± SD (median) | 38.76±7.72 (42.00) | 37.42±4.37 (39.00) | 37.96±5.88 (39.00) | 0.117 |
| N | 13 | 19 | 32 | |

SD: Standard deviation, Data-logging: Hearing aid daily use (h), MBRS-TV: Turkish version of the Maternal Behavior Rating Scale, CBRS-TV: Turkish version of the Child Behavior Rating Scale, PEACH-QUIET: The Parents' Evaluation of Aural/Oral Performance of Children-QUIET, PEACH-NOISE: The Parents' Evaluation of Aural/Oral Performance of Children-NOISE, Overall PEACH: The Parents' Evaluation of Aural/Oral Performance of Children-Overall

The distribution of the answers obtained from the Hearing Aid Awareness Question Form is given in Figure 1. In the findings of the Hearing Aid Awareness Question Form created for parents, the best scores were seen in earmold change (96.9%), earmold tube change (96.8%) and regular hearing aids battery change (93.8%). The lowest scores were seen in the use of cleansing tablets for earmolds (21.9%), use of drying capsules for earmolds (28.1%), use of tamper-proof battery doors (53.1%) and use of pediatric clips hearing aid holder (53.1%).

No statistically significant relationship was found between the daily use of hearing aid and the Turkish version of the MBRS scores ($r_s=0.302, p=0.098$) (Table 3). There were no statistically significant correlations between individuals' daily use of the hearing aids and the CBRS-TV scores ($r=0.288, p=0.116$). High and statistically significant correlations were identified between the PEACH-QUIET subscale score, the overall PEACH score and the MBRS-TV scores ($r=0.734, p<0.001; r=0.704, p<0.001$, respectively). There were moderate and significant correlations between the MBRS-TV and the PEACH-NOISE subscale scores ($r_s=0.602, p<0.001$). Positive, moderate and significant correlations were also identified between the CBRS-TV and the PEACH-QUIET subscale scores, the PEACH-NOISE subscale score and the overall PEACH scores ($r=0.620, p<0.001; r=0.563, p=0.001; r=0.644, p<0.001$, respectively). Again, there was no significant correlation of data logging with the PEACH-QUIET subscale score ($p=0.096$), the PEACH-NOISE subscale score ($p=0.470$) and with the overall PEACH scores ($p=0.235$).

Positive and statistically significant correlation was found between the use of cleansing tablets for earmolds, which is the third item of the Parents' Hearing Aid Awareness Question

Form, and the CBRS-TV scores ($r=0.358, p=0.044$). Positive, moderate and significant correlation was identified between the scores obtained from question 9 'Do you check blockage or tear in the ear molds or tubes for clogs, tears, etc?' and MBRS-TV scores ($r=0.433, p=0.013$).

Similarly, positive and statistically significant correlations were found between the scores obtained from question 18 of the Hearing Aid Awareness Question Form 'Do you use a tamper-proof battery door against the risk of removing or swallowing the battery?' and the MBRS-TV ($r=0.350, p=0.049$) and CBRS-TV ($r=0.383, p=0.031$) scores.

Positive, moderate and statistically significant correlation was identified between the scores of question 20 in the Hearing Aid Question form, 'Does your child use the hearing aid willingly?' and the MBRS-TV ($r=0.503, p=0.003$). Positive, strong and statistically significant correlation was also found between the scores given to this question and the CBRS-TV ($r=0.700, p<0.001$). After comparing the daily use of hearing aid with the answers to questions asked, while moderate and significant correlations were found between the scores from questions 10, 11, 18, 20 and 24; positive, strong and statistically significant correlations were found with the scores from questions 19, 23 and 25 (Table 4).

There were statistically significant correlations close to a moderate level between question 19 of the Hearing Aids Awareness form 'Does your child wear the hearing aid during all waking hours?', the PEACH-QUIET subscale score ($r=0.378, p=0.033$), the noise subscale score ($r=0.379, p=0.032$), and with the overall PEACH score ($r=0.399, p=0.024$). Positive, strong and statistically significant correlations were identified between the scores of question 20 of the Hearing Aid Awareness form 'Does your child use the hearing aid willingly?', the PEACH-QUIET subscale score ($r=0.703, p<0.001$), the PEACH-Noise subscale score ($r=0.633, p<0.001$), and the overall PEACH score ($r=0.701, p<0.001$).

