



# Direct Health Expenditure Analysis Related to Hearing Loss in Individuals Using Hearing Aids and Cochlear Implants

## Original Investigation

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## Abstract

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**Objective:** This study aimed to investigate the expenditures related to hearing devices and compare the differences in expenditures in child and adult users.

**Methods:** A preliminary questionnaire was developed and conducted amongst hearing aid and cochlear implant users. A total of 178 patients (57.3% were hearing aid users, 42.7% were cochlear implant users) were included in the study and grouped as adults (first group, 50 patients), and children 1< (second group, 123 patients).

**Results:** The results of the study showed that individuals used approximately 4.5% of their annual income as health expenditure related to hearing loss. This rate was over 5% for child users, and about 2.7% for adult users. Moreover, the expenditure made by adult users was below the amount of expenditure made for children in all health expenditure indicators.

**Conclusion:** Supporting the family budget for hearing loss expenditures not covered by the public health insurance will minimize the financial problems caused by the disability.

**Keywords:** Health economics, health expenditures, hearing loss, hearing aids, cochlear implants

## Introduction

Direct and indirect expenditures due to hearing loss are a financial and moral burden on families. People with sensorineural hearing loss should use their hearing device lifelong. The expenditures are not limited to the hearing devices themselves as there are several potential additional costs (such as batteries,

accessories, repairs, replacements). The fact that cochlear implants (CIs) require surgical intervention makes them costly compared to amplification devices (1). The expected lifetime cost of a child with prelingual profound hearing loss can exceed one million US dollars (\$), mainly due to their need for special education and low work productivity (2). Therefore,

devices cause high costs for both users (and their families) and governments.

Like in many countries, healthcare financing in Turkey consists of taxes, social insurance premiums, out-of-pocket payments, and private health insurance in a mixed model. The Social Security Institution (SSI) pays part or the entire of the device costs of a hearing aid (HA) and a CI for candidates who meet specific prespecified criteria. Expenditures for the remaining costs are out-of-pocket payments by patients themselves or households. The adverse effects of out-of-pocket expenditures are seen among individuals who need healthcare the most and cannot receive this care because they do not have the capacity to pay, and therefore their disease is not treated (3). Out-of-pocket health expenditure made by households in Turkey for expenses such as treatment or medicine was approximately US\$ 5 billion 919 million in 2019. In the same year, the ratio of household out-of-pocket health expenditure to total health expenditure was reported as 16.7% (4). In Turkey, additional auditory rehabilitation, advanced CI models (such as processor upgrade costs with advanced features), and the remaining HA cost must be paid out-of-pocket by the user or the parent.

The conditions of healthcare financing are country-specific and cannot be estimated relative to other countries, as differences in healthcare affect the results of cost analysis (5). There are three types of financial costs for individuals with hearing loss (6). The first is the direct medical costs, which reflect the cost of all resources used during the assessment, treatment, and follow-up. The second is the direct non-medical costs arising from the patient's need for healthcare intervention (such as hospital transportation costs). The last is the indirect or time costs, which measure the time and the labor loss of the patient because of the intervention or their medical condition. All these costs are considered equivalent to missed opportunities to acquire them (7). As this goes on for a long time, families may be exposed to high time and travel costs. This study investigated the direct hearing loss related costs of pediatric and adult HA or CI users in Turkey. The current study should also verify the hypothesis that costs for children are higher than for adults, and costs for a CI are higher than those for a HA.

## Methods

The study was approved by the Clinical Research Ethics Committee of İstanbul University-Cerrahpaşa, Cerrahpaşa Medical Faculty (Approval no. 11/06/2020-70543). The written consent of all participants (or their parents) was obtained after they were informed about the study. The study is a descriptive and cross-sectional research. We developed and applied a preliminary questionnaire based on existing devices for expenditures related to hearing loss. Experts were consulted in the preparation of the questionnaire used in

the data collection phase. These experts include audiologists, health economists, and clinicians. The questionnaire we used has a content that will illuminate the expenditures of the family for the individual with hearing loss and the process that the family goes through due to this loss. Expenditures consist of out-of-pocket expenditures. Out-of-pocket health expenditure is the expenditure that households make directly to service providers for health-related goods or services that are not partially or fully reimbursed by any person or institution.

