



# Children with Conductive Hearing Loss Fitted with Hearing Aids: Outcomes and Caregiver Experiences in South Africa

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Int Arch Otorhinolaryngol 2023;27(1):e83–e96.

## Abstract

**Introduction** Hearing aids are a frequent management option for children with conductive hearing loss (CHL) and it is necessary to determine the efficacy of outcomes. Limited information regarding caregivers' perceptions and experiences are available to examine outcomes in this population.

**Objectives** To describe hearing aid outcomes and caregivers' experiences for children with CHL who wear behind-the-ear (BTE) hearing aids.

**Methods** Retrospective review of clinical data from 19 children between 0 and 13 years of age with CHL, who were fitted with BTE hearing aids between January 2017 and March 2020. Hearing aid outcomes were documented at one month post-hearing aid fitting, via average daily use and caregiver and teacher reports obtained through the Parents' Evaluation of Aural/oral performance of Children (PEACH) and the Teachers' Evaluation of Aural/oral performance of Children (TEACH). Telephonic surveys were conducted with 13 caregivers to explore their experiences. Qualitative data from open-ended questions were analyzed thematically.

**Results** The average hearing aid use was 6.5 hours/day (2.0 standard deviation, SD; range 4.1–10.3) for bilateral hearing aid users. Questionnaire results indicated that most children (PEACH – 83.3% and TEACH – 92.3%) used their hearing aids more than 75% of the time. Participants performed better in quiet environments with limited sensitivity to loud sounds at home and at school. Reported challenges included stigma and device compliance.

**Conclusions** Children with CHL used their hearing aids for comparable hours (5–8 hours/day), as reported for children with sensorineural hearing loss, but less than the recommended 10 hours/day required for adequate language development. Caregivers reported benefits equivalent to expectations, with challenges similar to those reported in high-income countries.

## Keywords

- ▶ pediatrics
- ▶ hearing aids
- ▶ conductive hearing loss
- ▶ outcome measures
- ▶ caregivers

received  
September 15, 2021  
accepted  
December 2, 2021

DOI <https://doi.org/10.1055/s-0042-1742769>.  
ISSN 1809-9777.

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Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

## Introduction

It is estimated that 466 million people globally have a disabling hearing loss, with at least 34 million being children under 15-years-old.<sup>1</sup> Hearing loss is the second most prevalent disability, affecting at least 15.5 million children globally under the age of 5 years.<sup>2</sup> Sub-Saharan Africa (SSA) has one of the greatest prevalence rates of hearing loss.<sup>3</sup> Estimates suggest that the prevalence of hearing loss in children from 5 to 14 years of age is 1.9% in SSA, more than double that of high-income countries (0.4%).<sup>4</sup>

More than 60% of hearing loss in children under the age of 15 years old is preventable.<sup>5</sup> However, many cases of childhood hearing loss, while preventable, are common in low-to-middle-income countries (LMICs), constituting almost half (48.9%) of all cases.<sup>6</sup> Prenatal and perinatal complications are risk factors related to hearing loss in LMICs, with postnatal infections being more prominent.<sup>7</sup> It is well documented that poor socioeconomic factors can lead to an increase in middle ear pathology and the associated preventable hearing loss, in addition to the restricted access to human resources and ear health care.<sup>1,7,8</sup>

The most prevalent causes of childhood hearing loss are associated with otitis media (OM, 57.1%) and congenital abnormalities (21.1%).<sup>2</sup> Several pathologies are associated with conductive hearing loss (CHL) and persistent contributors include outer ear malformations (atresia or microtia), middle ear malformations (cholesteatoma or ossicle malformation) and genetic syndromes (Treacher Collins, Down syndrome, Goldenhar syndrome, Cornelia de Lange syndrome, and CHARGE syndrome).<sup>7,9</sup> These contributors tend to occur more frequently in LMICs, adding to the high incidence of CHL in SSA.<sup>10</sup> The most common and treatable cause of CHL is OM.<sup>7</sup> Additionally, OM is the greatest contributor (63.7%) of hearing loss in children under the age of 5 years.<sup>11-13</sup> Chronic OM is often associated with mild to moderate CHL, and if left untreated can lead to permanent sensorineural hearing loss (SNHL).<sup>1,12</sup>

Globally, more than 98.7 million people have hearing loss secondary to acute OM and chronic suppurative otitis media (CSOM).<sup>14</sup> At least 80% of all children will have an episode of acute otitis media (AOM) before 3 years of age, with an incidence of at least 43% in SSA.<sup>15-17</sup> The global incidence of CSOM is 4.8%, and it accounts for more than half of the global burden of hearing loss.<sup>12,16,18</sup> The second highest prevalence rate of CSOM globally is SSA,<sup>12,13</sup> with HIV-positive children being more prone and severely affected than immunocompetent children.<sup>19</sup>

Previously, it was estimated that South Africa had a childhood OM prevalence rate between 3.8 and 12%.<sup>20,21</sup> However, these studies only focused on school-age children, rather than younger preschool children who are more likely to acquire OM.<sup>16,22</sup> It was recently found that otitis media with effusion (OME) was the most common pathology in South African children aged 2 to 5 years (23.9%), with AOM only found in 3% of the children younger than 2-years-old.<sup>16</sup> Additionally, CSOM was found to occur more frequently in children aged 6 to 15 years, with a notable prevalence of

9.3%.<sup>16,18</sup> While the prevalence of OM decreases with age, its impact on hearing has long lasting effects.<sup>12</sup>

The development of spoken language is proportionate to hearing ability.<sup>23</sup> If not addressed timeously, hearing loss may not only have implications for language development, but also cognitive development, academic performance, as well as socio-emotional development.<sup>24-26</sup> Children who develop postlingual hearing loss are also impacted by hearing loss, often in terms of the quality of speech production, and cognitive and literacy skills.<sup>11,13,27</sup> Children with CHL were found to have increasing difficulties in speech perception and reading, delayed reaction to auditory input, vocabulary limitations, and attention difficulties.<sup>28-30</sup> In addition, CHL is associated with poor task orientation skills and difficulties with independent class work.<sup>29,31</sup> Two separate studies in children with unilateral atresia and CHL (older than 5 and 6 years respectively), indicated no grade failure when they used hearing technology such as FM systems and amplification devices.<sup>10,30</sup> The National Institute for Clinical Excellence (NICE) have recommended the use of hearing aids for OME that has not resolved within three months, or as an alternative to ventilation tube insertion.<sup>32</sup> Additionally, the use of hearing aids has been recommended while awaiting surgery to limit the negative effects of temporary hearing loss on a child's academic performance.<sup>32</sup> The use of hearing aids during this time will assist by optimizing the child's listening and learning environments.<sup>32,33</sup> In children with a genetic predisposition to CHL, such as Down syndrome, behind-the-ear (BTE) hearing aids have already been recommended as the standard of care.<sup>32,33</sup>

While hearing aids are an option to manage CHL, they are only effective if frequently used by the child.<sup>34</sup> Previous reports confirmed that at least two thirds of children with CHL due to OM, and who were fitted with BTE hearing aids, made use of them.<sup>35,36</sup> A more recent study indicated that at least a third of pediatric Ear, Nose and Throat (ENT) patients with OME were referred to a hearing health professional for temporary hearing aid fitting, with up to 50% receiving this intervention while the remainder had their CHL resolved by the time of assessment.<sup>34</sup> Of those who received intervention, it was reported that 95% used their hearing aids, but average usage time was varied.<sup>34</sup> There is limited data available on the outcomes of children with CHL fitted with BTE hearing aids, with available studies using small sample sizes and focusing mostly on high income countries.<sup>34,37</sup> Research into the management and outcomes of children with CHL is necessary to support evidence-based service delivery and improved, family centered care.