Question 25 of the Hearing Aids Awareness form 'How many hours on average does your child use the hearing aid?' was positively and significantly related to the PEACH-QUIET subscale score ($r=0.459, p=0.008$) and the overall PEACH score ($r=0.380, p=0.032$).

Results from the multivariate linear regression analyses (based on the backward stepwise variable selection method) for the overall PEACH score, the PEACH-QUIET subscale score, and the PEACH-NOISE subscale score are presented in Table 5. After removing the effects of all other variables included in the model, the scores from questions 17 and 24 of the Hearing Aid Awareness Question Form for Parents and the CBRS-TV score were found to be significant factors on the overall PEACH score. Findings from the analysis for the PEACH-QUIET subscale score alone revealed that

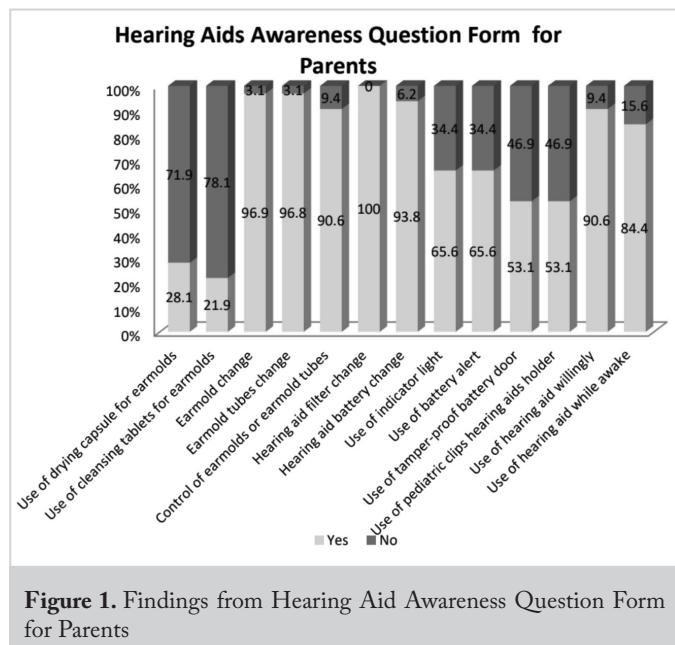


Figure 1. Findings from Hearing Aid Awareness Question Form for Parents

the scores from question 18 ($\beta=1.69, p=0.012$), question 24 ($\beta=1.74, p<0.001$), and the CBRS-TV ($\beta=0.27, p<0.001$) scores were positively associated with the PEACH-QUIET subscale performance. The results for the PEACH-NOISE subscale score alone showed that the scores from questions 17 and 24, and the CBRS-TV scores were associated with the PEACH-NOISE subscale score. A unit increase in the score given to question 24 of the Hearing Aid Awareness Question Form for Parents (i.e., using the hearing aids longer) caused a 2.35-fold increase in the PEACH-NOISE subscale score, a 1.74-fold increase in the PEACH-QUIET subscale score, and a 4.06-fold increase in the overall PEACH score. It was observed that the use of the pediatric clip hearing aids holder (question 17) had a significant effect in decreasing both the overall PEACH score ($\beta=-3.07, p=0.008$) and the PEACH-NOISE subscale score ($\beta=-1.88, p=0.012$) (Table 6).

Discussion

Auditory perception measurements and language development assessments are used to evaluate auditory performance in children using hearing aids. It has been reported that since children with hearing loss exhibit lower language skills and auditory performance compared to children with normal hearing, formal auditory test batteries used for young children did not match their real-life performances and parent observations would provide more accurate information (24, 25).

The sample group included in our study consisted of children who were diagnosed with hearing loss, started to use hearing aids in the early period, received regular auditory rehabilitation, did not have any additional disabilities, had hearing aids within the speech area, and whose receptive language developments were compatible with their peers. In the current study, we aimed to investigate how the correct use of the hearing aid, the parents' level of knowledge about the hearing aid, parent-child interaction and the daily use of the hearing aid affected the subjective auditory performance

of the children using hearing aids. To that end we used the MBRS, CBRS, PEACH and the Hearing Aid Awareness Question Form for Parents in our study.