We gathered the data from more than 15 months of administration in a clinical setting and then matched them to a comprehensive database. We calculated the sample size using power analysis. In the study, we used the 5% first type error ( $\alpha$ ), 0.5 Cohen medium standardized effect size, distribution ratio of 3 between groups (if child participant is 3x, adult participant x, the reason for this is that pediatric patients require more clinical appointments compared to adults to monitor hearing and language development processes more closely and to avoid possible problems), and 80% power (20% second type error,  $\beta$ ). The required minimum sample size was calculated with the help of the G-Power program and found to be minimum 170 patients, namely, 43 for the first group, and 127 for the second group. In the study, the data collection phase was terminated when we reached the specified minimum number of observations, and we created the dataset with 178 patients, 50 in the first group and 128 in the second group.

We queried the demographic characteristics of the patients, such as age, gender, device used, and comorbidities to see the profile of the participants. The first part of the research questionnaire contains demographic and hearing loss information about the individuals. The second part of the research questionnaire contains information about the individual, relating to background and economic burden.

Before the questions about their expenditure and income levels, patients were asked about details as their health plan, state support for the device or battery, annual clinic visit frequency, whether they borrowed money to purchase the device and their subjective perception of the hearing loss expenditures. Four closed-ended questions (yes or no) were asked to investigate subjective perceptions of the participants for hearing loss and hearing device costs. These questions are whether hearing loss expenditures negatively affect the family budget, whether the expenditures are necessary for better communication skills of the patients, whether the expenditures limit the basic living expenses, and whether the renewal period determined for the device support is sufficient.

In the third part of the study, we presented descriptive statistics of data on the expenditures and the incomes of the patients. We divided their hearing loss expenditures into two

subgroups. Expenditures are the amount of direct payments made for the device itself, annual battery payments, annual earmold payments, annual accessory payments. The sum of these items is the total direct hearing loss expenditure. We also inquired about their annual direct non-health expenditures incurred due to hearing loss. These consist of annual food and transportation expenditures. We then calculated the annual total health expenditure, which is the sum of annual total direct health expenditure and the annual direct non-health expenditure. At this stage, we also calculated the share of the total direct health and non-health expenditures (food + transportation) in the annual income.

In this study, we mainly investigated two aspects: first, we compared the costs, and the expenditures incurred from purchasing the HAs or CIs, and then we queried whether or not there were differences between the expenditures incurred by adults and children. We also queried the patients' direct non-health expenditures (such as transportation, food) and tried revealing the financial burdens arising from hearing loss in the budget by proportioning these expenditures according to the share of their income. We also queried the patients' subjective expenditure perception and conditions, such as clinical visits, family history of hearing loss, and comorbidities, along with demographic characteristics of the patients. The answers are based on the information given by the parents (if a child) or by the individuals themselves (if adult).

### Statistical Analysis

In the analysis, we used frequency and percentage for categorical variables and mean/standard deviation descriptive statistics for numerical variables in the presentation and intergroup comparisons of demographic and clinical data of patients. Also, in the comparison of the health expenditure and cost data of the patients between the groups and in the statistical significance test, we used the Mann-Whitney U test for the comparisons of the two groups, and the Kruskal-Wallis test for the comparisons of more than two groups. We used the 0.05 level for statistical significance in both mean comparison tests. We also used skewness and kurtosis values for distributing the data. We used Microsoft Office 365 Excel for the calculation of health expenditures and the SPSS (Statistical Package for the Social Sciences) 23.0 package program for the statistical analysis of the data.

### Results

Data on the demographics of the participants and the brands of their devices are presented in Table 1 and Figure 1. Other information about the HAs, state supports, and users' subjective perceptions of the expenditures are presented in Figures 2 and 3.