Understanding caregivers' experiences is also important for hearing health professionals to provide family centered care.<sup>38</sup> While some studies have investigated the experiences of caregivers of children with hearing loss who were fitted with hearing aids, these have been limited to caregivers of school-aged children and children with permanent SNHL.<sup>39,40</sup> However, the data from these studies suggest that caregivers' experiences, challenges, and perceived benefits of hearing aids can impact outcomes in terms of hearing aid use.<sup>38-40</sup> There is a dearth of data on caregivers' experiences of children with

CHL fitted with hearing aids, with current available data focusing only on reasons for poor hearing aid use.<sup>34</sup>

As a common management option for OM, it is necessary to determine whether hearing aids are an effective and utilized treatment for childhood CHL, as well as what caregivers' perceptions and experiences are regarding perceived outcomes. Therefore, this study describes hearing aid outcomes and caregivers' experiences for children with CHL fitted with BTE hearing aids.

## Methods

This study was approved by the University of Pretoria Human Research Ethics Committee (HUM064/0519), the University of Cape Town Human Research Ethics Committee (176/2019), and the Red Cross War Memorial Children's Hospital Ethics Committee (RCC202).

### Study Population

Red Cross War Memorial Children's Hospital is the first independent tertiary institution in SSA dedicated entirely to child health care. The Department of Audiology provides specialized diagnostic and intervention services for children from birth to 13 years of age from the public health sector. We conducted a retrospective review of clinical data from children aged 0 to 13 years, diagnosed with unilateral or bilateral CHL, who were fitted with BTE hearing aids between January 2017 and March 2020. A cross-sectional prospective caregiver-focused telephonic survey was conducted between July 2020 and December 2020.

The definition for CHL used by the Department of Audiology is adapted from Schlauch and Nelson<sup>41</sup> and constitutes a difference of 15 dBHL between air conduction and bone conduction thresholds, with bone conduction thresholds being better than 20 dBHL; at all thresholds between 500 Hz and 4000 Hz. When CHL is diagnosed, an ENT consultation takes place to determine which method of management will be followed: watchful waiting, medical management in terms of prescription medication, scheduling of surgical management, or monitoring of hearing until eligible for surgical management. Each child then receives a follow-up hearing assessment in 3 months' time to determine whether the selected management option was successful. In cases where there is no improvement in hearing thresholds, no active otorrhoea, or the child is awaiting surgical treatment until they are old enough, the hearing health professional in consultation with the child and caregiver will discuss the benefits of amplification by means of hearing aid fitting. Academic performance is also taken into consideration for decision-making, and a report from the child's teacher is required to determine if the hearing loss had an impact on school performance. Should the child and caregiver consent, ear mold impressions are taken, and an appointment for hearing aid fitting is scheduled.

Children (0–13 years old) diagnosed with CHL (unilateral or bilateral) and fitted with BTE hearing aids (unilaterally or bilaterally) for at least one month, and with data available for at least one functional outcome measure—be it the Parents' Evaluation of Aural/Oral performance of Children (PEACH) or

the Teachers' Evaluation of Aural/Oral performance of Children (TEACH)—were considered as eligible participants for this study. Caregivers were later identified through their relationship with the pediatric hearing aid users and contacted regarding their willingness and availability to participate in a telephonic survey.

## Data Collection Materials and Procedures

### Retrospective Record Review

Patient data are routinely captured by the Department of Audiology in an electronic database. This database was utilized to retrospectively identify participants with CHL, who were fitted with BTE hearing aids between January 2017 and March 2020. Some data, not present in the electronic database, were captured from clinical records of patients' hospital files. Data collected included demographic information, family income, age of diagnosis of hearing loss, age at fitting of hearing aids, hearing aid fitting information—such as real-ear-to-coupler difference (RECD) and aided speech intelligibility index (SII) scores for average sounds—average daily hearing aid use (in hours) at the one month follow-up (data-logging), and hearing aid functional outcome measures (PEACH and TEACH questionnaires).

The PEACH (designed for children > 2 years)<sup>42</sup> and TEACH (designed for school aged children)<sup>43</sup> questionnaires were routinely issued to caregivers and teachers in hard copy at the initial hearing aid fitting, and they were asked to complete the questionnaires the day before the first follow-up appointment (scheduled for one month after hearing aid fitting). Thus, PEACH and TEACH outcomes were obtained one month after the hearing aid fitting. These questionnaires were used in their original English format. Both questionnaires were scored, and results were recorded by the hearing health professional at the follow-up appointment. The PEACH and TEACH questionnaires measure everyday functional and auditory communication performance at home and school, respectively.<sup>42–45</sup> Listening performance is rated in a variety of communication situations, in quiet and noisy environments.<sup>42</sup> Several studies have recommended the PEACH and TEACH questionnaires to evaluate pediatric hearing aid use, as they obtain real-life examples of the impact of hearing loss,<sup>34,44,46</sup> and are quick and easy to complete.<sup>46</sup> These questionnaires are not only used for SNHL, but also for monitoring children with OM, as they account for fluctuations in hearing loss.<sup>34</sup> Additionally, the questionnaires were validated on both normal hearing children and children with hearing loss. Good test-retest reliability (0.93) and internal consistency (0.88) were confirmed.<sup>42</sup>

The PEACH and TEACH questionnaires rate listening behavior according to a five-point rating scale from 0 (Never) to 4 (Always). The PEACH questionnaire consists of 13 items: 2 regarding the child's hearing aid usage and loudness comfort; the remaining 11 items gather information about the child's auditory behavior, and awareness to environmental sounds in quiet (5 questions) and noisy (6 questions) situations.<sup>42</sup> The TEACH questionnaire consists of 11 items: two regarding the child's hearing aid usage and loudness comfort; the remaining 9 items gather information about the child's auditory behavior,

and awareness to environmental sounds in quiet (5 questions) and noisy (4 questions) situations.<sup>43</sup> In both questionnaires a percentage score is calculated for quiet, noisy, and overall results. The total percentage score for each subset is plotted, and auditory behavior with hearing aids is then determined as typical performance, possible review indicated, or further review indicated<sup>42,43</sup>.