Examination of the Relationship Between the Daily Use of Hearing Aids and Parent-Child Interaction

Moeller et al. (26) stated that parents should guide their children to continue wearing their hearing aids when they want to remove them, and it has been shown that both parent and child behaviors play a role in hearing aid use. Although the findings obtained from the current study are compatible with the referred study, it was thought that the reason why no significant relationship could be found between the parent-child interaction and the daily use of hearing aids may be due to the limited number of participants. Good interaction may make the parent think that the child is benefiting from the hearing aid and may encourage them to increase the wearing time. Parents should ensure that their children wear their hearing aids during all waking hours and increase the wearing time by showing the right behaviors.

Examination of Parents' Levels of Knowledge About Hearing Aid Use

Based on the results obtained from the Hearing Aid Awareness Questionnaire created by the researchers, it was concluded that parents had a lack of knowledge on some points about the use of hearing aids. In line with the responses given by the parents, earmold change, earmold tube change, battery change, checking the mold and tube for tearing/clogging while wearing the hearing aids were the most common controls by the parents. Parents were least informed about the uses of drying capsules, cleansing capsules, protective battery caps and pediatric clip hearing aids holders.

Our aim in creating a hearing aid awareness questionnaire was to reveal the issues that parents had difficulty with and were concerned about. Our findings revealed that parents had

Table 3. Correlation analysis of Hearing Aid Awareness Question Form for Parents with Hearing Aid daily use, and with other scale scores

| Age adjusted correlations | | | | | | |
|----------------------------|---------|----------------|----------------------------|----------------------------|---------------------|---------------|
| | MBRS-TV | CBRS-TV | PEACH-QUIET subscale score | PEACH-NOISE subscale score | Overall PEACH score | Data logging |
| MBRS-TV | 1.000 | 0.855 (<0.001) | 0.734 (<0.001) | 0.602 (<0.001) | 0.704 (<0.001) | 0.302 (0.098) |
| CBRS-TV | | 1.000 | 0.620 (<0.001) | 0.563 (0.001) | 0.644 (<0.001) | 0.288 (0.116) |
| PEACH-QUIET subscale score | | | 1.000 | 0.693 (<0.001) | 0.881 (<0.001) | 0.305 (0.096) |
| PEACH-NOISE subscale score | | | | 1.000 | 0.943 (<0.001) | 0.135 (0.470) |
| Overall PEACH score | | | | | 1.000 | 0.220 (0.235) |
| Data-logging | | | | | | 1.000 |

MBRS-TV: Turkish version of the Maternal Behavior Rating Scale, CBRS-TV: Turkish version of the Child Behavior Rating Scale, PEACH-QUIET subscale score: Parents' Evaluation of Children's Aural/Oral Performance in Quiet Environment, PEACH-NOISE subscale score: Parents' Evaluation of Children's Aural/Oral Performance in Noisy Environment, Overall PEACH score: Parents' Total Assessment of Children's Aural/Oral Performance, Data logging: daily use of hearing aid

difficulties in and lack of knowledge about the management of hearing aids, and this finding was supported by the information in the literature (16). In a study by Meibos et al. (27), most audiologists stated that parents should receive more training in hearing aid management. Given the consistency between our results and the literature, detailed information should be given to parents, both verbally and in writing, about hearing aid management.

Investigation of the Effect of Parents’ Knowledge About Hearing Aids on Regular Hearing Aid Use

Studies in the literature reported that parents lacked knowledge about using hearing aids, and that children could be encouraged to use their hearing aids for longer periods if and when parents are equipped with the knowledge and skills to support their children (10, 11, 17). Moreover, these studies reported that safety precautions (against swallowing the battery, putting the device in the mouth, etc.), the worry of losing their children’s hearing aids, the fear that the device

might break down as a result of the device getting wet or sweating, all negatively affect the duration of hearing aid use (26). In our study, we observed that children’s use of hearing aids for as long as they are awake, using them willingly, and using them with the necessary apparatus for safety measures increased daily usage time. In the light of these findings, we concluded that a parent with sufficient knowledge about the use of hearing aids increased the daily use of hearing aids by children.