**Table 1.** Demographic and hearing loss information

Characteristics	Total	Patient	
	(n=178) 100%	Child (n=128) 71.9%	Adult (n=50) 28.1%
Age (months)			
Min-max (median)	18–926 (105.5)	18–290 (74.5)	201–926 (517.0)
Mean ± SD	203.08±222.18	86.23±53.135	502.22±209.826
Gender			
Female	92 (51.7%)	60 (46.9%)	32 (64.0%)
Male	86 (48.3%)	68 (53.1%)	18 (36.0%)
Type of hearing device			
Hearing aid	102 (57.3%)	65 (50.8%)	37 (74.0%)
Cochlear implant	73 (41.0%)	61 (47.7%)	12 (24.0%)
Bimodal	3 (1.7%)	2 (1.6%)	1 (2.0%)
Side of hearing device			
Unilateral	56 (31.5%)	27 (21.1%)	29 (58.0%)
Bilateral	122 (68.5%)	101 (78.9%)	21 (42.0%)
Usage time (months)			
Min-max (median)	2–840 (25)	2–268 (18)	4–840 (296)
Mean ± SD	113.57±191.26	33.66±41.825	318.12±261.21
Comorbidities			
None	133 (74.7%)	103 (80.5%)	30 (60.0%)
One	36 (20.2%)	19 (14.8%)	17 (34.0%)
At least two	9 (5.1%)	6 (4.7%)	3 (6.0%)
Hearing loss in family			
None	119 (66.9%)	84 (65.6%)	35 (70.0%)
One	40 (22.5%)	31 (24.2%)	9 (18.0%)
At least two	19 (10.7%)	13 (10.2%)	6 (12.0%)
Using IC/CI in family			
None	144 (80.9%)	101 (78.9%)	43 (86.0%)
Hearing aid	15 (8.4%)	11 (8.6%)	4 (8.0%)
Cochlear implant	19 (10.7%)	16 (12.5%)	3 (6.0%)
Annual clinical visit frequency			
1-2 times	113 (63.5%)	71 (55.5%)	42 (84.0%)
3-4 times	43 (24.2%)	41 (32.0%)	2 (4.0%)
More than 5 times	22 (12.4%)	16 (12.5%)	6 (12.0%)

SD: Standard deviation

On clinical appointment days, 26.4% of the participants spend about 1 hour, 41% spend about 2 hours, 19% about 3 hours, and the rest spend more than 4 hours at the hospital.

84.2% of the participants lived in the same city as the study center and the average transportation cost of the participants was US\$26.119±77 per year. The findings are presented in Table 2.

We also compared the differences in the expenditures based on whether the participants used the HA or the CI for themselves or for their children. As shown in Table 2, in all health expenditure indicators, adult users' expenditures are lower than those of child users. Annual battery expenditure, annual total direct health expenditure, annual transportation expenditure, annual food expenditure, annual total health expenditure and the share of annual total health expenditure

in income level were higher in children than in adult patients, and the difference was statistically significant ( $p < 0.05$ ).

One of the important indicators for us in terms of patients' health expenditure level is the share of their annual total health expenditure in their income. This indicator shows us how much of their annual income is used by patients as health expenditure related to hearing loss. The calculation made on a total of 178 patients showed that these individuals used approximately 4.5% of their annual incomes as health expenditure related to hearing loss. While this rate was as high as 5% in child patients, it was approximately 2.7% in adult patients.

In the last part of the study, we analyzed participants' HA and CI expenditures in further detail. The findings are presented in Table 3. According to this analysis, the amount paid by the family for the device, the average annual battery expenditure, annual accessory expenditure, annual total direct health expenditure, annual total health expenditure, share of annual total health expenditure in income were statistically significantly different among the groups. While the group with the highest health expenditure in all expenditure items used both, when CIs and HAs were compared, the level and the share of the health expenditures related to CIs were found to be higher than those for HAs. The annual health expenditure of those who use bilateral devices was 14% of their income. Additionally, the share of health expenditures related to CIs in annual income was approximately 5.8%, and that related to HAs was approximately 3% of participants' annual incomes.