### Prospective Telephonic Caregivers Survey

Data on caregivers' perceptions and experiences were collected using a telephonic survey (**Appendix**). The survey's data were used to enhance and supplement the retrospective, descriptive, and functional outcome data. Specific sections of the Parent Hearing Aid Management Inventory (PHAMI) were used in the survey, with minor adaptations.<sup>38</sup> The PHAMI questionnaire was specifically developed to better understand caregivers' access to information and their experiences with their child's hearing aid management through four domains.<sup>38</sup> We used 2 domains of the PHAMI questionnaire, with minor adaptations, for this study, namely the "feelings and habits" and "hearing aid use". Internal consistency has been confirmed for the PHAMI.<sup>38</sup>

The telephonic survey obtained caregivers' information regarding their child's hearing aid use; thoughts and feelings regarding management and use of hearing aids; and hearing aid use challenges encountered. The survey was designed to be answered in English, but for cases in which isiXhosa speaking caregivers struggled to understand the question, the interviewer would then translate accordingly into isiXhosa. The survey consisted of five sections, and a total of 36 items were included: 30 close-ended questions and 6 open-ended questions. A Likert scale (1 = strongly disagree to 5 = strongly agree) was used in the 2 sections that contained the 2 domains from the PHAMI questionnaire. A section with open-ended questions regarding expectations and challenges was included, to attain a better understanding of the specific challenges encountered by caregivers of children with CHL fitted with hearing aids. Caregivers were contacted telephonically, and the verbal consent form was read to them to validate their participation in the survey. On confirmation of consent, the survey was carried out by the interviewer, which took between 15 and 20 minutes. All survey information was captured manually in hard copy by the interviewer, and was later recorded electronically for analysis.

### Data Analysis

All data were captured on an Excel spreadsheet, using Microsoft Excel 2018 (Microsoft Corp. Redmond, WA, USA). The data were analyzed using SPSS 27 (IBM Corp. Armonk, NY, USA) version 27.0. Quantitative data analyses consisted of descriptive statistics, in terms of measures of central tendency and measures of variability; with internal consistency of the two Likert scale survey sections calculated by the Cronbach Alpha test. In both the PEACH and TEACH questionnaires, percentage scores were calculated for the quiet, noisy, and overall domains. A thematic analysis was conducted for the qualitative data obtained from the open-ended questions of the telephonic survey. This qualitative data was categorized, coded, and subsequently grouped according to central themes.

## Results

A total of 3,333 children were diagnosed with hearing loss at Red Cross War Memorial Children's Hospital between January 2017 and March 2020, of which 2,135 (64.1%) were diagnosed with CHL. During this period, 43 children with CHL were fitted with BTE hearing aids (unilaterally or bilaterally). Of this group, 19 children were included in this study, since they were fitted with BTE hearing aids for at least one month and had data available for at least one functional outcome measure. The mean age at diagnosis of CHL for this sample was of 77.6 months (36.0 SD; range 12.0–144.0), and the mean age at the one month hearing aid follow-up was of 88.6 months (36.9 SD; range 14.0–149.0).

### Hearing Aid Fitting and Use

The mean age at hearing aid fitting was 87.6 months (36.9 SD; range 13.0–148.0) with a mean delay from time of diagnosis to hearing aid fitting of 10.1 months (12.0 SD; range 0.0–39.0). A total of 11 pediatric hearing aid users (57.9%) were fitted bilaterally, and 8 (42.1%) were fitted unilaterally ( $n = 19$ ). Most children (84.2%,  $n = 16/19$ ) presented with some form of OM, and the degree of hearing loss was either mild (47.4%,  $n = 9/19$ ) or moderate (52.6%,  $n = 10/19$ ). **Table 1** provides a description of the sample population.

Hearing aid fitting details were available for 17 of the 19 (89.5%) participants at the initial hearing aid fitting. The RECD was measured for 3 children (17.6%), and specific age predicted RECD values were used for 14 children (82.4%). The aided SII values for average speech input at initial fitting were reviewed for this study. As pediatric hearing aid users were fitted either unilaterally or bilaterally, we used the aided SII percentages for the ear with the higher percentage value for bilateral hearing aid users. Across the sample ( $n = 17$ ) the aided SII value was 86.4% on average (6.1 SD; range 78.0–100.0). The aided SII values for average speech input (65 dB SPL) were plotted by severity of hearing loss (pure tone average in dB HL) using the Aided SII Normative Values Worksheet.<sup>47</sup> Hearing aid users in this study sample with available data ( $n = 17$ ) had SII values for average speech input representative of typical audibility for the severity of their hearing loss.<sup>47</sup>

Hearing aid use was tracked through data logging at the one month follow-up appointment for the 14 pediatric hearing aid users whose hearing aids had data logging functionality. Data logging for bilateral hearing aid users was determined by selecting the recorded logging of the better ear. The average hours per day that hearing aids were used was similar for unilateral (6.2 hours/day, 2.6 SD; range 3.8–10.1;  $n = 5$ ) and bilateral hearing aid users (6.5 hours/day, 2.0 SD; range 4.1–10.3;  $n = 9$ ).

### Caregiver and Teacher Reported Outcomes and Experiences

#### PEACH and TEACH Ratings

The PEACH questionnaires were completed by caregivers and submitted by 12 caregivers of pediatric hearing aid users at