Investigation of the Effect of Parents’ Knowledge About Hearing Aids on Parent-Child Interaction

It has been stated that children depend on their parents for managing their devices and parental attitudes were an important factor in the success of appropriate intervention (16, 17). The findings of our study revealed that families with better parent-child interaction also had better level of knowledge about hearing aids. It is thought that this could be because parents who are responsive to their child’s wishes

Table 4. Correlation analysis between the hearing aid awareness questions for parents and the MBRS-Turkish version, CBRS-Turkish version scores and daily use of hearing aids

| Items | MBRS-TV | CBRS-TV | Data logging r (p-value) |
|-------|-----------------|------------------|--------------------------|
| Q1 | 0.249 (0.169) | 0.227 (0.211) | 0.108 (0.556) |
| Q2 | 0.258 (0.202) | 0.225 (0.470) | 0.263 (0.146) |
| Q3 | 0.333 (0.062) | 0.358* (0.044) | -0.223 (0.219) |
| Q4 | 0.497 (0.069) | 0.547 (0.287) | -0.192 (0.292) |
| Q5 | - | - | - |
| Q6 | 0.203 (0.126) | 0.099 (0.320) | -0.015 (0.934) |
| Q7 | - | - | - |
| Q8 | 0.417 (0.089) | 0.354 (0.625) | 0.268 (0.138) |
| Q9 | 0.433* (0.013) | 0.221 (0.224) | -0.199 (0.274) |
| Q10 | -0.212 (0.243) | -0.290 (0.107) | 0.513** (0.003) |
| Q11 | -0.030 (0.265) | -0.272 (0.304) | 0.379* (0.033) |
| Q12 | 0.046 (0.802) | 0.035 (0.848) | 0.112 (0.543) |
| Q13 | 0.198 (0.059) | 0.103 (0.072) | 0.070 (0.702) |
| Q14 | 0.093 (0.614) | -0.016 (0.929) | -0.116 (0.527) |
| Q15 | 0.188 (0.304) | 0.137 (0.455) | 0.028 (0.879) |
| Q16 | 0.287 (0.111) | 0.302 (0.093) | 0.252 (0.164) |
| Q17 | -0.140 (0.444) | -0.153 (0.403) | -0.274 (0.130) |
| Q18 | 0.350* (0.049) | 0.383* (0.031) | 0.470** (0.007) |
| Q19 | 0.122 (0.505) | 0.198 (0.277) | 0.713** (<0.001) |
| Q20 | 0.503** (0.003) | 0.700** (<0.001) | 0.584** (<0.001) |
| Q21 | 0.118 (0.520) | 0.021 (0.911) | 0.064 (0.728) |
| Q22 | -0.046 (0.242) | -0.273 (0.294) | 0.261 (0.148) |
| Q23 | 0.314 (0.320) | 0.176 (0.225) | 0.686** (<0.001) |
| Q24 | 0.190 (0.116) | 0.041 (0.395) | 0.363* (0.041) |
| Q25 | 0.359 (0.198) | 0.371 (0.290) | 0.677** (<0.001) |

Q: Question, Data logging: Daily use, MBRS-TV: Turkish version of the Maternal Behavior Rating Scale, CBRS-TV: Turkish version of the Child Behavior Rating Scale, r (p-value): correlation coefficient, *p<0.05, **p<0.001

Table 5. Correlations between the parent’s evaluation of auditory/oral performances of the children and the scores of the hearing aid awareness question form for parents

| Items | PEACH-QUIET subscale score r (p-value) | PEACH-NOISE subscale score (p-value) | PEACH-total |
|-------|---|---|------------------|
| Q1 | 0.116 (0.527) | 0.330 (0.065) | 0.242 (0.182) |
| Q2 | 0.053 (0.773) | 0.272 (0.131) | 0.176 (0.334) |
| Q3 | 0.203 (0.266) | 0.106 (0.563) | 0.159 (0.384) |
| Q4 | 0.172 (0.347) | 0.049 (0.792) | 0.103 (0.576) |
| Q5 | - | - | - |
| Q6 | -0.095 (0.605) | -0.146 (0.424) | -0.148 (0.419) |
| Q7 | - | - | - |
| Q8 | 0.177 (0.333) | 0.091 (0.622) | 0.122 (0.507) |
| Q9 | 0.172 (0.345) | 0.164 (0.370) | 0.177 (0.333) |
| Q10 | -0.054 (0.770) | -0.074 (0.685) | -0.068 (0.711) |
| Q11 | 0.106 (0.562) | 0.000 (1.000) | 0.062 (0.737) |
| Q12 | 0.057 (0.757) | 0.059 (0.750) | 0.061 (0.740) |
| Q13 | -0.137 (0.453) | -0.173 (0.343) | -0.181 (0.321) |
| Q14 | -0.049 (0.788) | 0.231 (0.203) | 0.105 (0.566) |
| Q15 | 0.032 (0.864) | 0.167 (0.362) | 0.109 (0.553) |
| Q16 | 0.212 (0.244) | 0.139 (0.449) | 0.182 (0.318) |
| Q17 | -0.320 (0.074) | -0.384* (0.030) | -0.373* (0.035) |
| Q18 | 0.508** (0.003) | 0.270 (0.134) | 0.402* (0.023) |
| Q19 | 0.378* (0.033) | 0.379* (0.032) | 0.399* (0.024) |
| Q20 | 0.703** (<0.001) | 0.633** (<0.001) | 0.701** (<0.001) |
| Q21 | 0.088 (0.634) | 0.115 (0.529) | 0.108 (0.557) |
| Q22 | 0.157 (0.391) | 0.157 (0.390) | 0.163 (0.373) |
| Q23 | 0.345 (0.053) | 0.251 (0.165) | 0.291 (0.106) |
| Q24 | 0.362* (0.042) | 0.402* (0.022) | 0.397* (0.025) |
| Q25 | 0.459** (0.008) | 0.291 (0.106) | 0.380* (0.032) |