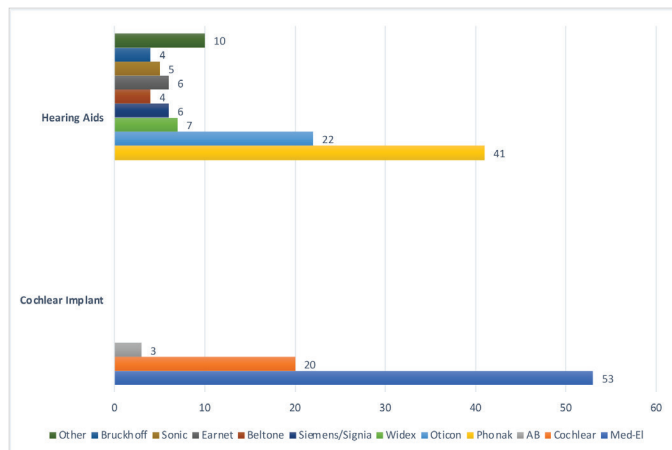


Figure 1. Brands of hearing devices

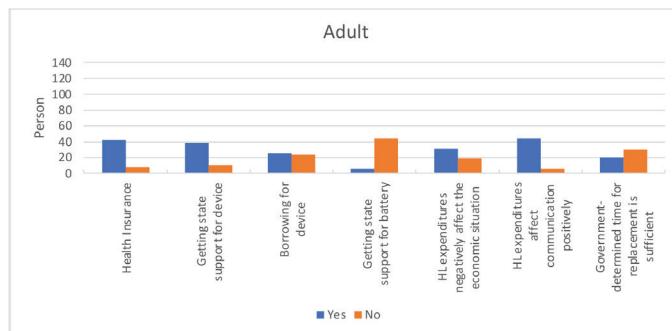


Figure 2. Borrowing, supports, and subjective perception of expenditures for adult users

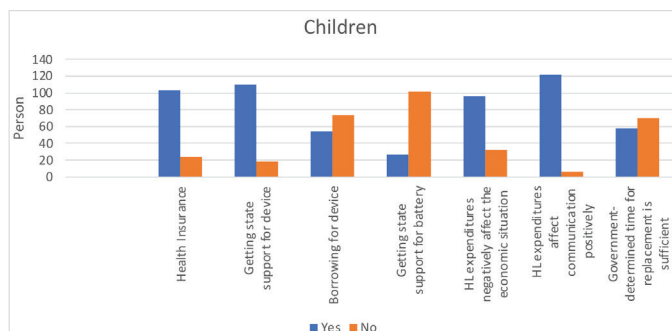


Figure 3. Borrowing, supports, and subjective perception of expenditures for pediatric users

## Discussion

Out-of-pocket health expenditures can create financial hardship by forcing people to choose between health expenses and other needs (8). In 2015, the global population spending more than 10% of their household budget on health services was 12.7%, and the portion of the population spending more than 25% on health services was 3% (8). The World Health Organization stated that the cost of hearing aids should be equal to or not exceed 3% of the gross national product per capita (9). In a survey of more than 40,000 households using the National Family Opinion panel in the US, hearing loss was shown to negatively impact household income on-average up to \$12,000 per year, depending on the degree of hearing loss (10). However, there are limited studies investigating out-of-pocket costs for hearing devices from the perspective of families (11). To the best of our knowledge, our study is the first to investigate the expenditures of hearing device users in Turkey. The main result of our study is that families spend about 4.5% of their annual income on out-of-pocket health expenditures due to hearing loss.