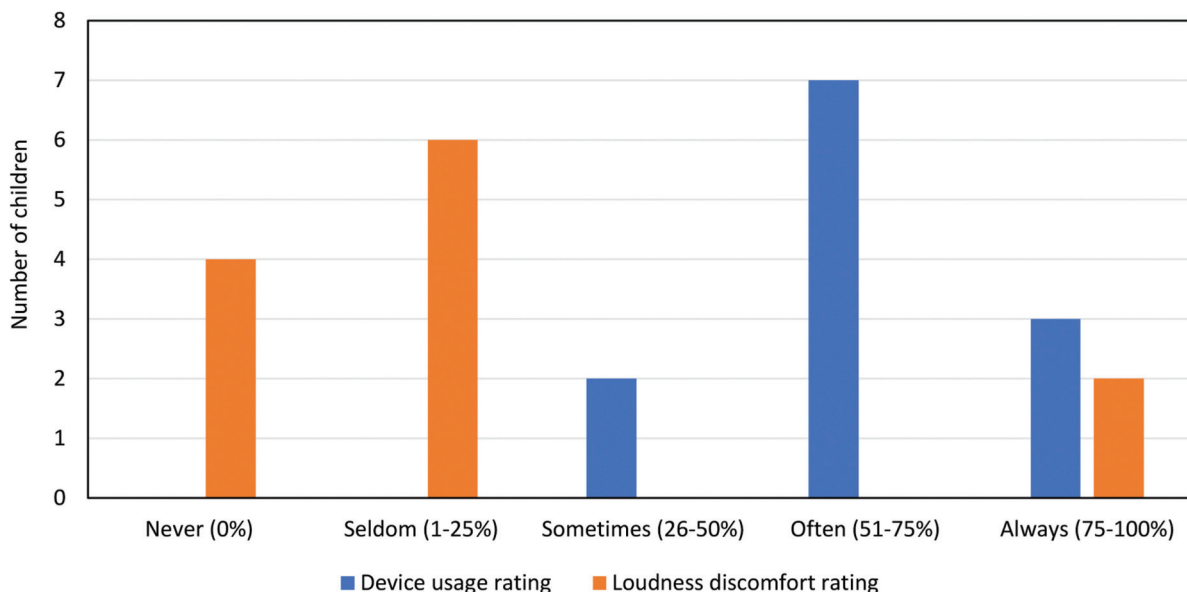
**Table 1** Demographic characteristics of pediatric hearing aid users and their caregivers

<i>Pediatric hearing aid users (n = 19)</i>	<i>n (%)</i>	<i>Caregivers (n = 13)</i>	<i>n (%)</i>
Gender		Respondent for caregiver survey	
Male	10 (52.6)	Father	1 (7.7)
Female	9 (47.4)	Mother	10 (76.9)
		Other	2 (15.4)
Home language		Caregiver home language	
Afrikaans	6 (31.6)	Afrikaans	4 (30.8)
English	6 (31.6)	English	3 (23.1)
isiXhosa	7 (36.8)	isiXhosa	6 (46.2)
Language of instruction		Interview language	
Afrikaans	2 (10.5)	Afrikaans	0 (0)
English	11 (57.9)	English	9 (69.2)
isiXhosa	6 (31.6)	isiXhosa	4 (30.8)
Educational setting			
Mainstream school	15 (78.9)		
Special needs school (mainstream curriculum)	1 (5.3)		
Special needs school (alternative curriculum)	2 (5.3)		
Too young for school	1 (5.3)		
Family income			
H0 (formally unemployed)	8 (42.1)		
H1 (0 USD–400.62 USD per month*)	8 (42.1)		
H2 (400.62 USD–1430.84 USD per month*)	3 (15.8)		
H3 (>1430.84 USD per month*)	0 (0.0)		
Comorbidities			
Microtia	1 (5.3)		
Congenital ptosis	1 (5.3)		
Fetal alcohol syndrome	1 (5.3)		
Down syndrome	2 (10.5)		
Neonatal jaundice	1 (5.3)		
Premature birth	1 (5.3)		
OM	16 (84.2)		
Types of OM (n = 16)			
AOM	2 (12.5)		
Chronic OM	7 (43.8)		
CSOM	5 (31.3)		
OME	2 (12.5)		
Degree of CHL**			
Mild (16–40 dBHL)	9 (47.4)		
Moderate (41–60 dBHL)	10 (52.6)		

Abbreviations: AOM, acute otitis media; CHL, conductive hearing loss; CSOM, chronic suppurative otitis media; OM, otitis media; OME, otitis media with effusion. Notes: \* Exchange rate of 1 USD = R14.56 (South African rand/ZAR). \*\*Degree of hearing loss according to Clark.<sup>48</sup>

the one month follow-up appointment. Caregivers' reports indicated that most pediatric hearing aid users (83.3%, n=10/12) used their hearing aid(s) often or always, and seldom or never complained of sensitivity to loud sounds (83.3%, n=10/12). ►**Figure 1** indicates the caregivers'

reported ratings of hearing aid use and loudness discomfort for 12 pediatric hearing aid users. The mean PEACH scores were similar in both Quiet (74.5%) and Noise (72.1%), indicating typical performance in those environments when aided (►**Table 2**). Based on PEACH scores, more than half



**Fig. 1** Caregiver-reported ratings of children’s hearing aid use and loudness discomfort level (n = 12).

**Table 2** Mean PEACH and TEACH percentage (%) scores for quiet, noise, overall

PEACH (n = 12)	M (SD)	Range
Quiet	74.5 (19.7)	30.0–100.0
Noise	72.1 (17.4)	45.0–100.0
Overall	73.4 (18.3)	36.0–100.0
TEACH (n = 13)		
Quiet	78.1 (22.1)	30.0–100.0
Noise	72.0 (31.5)	6.3–100.0
Overall	75.4 (26.1)	19.4–100.0

of the participants (58.3%, n = 7/12) showed typical performance overall (► **Figure 2**).

The TEACH questionnaires were completed by involved teachers and submitted by 13 caregivers of pediatric hearing aid users at the one month follow-up appointment. Teachers’ reports indicated that almost all pediatric hearing aid users (92.3%, n = 12/13) used their hearing aid(s) often or always, and seldom or never (84.6%, n = 11/13) showed sensitivity to loud sounds. ► **Figure 3** indicates the teachers’ reported ratings of hearing aid use and loudness discomfort for 13 pediatric hearing aid users. The mean TEACH percentage scores were higher in Quiet (78.1%) than in Noise (72.0%) (► **Table 2**).

**Prospective Caregiver Survey**

Only 13 (68%) of the 19 caregivers consented to a telephone survey (4 caregivers could not be reached and 2 declined). At the time of the telephone survey, 6 children (46.2%) were still active hearing aid users, while 7 children (53.8%) did not use their hearing aids anymore (n = 13). Caregivers’ reasons for their children no longer using their hearing aid

(s) was largely due to improved hearing (57.1%, n = 4/7), with the remaining 42.9% reporting otorrhoea (n = 1/7), bullying (n = 1/7), or patient’s discomfort (n = 1/7) as reasons for interrupted use. The average duration of hearing aid use for the active hearing aid users at the time of the telephonic survey was of 43.6 months (41.8 SD; range 2.0–156.0), while the average duration of hearing aid use for those who did not use hearing aids anymore was of 14.4 months (13.1 SD; range 2.0–37.0).

Caregivers were asked to report on typical daily hearing aid use for their children. Those whose children were no longer actively using their hearing aid(s) were asked to report this in retrospect. Most caregivers (69.2%, n = 9/13) reported hearing aid use from 5 to 10 hours a day, with almost a quarter (23.1%, n = 3/13) reporting hearing aid use of less than 5 hours a day, and only 1 caregiver reporting hearing aid use for all waking hours.