Q: Question, r (p-value): correlation coefficient, PEACH-QUIET subscale score: Parents’ Evaluation of Children’s Aural/Oral Performance in Quiet Environment, PEACH-NOISE subscale score: Parents’ Evaluation of Children’s Aural/Oral Performance in Noisy Environment; *p<0.05, **p<0.001

Table 6. Predictors of Overall PEACH score, PEACH-QUIET subscale score, and PEACH-NOISE subscale score: findings of backward variable selection method

| Response | Overall PEACH-score | | | PEACH-QUIET subscale score | | | PEACH-NOISE subscale score | | |
|------------------|---|---------------|----------------|--|---------------|----------------|---|---------------|----------------|
| | Variables included in the model | | | | | | | | |
| | Age, maternal education, data logging, Q17, Q18, Q19, Q20, Q24, Q25, MBRS-TV, CBRS-TV | | | Age, maternal education, data logging, Q18, Q19, Q20, Q24, Q25, MBRS-TV, CBRS-TV | | | Age, maternal education, data logging, Q20, Q24, Q17, Q19, MBRS-TV, CBRS-TV | | |
| | Selected predictors according to the Backward Stepwise linear regression | | | | | | | | |
| | Variable | β (SE) | p-value | Variable | β (SE) | p-value | Variable | β (SE) | p-value |
| | Q17 | -3.07 (1.08) | 0.008 | Age | 0.53 (0.31) | 0.09 | Q24 | 2.35 (0.52) | <0.001 |
| | Q24 | 4.06 (0.80) | <0.001 | Q18 | 1.69 (0.63) | 0.012 | Q17 | -1.88 (0.70) | 0.012 |
| | CBRS-TV | 0.60 (0.08) | <0.001 | Q24 | 1.74 (0.42) | <0.001 | CBRS-TV | 0.29 (0.05) | <0.001 |
| | | | | CBRS-TV | 0.27 (0.05) | <0.001 | | | |
| R ² : | 0.764 | | | 0.745 | | | 0.684 | | |
| SE of estimate | 3.01 | | | 1.56 | | | 1.95 | | |

Q: Question, PEACH-QUIET subscale score: Parents’ Evaluation of Children’s Aural/Oral Performance in Quiet Environment, PEACH-NOISE subscale score: Parents’ Evaluation of Children’s Aural/Oral Performance in Noisy Environment, Overall PEACH score: Parents’ Total Assessment of Children’s Aural/Oral Performance, SE: Standard error

(Evans JD. Straightforward Statistics for the Behavioral Sciences. 1st ed. Pacific Grove, Calif: Brooks/Cole Publishing; 1996. p.600.)

and needs can more easily solve the difficulties encountered in the use of hearing aids as a result of their responsive behavior. In line with the findings, we observed that children's fond use of their hearing aids were related to parent and child behavior.

Factors Affecting Auditory Performance

Studies have shown that children who used hearing aids full-time had better auditory performance and more vocabulary as the duration of auditory deprivation got shorter (5, 11, 14). The reason why no significant relationship could be found between the duration of daily use and subjective auditory performance is thought to be due to the limited number of samples. In addition, this situation suggests that the duration of daily use alone will not be a factor in subjective auditory performance. Therefore, in our study, we also assessed parent-child interaction, child behaviors and parents' knowledge levels about hearing aids along with their daily use times.