The sub-sections that utilized Likert scale questions (feelings, habits, and challenges related to hearing aid use) were checked for internal consistency and were found to have a Cronbach  $\alpha$  value of 0.11 and 0.88, respectively. This indicates that the section related to challenges showed good consistency, similar to previous findings of the PHAMI questionnaire (Cronbach  $\alpha$  = 0.82).<sup>38</sup> Questions related to feelings and habits showed poorer consistency, but could not be compared to previous PHAMI findings as consistency was not reported in the original study for this section.<sup>38</sup> Possible reasons for poor internal consistency could be related to the subjective nature of the questions and the fact that they do not follow a specific theme.

When reviewing caregivers’ feelings and habits (► **Table 3**), all caregivers (100.0%, n = 13/13) felt that the hearing aid(s) help/helped their child; with more than three quarters of them (76.9%, n = 10/13) reporting that they could confidently tell when their child’s hearing aids were not working correctly. Almost all caregivers reported that they

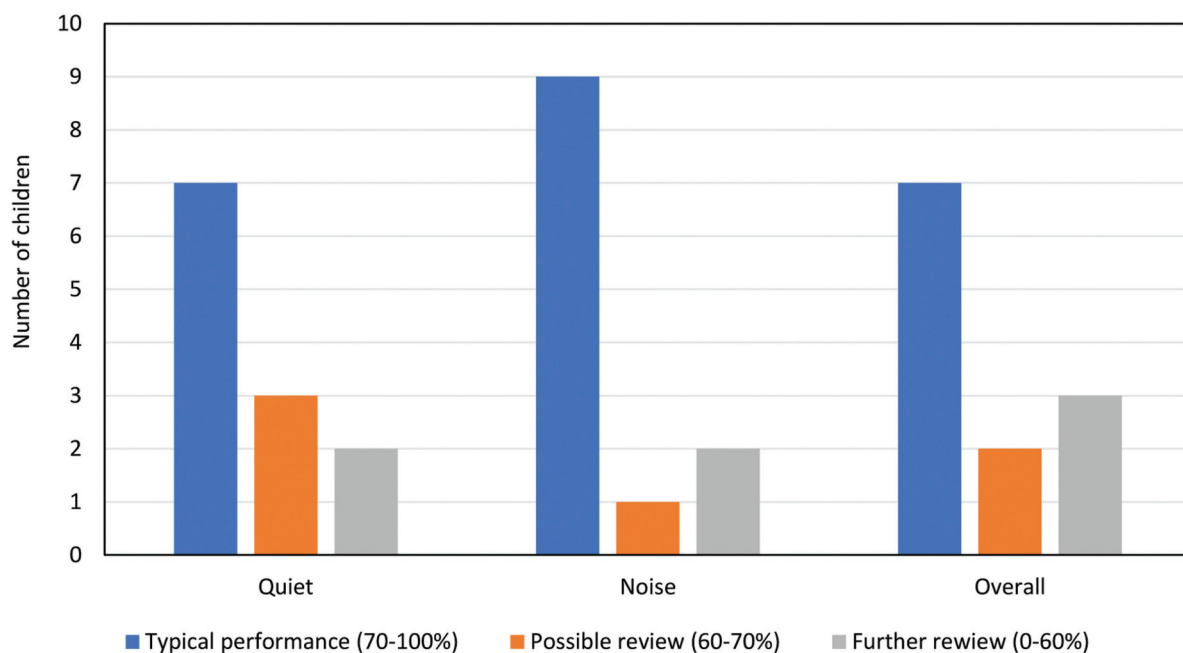


Fig. 2 PEACH percentage score represented as auditory behavior for quiet, noise, and overall (n = 12).

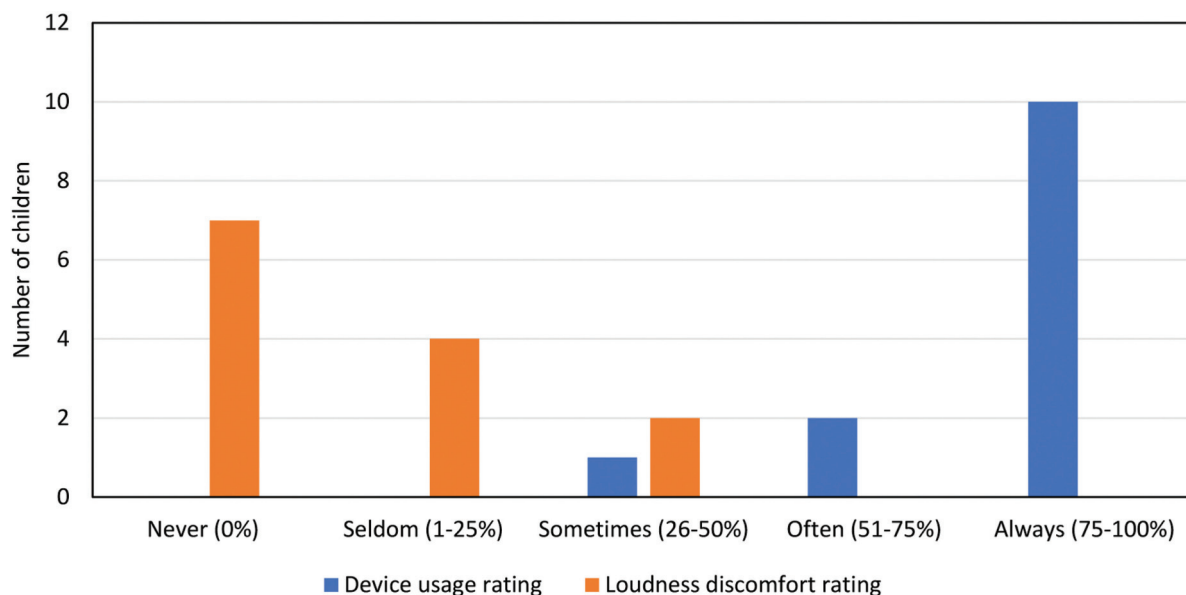


Fig. 3 Teacher-reported ratings of children's hearing aid use and loudness discomfort level (n = 13).

checked their child's hearing aids every day (92.3%, n = 12/13).

When asked about how their child's hearing aid use is/was affected by various challenges (►Table 4), caregivers reported difficulty with frequent ear infections (61.5%, n = 8/13), frequent ear pain (53.8%, n = 7/13), maintaining use during activities (53.8%, n = 7/13), and frequent feedback (46.2%, n = 6/13). However, most caregivers reported that they did not have difficulty getting into a set routine (76.9%, n = 10/13) and coping with the demands of managing the hearing aids (76.9%, n = 10/13). When reviewing audiological management as a possible challenge, most caregivers felt

there was not a long wait time to get an appointment with the hearing health professional (84.6%, n = 11/13) and almost all caregivers felt that the hearing health professional was able to answer their questions during their appointments (92.3%, n = 12/13). Additionally, most caregivers (84.6%, n = 11/13) reported they did not run out of batteries before their next appointment.

The answers to open-ended questions from the telephone survey were gathered from 13 caregivers. The questions inquired about benefits and challenges of hearing aid use, expectations of hearing aids, as well as the pediatric hearing aid users' feelings towards using hearing aids. Six themes

**Table 3** Caregivers' feelings and habits towards hearing aids (n = 13)<sup>†</sup>

	Disagree* n (%)	Unsure n (%)	Agree* n (%)
I accept/accepted my child's hearing loss	2 (15.4)	2 (15.4)	9 (69.2)
I am/was concerned with the appearance of my child's hearing aids	5 (38.5)	0 (0.0)	8 (61.5)
I am/was concerned about what others think**	5 (38.5)	3 (23.1)	5 (38.5)
I am/was concerned about how I will/would deal with my child's feelings about their hearing aids	3 (23.1)	2 (15.4)	8 (61.5)
I think the hearing aids help/helped my child	0 (0.0)	0 (0.0)	13 (100.0)
My child does not/did not need hearing aids	8 (61.5)	1 (7.7)	4 (30.8)
I think occasional hearing aid use is/was enough for my child to learn	4 (30.8)	1 (7.7)	8 (61.5)
I feel/felt quite frustrated with handling the hearing aids every day	7 (53.8)	0 (0.0)	6 (46.2)
I feel/felt confused about how to keep the hearing aids on my child	8 (61.5)	0 (0.0)	5 (38.5)
I feel/felt confident I can tell when my child's hearing aids are not working correctly	0 (0.0)	3 (23.1)	10 (76.9)
I check/checked my child's hearing aids every day	1 (7.7)	0 (0.0)	12 (92.3)
Talking with other parents helps/helped me manage the hearing aids**	4 (30.8)	4 (30.8)	5 (38.5)
The fact that the hearing aids are/were supposed to be temporary helps/helped me to manage them	3 (23.1)	2 (15.4)	8 (61.5)

Notes: <sup>†</sup>Adapted from Munoz et al.<sup>38</sup> \* Ratings of "strongly disagree" and "disagree" were combined as a "disagree" response and ratings for "strongly agree" and "agree" were combined as an "agree" response. \*\* Due to rounding, percentages may not precisely reflect the absolute figures.

**Table 4** Caregivers' challenges experienced impacting hearing aid use (n = 13)<sup>†</sup>

	Disagree* n (%)	Not Sure n (%)	Agree* n (%)
Distractions and needs of other children in the home	8 (61.5)	0 (0.0)	5 (38.5)
Activities (playing outside, riding in the car)	5 (38.5)	1 (7.7)	7 (53.8)
My child's behavior**	6 (46.2)	2 (15.4)	5 (38.5)
Difficulty getting a set routine	10 (76.9)	0 (0.0)	3 (23.1)
Long wait time to get an appointment with the hearing health professional	11 (84.6)	0 (0.0)	2 (15.4)
Other caregiver's ability to manage hearing aids	11 (84.6)	2 (15.4)	0 (0.0)
The hearing health professional's lack of response to my questions during the appointment	12 (92.3)	0 (0.0)	1 (7.7)
Difficulty coping with the demands of managing hearing aids	10 (76.9)	0 (0.0)	3 (23.1)
Frequent ear infection, such as leaking ears	4 (30.8)	1 (7.7)	8 (61.5)
Frequent ear pain	6 (46.2)	0 (0.0)	7 (53.8)
Frequent feedback (whistling/squealing) from the hearing aids	7 (53.8)	0 (0.0)	6 (46.2)
My concern with the appearance of my child's hearing aids	9 (69.2)	1 (7.7)	3 (23.1)
Running out of batteries before my next appointment	11 (84.6)	0 (0.0)	2 (15.4)
The hearing aids not working correctly	11 (84.6)	1 (7.7)	1 (7.7)
My child's reaction to sounds when wearing the hearing aids	8 (61.5)	0 (0.0)	5 (38.5)
Difficulty keeping the hearing aids on	9 (69.2)	1 (7.7)	3 (23.1)

Notes: <sup>†</sup>Adapted from Munoz et al.<sup>38</sup> \* Ratings of "strongly disagree" and "disagree" were combined as a "disagree" response and ratings for "strongly agree" and "agree" were combined as an "agree" response. \*\* Due to rounding, percentages may not precisely reflect the absolute figures.

were extracted following qualitative inductive thematic analysis. These themes are summarized with examples in ►Table 5, in terms of perceived benefits, challenges, expectations, and the child's feelings.

## Discussion

Hearing aid use for all children with CHL in this study showed consistent daily use within the first month post-fitting.



**Table 5** Thematic analysis of open-ended questions of the caregiver telephone survey (caregiver perceptions and experiences) (n = 13)

Themes	Sub-themes	Examples/ illustrative quotes
Benefits	Improved hearing and communication	<p><i>“He has improved speech, communication and learning”</i></p> <p><i>“Hears better at school... she understands us better”</i></p> <p><i>“Don’t have to shout anymore. Can talk softer now”</i></p> <p><i>“Struggles to communicate when hearing aids are not on”</i></p> <p><i>“She stopped looking at my mouth when I talk”</i></p>
	Improved behavior	<p><i>“She is more pleasant person”</i></p> <p><i>“She copes better at school”</i></p> <p><i>“Improved her behavior at school; she used to become frustrated and was very short tempered”</i></p>
Challenges	Stigma / bullying	<p><i>“She was bullied a lot at school”</i></p> <p><i>“She is seeing she is different and doesn’t like to wear them”</i></p> <p><i>“Other children made fun of him”</i></p>
	Device compliance	<p><i>“Difficulty keeping them in his ears, especially on the playground”</i></p> <p><i>“He didn’t want to wear it... he took them out all the time”</i></p> <p><i>“I forget to put the hearing aids on over the weekend”</i></p> <p><i>“Teacher was always complaining that the hearing aid is making a noise”</i></p>
Expectations		<p><i>“That he would learn at school”</i></p> <p><i>“Help him hear better and do better at school”</i></p> <p><i>“Help her hear better as she speaks loudly”</i></p>
Child’s feelings towards hearing aid use	Acceptance	<p><i>“He loved them!”</i></p> <p><i>“No problems. She reminds me in the morning”</i></p> <p><i>“He loves them... asks for them”</i></p> <p><i>“Feels normal”</i></p> <p><i>“Most of the time she doesn’t mind wearing them and often fetches them for me”</i></p> <p><i>“She did not have a problem because it helped her”</i></p> <p><i>“She loved them so much she even wanted them back when she no longer needed them”</i></p>
	Dislike	<p><i>“She does not like them at all and does not want to wear them”</i></p> <p><i>“He did not really like them, but he knew they help him”</i></p>

Additionally, the caregivers’ reported outcomes indicated typical auditory performance with hearing aids for more than half of the children (53.8%) at 1 month post-fitting. Survey responses indicated that all caregivers supported the use of hearing aids and noted an improvement in their child’s hearing from the time of hearing aid fitting. Based on the positive auditory performance and the fact that most of the sample (84.2%) presented with some form of OM, the benefit of BTE hearing aids was confirmed for this population of children with CHL.