Janjua et al. (28) stated that parents of children with hearing loss should be extremely responsive to their children's wishes and behaviors and that a more child-centered interaction should be established by encouraging their children. In the presented study, we found that parent-child interaction had a significant effect on children's subjective auditory performances. We moreover observed that child behaviors along with parental behaviors had positive effects on auditory performance. Obtaining findings consistent with the previous study suggests that the literature is strengthened.

The questionnaire evaluating the parents' knowledge of hearing aid use revealed that better parental knowledge were associated with an improvement in subjective auditory performance. There are no resources available where parents can easily find sufficient information on hearing aid use and care after diagnosis and intervention (15, 16, 29, 30). In studies, parents stated that they removed the hearing aids when outside of their home because of concerns about losing the hearing aid (15, 16). In response to this information in the literature, the use of pediatric clip hearing aids holders for security measures has also been encountered with effective results on auditory performance. In a study conducted with preschool children, it was stated that most of the parents did not have the necessary knowledge and skills to understand whether or not the hearing aid was working properly (6). In our study, we observed that when the indicator lights of hearing aids were not used, parents had difficulty in understanding whether or not the device was working.

To summarize, in cases which the factors that can affect acoustic parameters are not taken into account (e.g., mold change, tube change, filter change, etc.), there may be a decrease in the subjective auditory performance scores, because consistent access to auditory stimuli cannot be achieved despite long-term use of hearing aids.

The present study boasts several notable strengths that contribute to its robustness, but besides the significant findings, this study is not without its limitations, which warrant careful consideration. The strongest aspect of the presented study is that it is the first study to assess the effects of parent-child interaction and hearing aid knowledge together on hearing aid use. While other studies focused on the factors affecting the use of hearing aids, such as education level, cognitive factors, starting age for hearing aid etc., in the current study, the factors that have a homogeneous distribution in terms of demographic characteristics and that have an effect on the auditory performance of the participants in the early childhood period have been assessed in detail.

In the study, the subjective auditory performance evaluation was made only in line with the information obtained from the parents in the evaluation of auditory performance. It was thought that the PEACH questionnaire alone would not suffice to evaluate the auditory performance of children with hearing loss. In future studies, objective assessment tools such as detailed auditory perception tests and cortical auditory evoked potential measurements can be used in addition to the scales to evaluate the auditory performance.

The Hearing Awareness Questionnaire created for the purposes of the study is a non-standard questionnaire since its validity and reliability has not yet been determined. It was used for the first time in this study as a continuation of the story form. It is planned to be expanded by standardizing in future studies.

The TEACH scale includes the evaluation of the auditory/verbal performance of children with hearing loss by their teachers. Since the Turkish validity/reliability study of the TEACH scale has not been performed yet, this scale was not included in our study. Only the effect of parental perspective on hearing aid use was investigated.

Conclusion

Our study has demonstrated a positive increase in auditory performance with the correct use of hearing aids. Since the resources available for parents to obtain information on hearing aid management are limited, the Hearing Aid Awareness Questionnaire was created, and thereby, comprehensive information was obtained to reveal the deficiencies in the use of hearing aids by parents. We concluded that the communication of parents with their children is quite effective on auditory performance and considering the positive effects of parental behavior on the child and vice versa, we suggest that it would be beneficial to add family education programs to auditory rehabilitation programs.

Ethics Committee Approval: The study was approved by Hacettepe University Non-Interventional Clinical Research

Ethics Committee on October 9, 2018 (decision no: GO 18/841-29).

Informed Consent: The research was carried out on a voluntary basis. As this study was conducted for research purposes, participants and researchers were asked to sign two written informed consent forms, i.e., the audiologist's explanation and the parent's permission statement for the child.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: N.Ö., M.Ö.B., Design: N.Ö., M.Ö.B., Data Collection and/or Processing: N.Ö., M.Ö.B., Analysis and/or Interpretation: S.Y.I., Literature Search: N.Ö., M.Ö.B., Writing: N.Ö.

Conflict of Interest: The authors have no conflicts of interest to declare.