The average age of diagnosis of CHL in this sample was 6.5 years, which is the age of entry to formal schooling in South Africa. The average age at hearing aid fitting was just over 7-years-old. A recent South African study investigating predictors of hearing technology use in children under the age of 11 years at an early intervention center in the Western Cape (with various types of hearing loss), noted lower means for both age of diagnosis (2.5 years) and hearing aid fitting (2.8 years).<sup>49</sup> This delay in diagnosis of CHL and subsequent hearing aid fitting is expected considering that 84.2% of this sample had a temporary CHL due to OM. Additionally, the delay between diagnosis and hearing aid fitting of almost one year (10.1 months) in this study sample could be attributed to long waiting periods for an

ENT appointment, as well as recommended periods of watchful waiting.<sup>32,50</sup>

The average daily hearing aid use (6.2 and 6.5 hours for unilateral and bilateral fittings, respectively) and caregivers’ reported use were comparable to the 5 to 8 hours/day previously reported for children with SNHL.<sup>38</sup> However, hearing aid use in this study was lower than the 9.4 hours per day recently reported by another South African study<sup>49</sup> for children with various types of hearing loss (including CHL), as well as the 10 hours per day required for adequate language development.<sup>51</sup> To the authors’ knowledge, there are no recommended guidelines regarding hearing aid use specific for children with CHL. The fact that almost half of the children (47.4%) in this study had a mild degree of hearing loss and 42.1% were fitted unilaterally may have contributed to the slightly lower reported usage, since severity of hearing loss is usually proportionate to hearing aid use.<sup>45,49</sup> Pediatric hearing aid users in this study likely used their hearing aids predominantly in certain listening and learning environments, with many probably having decreased usage over weekends and during holidays.<sup>35,36</sup> The fact that more than two thirds (68.8%) of pediatric hearing users with OM had less severe forms of the disease (AOM, COM, OME) may possibly explain why more than half (53.8%) only used their

hearing aids for over 1 year. Furthermore, the nature of CSOM, the number of children diagnosed with CSOM (31.3%), as well as the long waiting period to access appropriate surgical management<sup>1,50</sup> are possible reasons why 46.2% of pediatric hearing aid users wore their devices for approximately four years (43.6 months).

Caregivers' reported outcomes according to the PEACH questionnaire results indicated that more than half (58.3%) of the pediatric hearing aid users in this study had typical auditory performance overall at one month post-fitting. The overall PEACH score of 73.8% reported here is slightly lower than that of a study on children with unilateral SNHL (84%), and slightly higher than that of a study on children with bilateral SNHL (68.3%).<sup>52,53</sup> The remaining hearing aid users (41.7%) required possible (16.7%) or further (25%) review based on PEACH scores. Since almost one third (31.3%) of this study sample had CSOM, the benefit of hearing aids during periods of otorrhoea may have been limited. Additionally, the fact that all children in this study had either a mild (47.4%) or a moderate (52.6%) degree of hearing loss could have further influenced the auditory performance in some cases. The PEACH and TEACH scores indicated that auditory behavior of pediatric hearing aid users in this study was better in quieter than noisier environments, and supported the positive correlation between these two questionnaires, as previously found by Ching et al.<sup>43</sup> High noise levels are known to have an impact on listening and learning, both at home and at school.<sup>29,31</sup> To overcome this, an increased signal to noise ratio is required, which can be supported by hearing aids or assistive listening devices like FM systems.

Results from the telephone survey showed that all caregivers felt that the hearing aids helped their child, which is in agreement with another study on hearing aid benefit in children with CHL.<sup>35</sup> Survey results indicated that caregivers observed an improvement in their child's hearing when using hearing aids, and that hearing aids should therefore be considered by both ENT specialists and hearing health professionals in the management of CHL. In contrast, Sjoblad et al.<sup>54</sup> found that almost two thirds of caregivers of children with SNHL questioned the benefit received from hearing aids initially, but this perception improved with time. The differences experienced by caregivers of these two groups of children could be related to the limited development of speech and language skills of children with SNHL, as well as the impact that severity of SNHL has on these skills.<sup>54</sup> Regardless of the reported benefit, several caregivers in this study were still concerned about the hearing aids' appearance (61.5%), and more than a quarter (38.5%) were concerned about opinions of others. These stigma concerns are in line with several studies on children with CHL and SNHL, which noted that caregivers felt that hearing aid aesthetics and thoughts of others were a concern.<sup>34,35,38,46,54</sup> This suggests that the concerns of caregivers in this study regarding their child's hearing aids are comparable to those in high-income countries. Furthermore, it highlights the importance of how hearing health professionals impart information to caregivers and support them to achieve effective hearing aid management and outcomes.<sup>38</sup>

The results of qualitative analyses of caregivers' reported expectations were in line with the benefits reported (improved hearing, communication, and behavior). Caregivers' reported challenges included stigma, device compliance, bullying specifically by school peers, and lack of buy-in from teachers as being barriers to hearing aid use. Several studies on children with both CHL and SNHL fitted with hearing aids have noted caregivers' challenges and concerns regarding stigma and bullying by school peers.<sup>34,38,46,54-56</sup> This may partly explain why the majority (61.5%) of caregivers felt that only occasional hearing aid use was enough for their child to learn, in addition to the large number of children with CHL as a result of OM (84.2%). In this study only a few caregivers reported daily hearing aid tasks as challenges to hearing aid use, with 3 caregivers reporting difficulty coping with the demands of managing hearing aids and 1 caregiver having reported running out of batteries. Surprisingly, only 38.5% of caregivers reported their child's behavior as a challenge to hearing aid use, which is a much lower rate than the 50% reported by Munoz et al.<sup>38</sup> Based on the answers of the open-ended questions, most caregivers (76.9%) reported positive feedback from the pediatric hearing aid user regarding wearing their hearing aids. There were, however, some (23.1%) children who were not as amenable to wearing their hearing aids, with 1 reporting that it was due to bullying at school. This feedback highlights the importance of counselling both the caregivers and the child, as well as liaising with teachers to address and alleviate stigma and bullying at school.<sup>38</sup>

While previous studies on pediatric hearing aid users focused on predictors of hearing aid use,<sup>45,49</sup> this study focused on the outcomes of a unique population—children with CHL that use BTE hearing aids. Due to the small sample size and variable age range (14.0–149.0 months) of pediatric hearing aid users in this study, possible associations between independent variables and outcome variables could not be evaluated. The discrepancy in daily hearing aid use between children with CHL and those with more permanent types of hearing loss could be because daily hearing aid use was reported at a single point in time – at the one month post-fitting follow-up – whereas other studies reported longitudinal data with multiple data points over time. Additionally, in comparison to children with CHL, the permanence and degree of SNHL can also account for the increase in daily hearing aid use seen for children with SNHL. Despite a limited sample size, this study provides contextual information regarding hearing aid use for CHL, allowing a better understanding of caregivers' experiences during the period of hearing aid use. Further studies with a larger sample size could investigate hearing aid outcomes of children with CHL prospectively, considering multiple data points for outcomes as well as possible predictors of hearing aid use for this unique population.

## Conclusion

Children with CHL used their hearing aids for 6 hours a day on average. Caregivers reported that the auditory performance

was typical for more than half of the children in this sample, confirming hearing aid benefit. Children experienced minimal listening discomfort at home and school after one month of hearing aid use. All caregivers supported the use of hearing aids for CHL, with clear reports of expectations meeting benefits. The challenges experienced by caregivers (stigma and compliance) are reflective of their counterparts in high-income countries, and of children with SNHL. While this study population is limited, caregivers of children with CHL see more auditory benefit at the initial follow-up than their SNHL counterparts. As the majority of pediatric hearing aid users in this study presented with some form of OM, study results suggest that the fitting of BTE hearing aids is a viable management option to limit the period of hearing loss, and should be a common recommendation by ENT specialists and hearing health professionals for children with CHL.

#### Conflicts of Interest

The authors have no conflict of interests to declare.

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**Appendix: Telephone Survey Questions**

**Study title: Outcomes of children with conductive hearing loss that are fitted with hearing aids in the Western Cape, South Africa**

**Section A: Caregiver’s Information**

Child’s \_\_\_\_\_ code: \_\_\_\_\_

Home language of parent/primary caregiver: \_\_\_\_\_

Language in which interview was conducted: \_\_\_\_\_

**Primary caregiver:**  Mother  Father  Other: \_\_\_\_\_

**Section B: Hearing Aid Use**

1. Does your child still wear (use) his/her hearing aid(s)?  
 YES  NO\*

\*If you have answered “No”, please kindly answer the remaining questions thinking back to the time when your child was wearing hearing aid(s).

a. If “Yes”, in your opinion why do you think it is important that your child wear (uses) his/her hearing aid(s)?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

b. If “No”, what are the reasons for your child not wearing (using) his/ her hearing aid(s) anymore?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

2. Each day my child typically uses/used their hearing aids:

all waking hours  most of the day (8-10 hours)  some of the day (5-7 hours)  a portion of the day (less than 5 hours)

**Section C: Feelings and Habits**

My feelings & habits (Circle the number that best describes how much you agree with the statement)	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1. I accept/accepted my child’s hearing loss*	1	2	3	4	5
2. I am/was concerned with the appearance of my child’s hearing aid(s)*	1	2	3	4	5
3. I am/was concerned about what others think*	1	2	3	4	5
4. I am/was concerned about how I will/would deal with my child’s feelings about their hearing aid(s)*	1	2	3	4	5
5. I think the hearing aid(s) help/helped my child*	1	2	3	4	5
6. My child does not/did not need hearing aid(s)*	1	2	3	4	5
7. I think occasional hearing aid use is/was enough for my child to learn*	1	2	3	4	5
8. I feel/felt quite frustrated with handling the hearing aid(s) every day*	1	2	3	4	5
9. I feel/felt confused about how to keep the hearing aid(s) on my child*	1	2	3	4	5
10. I feel/felt confident I can tell when my child’s hearing aid(s) are/ were not working correctly*	1	2	3	4	5
11. I check/checked my child’s hearing aid(s) every day*	1	2	3	4	5
12. Talking with other parents helps/helped me manage the hearing aid(s)*	1	2	3	4	5
13. The fact that the hearing aids are/were supposed to be temporary helps/helped me to manage them	1	2	3	4	5

\*Adapted from Munoz et al., 2015. Pediatric Hearing Aid Use: Parent-Reported Challenges. *Ear & Hearing*, 36; 279–287.

**Section D: Challenges Relating to Hearing Aid Use**

My child's hearing aid use is/was affected by: (Circle the number that best describe how much you agree with the statement)	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1. Distractions and needs of other children in the home*	1	2	3	4	5
2. Activities (e.g. playing outside, riding in the car)*	1	2	3	4	5
3. My child's behavior*	1	2	3	4	5
4. Difficulty getting a set routine*	1	2	3	4	5
5. Long wait time to get an appointment with the hearing health professional*	1	2	3	4	5
6. Other caregiver's ability to manage hearing aids*	1	2	3	4	5
7. The hearing health professional's lack of response to my questions during the appointment*	1	2	3	4	5
8. Difficulty coping with the demands of managing hearing aids*	1	2	3	4	5
9. Frequent ear infection, such as leaking ears*	1	2	3	4	5
10. Frequent ear pain	1	2	3	4	5
11. Frequent feedback (whistling/squealing) from the hearing aids*	1	2	3	4	5
12. My concern with the appearance of my child's hearing aids*	1	2	3	4	5
13. Running out of batteries before my next appointment	1	2	3	4	5
14. The hearing aids not working correctly*	1	2	3	4	5
15. My child's reaction to sounds when wearing the hearing aids*	1	2	3	4	5
16. Difficulty keeping the hearing aids on*	1	2	3	4	5

\*Adapted from Munoz et al., 2015. Pediatric Hearing Aid Use: Parent-Reported Challenges. *Ear & Hearing*, 36; 279–287.

**Section E: Caregiver's Thoughts and Feelings Regarding Hearing Aid(s)**

1. In your opinion, how do/did the hearing aid(s) help your child?

\_\_\_\_\_ -  
 \_\_\_\_\_ -  
 \_\_\_\_\_ -  
 \_\_\_\_\_ -

2. In your opinion, what do/did you find most challenging about your child's hearing aid use?

\_\_\_\_\_ -  
 \_\_\_\_\_ -  
 \_\_\_\_\_ -  
 \_\_\_\_\_ -

3. What did you expect from the hearing aids when your child started using them?

\_\_\_\_\_ -  
 \_\_\_\_\_ -  
 \_\_\_\_\_ -

4. Did you feel that the hearing aid(s) did what you expected them to?

\_\_\_\_\_ -  
 \_\_\_\_\_ -  
 \_\_\_\_\_ -  
 \_\_\_\_\_ -

5. How did/does your child feel about wearing his/her hearing aids?

\_\_\_\_\_ -  
 \_\_\_\_\_ -  
 \_\_\_\_\_ -  
 \_\_\_\_\_ -