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Main Points

- Hearing loss is one of the most common types of childhood disorders and negatively affects language development, cognitive skills, social development, and educational process.
- After the diagnosis of hearing loss, these negative effects are reduced with appropriate audiological intervention and rehabilitation.
- Since children with hearing loss are dependent on their parents for the use of hearing aids, parents should be informed about the use of hearing aids.
- In addition, one of the factors affecting the auditory performance development of children with hearing loss is parent-child interaction, and parents should be informed about appropriate rehabilitative strategies.

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Appendix A. Hearing Aid Awareness Question Form for Parents and summary statistics

| Item No | Hearing Aid Awareness Questions for Parents | Response | | |
|---------|--|-------------------------|--------------------------|-----------------------------|
| Q1 | 1. Do you use a drying capsule for earmolds? | Yes 11 (34.4) | | No 21 (65.6) |
| Q2 | 2. How often do you change the drying capsule for earmolds? (month) | 0-2 10 (31.3) | 2-3 - | 3+ 22 (68.8) |
| Q3 | 3. Do you use a cleansing tablet for earmolds? | Yes 7 (21.9) | | No 25 (78.1) |
| Q4 | 4. How often do you use earmold cleaning tablets in a week? | 1 5 (15.6) | 1-3 2 (6.3) | 3+ 25 (78.1) |
| Q5 | 5. Do you change the earmolds regularly? | Yes 32 (100) | | No 0 (0) |
| Q6 | 6. How often do you change your earmolds? (month/s) | 0-6 28 (87.5) | 6-12 2 (6.3) | 12+ 2 (6.3) |
| Q7 | 7. Do you change the earmold tubes regularly? | Yes 32 (100) | | No 0 (0) |
| Q8 | 8. How often do you change your earmold tubes? (month/s)? | 0-3 16 (50) | 3-6 12 (37.5) | 6+ 4 (12.5) |
| Q9 | 9. Do you check the earmold or the earmold tubes for clogs, tears, etc.? | Yes 30 (93.8) | | No 2 (6.2) |
| Q10 | 10. Do you change the hearing aid filter regularly, if it requires replacement? | Yes 30 (93.8) | | No 2 (6.2) |
| Q11 | 11. If the hearing aids filter requires replacement, how soon do you change it? (month/s) | 0-3 28 (87.5) | 3-6 - | 6+ 4 (12.5) |
| Q12 | 12. Do you replace the hearing aid batteries regularly? | Yes 31 (96.9) | | No 1 (3.1) |
| Q13 | 13. How often do you replace hearing aid batteries? (says) | 0-6 18 (56.3) | 7-10 9 (28.1) | 10+ 5 (15.6) |
| Q14 | 14. Do you keep the indicator lights on to monitor the working status of the hearing aid, battery warning, and program change, etc.? | Yes 19 (59.4) | | No 13 (40.6) |
| Q15 | 15. Does the indicator light give a warning when the battery is low? | Yes 24 (75) | | No 8 (25) |
| Q16 | 16. Do you use the buttons for volume/program control? | Yes 6 (18.8) | | No 26 (81.2) |
| Q17 | 17. Do you use a pediatric clip hearing aids holder to prevent the hearing aid from falling off or getting lost? | Yes 15 (46.9) | | No 17 (53.1) |
| Q18 | 18. Do you use a tamper-proof battery door against the risk of removing or swallowing the battery? | Yes 19 (59.4) | | No 13 (40.6) |
| Q19 | 19. Does your child wear the hearing aid during all waking hours? | Yes 27 (84.4) | | No 5 (15.6) |
| Q20 | 20. Does your child use the hearing aid willingly? | Yes 29 (90.6) | | No 3 (9.4) |
| Q21 | 21. Does your child wear the hearing aid/s to kindergarten/preschool? | Yes 31 (96.9) | | No 1 (3.1) |
| Q22 | 22. How many hours does your child use the hearing aid in kindergarten/preschool? | >5 27 (84.4) | 2-5 3 (9.4) | <2 2 (6.2) |
| Q23 | 23. When does your child wear the hearing aid? | At wake up 21 (65.6) | At breakfast 4 (12.5) | After breakfast 7 (21.9) |
| Q24 | 24. When does your child take off the hearing aid? | At night 28 (87.5) | After dinner - | Before dinner 4 (12.5) |
| Q25 | 25. How many hours on average does your child use the hearing aid per day? | >8 26 (81.3) | 6-8 1 (3.1) | <6 5 (15.6) |