Cost is one of the primary reasons for non-adoption of hearing devices (12). According to the MarkeTrak VII Survey, 76% of the respondents mentioned financial constraints as a barrier

to HA adoption, 64% said they could not afford hearing aids, and nearly half (49%) indicated cost as a definite reason why they don't use hearing aids (13). Because of low savings rates in developing countries, patients often borrow from family, friends, or moneylenders, or sell their property (14). In the presented study, 44.9% of the participants borrowed to buy or upgrade their hearing devices. HA and CI users must pay for any failures or device accessories (alternative costs such as assistive listening devices, waterproof case) that fall out of warranty. In our study, many of the participants (71.3%) reported that their basic living expenses (such as clothing and food or their social activities) were limited by expenditures related to hearing loss. Parents of pediatric device users (75%) reported more limitations than adults (62%). This result is associated with the hypothesis that pediatric (5%) device users spend more than adults (2.7%). In a similar study that evaluated the direct medical cost of CIs in France, average costs in the first year of implant use were reported to be €34,686 per child and €31,946 per adult (5). A previous

study investigated mothers' willingness to pay (WTP) for healthcare costs for themselves and their children. The average WTP for mothers and for children were \$37 and \$57, respectively (15). Another study reported that most parents considered no other options that could improve their child's quality of life to the same extent and parents were willing to pay substantial monthly amounts for CIs (16).

HA and CI users should followed-up with regular fine-tuning appointments to achieve maximum efficiency with their device. Considering factors such as age and experience in our clinical practice, we provide our patients with more frequent appointments in the early period of after they start using their hearing devices and reduce this frequency in the later period of their follow up. Our study showed that pediatric device users made more frequent clinic visits per year than adults, as expected, and a substantial portion of all participants (36.6%) visited our clinic more than three times a year (Table 1). A study of the time and out-of-pocket

**Table 2.** Costs and expenditure of the hearing loss by patients (\$) \*\*

Characteristics	Total	Patient		p-value
	(n=178) 100%	Child (n=128) 71.9%	Adult (n=50) 28.1%	
The amount paid by the family for the device Mean ± SD	394.4±62.3	428.12±70.8	305.41±31.1	0.240
Annual battery expenditure Mean ± SD	117.65±126.9	130.6±141.5	84.4±68.7	0.029*
Annual earmold expenditure Mean ± SD	13.45±21.5	14.11±23.1	11.04±13.5	0.907
Annual accessory expenditure Mean ± SD	38.75±114	46.23±129.1	19.88±56.7	0.198
Annual total direct health expenditure Mean ± SD	169.52 ±211.5	191.6±238.8	113.1±102.3	0.026*
Annual transportation expenditure Mean ± SD	26.11±77.4	33.6±90.1	6.76±8.75	0.037*
Annual food expenditure Mean ± SD	8.65±22.5	10.14±26.3	4.88±5.29	0.034*
Annual total health expenditure Mean ± SD	204.3±230.9	235.3±253.3	124.7±103.1	0.004*
Share of annual total health expenditure in income Mean ± SD	0.044±0.051	0.050±0.057	0.027±0.027	0.007*

SD: Standard deviation, \*Significant at 0.05 according to the Mann-Whitney U test, \*\*(\$1 is approximately 8.5 Turkish Liras; the monthly minimum wage in Turkey is approximately \$332.4, August 2021)

**Table 3.** Costs and expenditure of the hearing loss by devices (\$) \*\*

Characteristics	Total	Patient			p-value
	(n=178) (100%)	Hearing aid (n=102) 57.3%	Cochlear implant (n=73) 41%	Both (n=3) 1.7%	
The amount paid by the family for the device Mean ± SD	393.7±62.3	398.9±282.2	395.9±271.6	156.8±271.7	0.000
Annual battery expenditure Mean ± SD	117.6±129	82.87±68.7	156.6±148.3	352.3±440.7	0.000*
Annual earmold expenditure Mean ± SD	13.46±21.5	18.42±16.9	7.54±25.76	0.00±0.00	0.000
Annual accessory expenditure Mean ± SD	38.7±114	6.53±32.5	72.5±128.3	313.6±543.3	0.000*
Annual total direct health expenditure Mean ± SD	169.5±211.5	107.1±77.3	236.1±233.4	668.9±981.05	0.000*
Annual transportation expenditure Mean ± SD	26.1±77.4	14.36±39	42.19±109.7	33.72±52.2	0.055
Annual food expenditure Mean ± SD	8.65±22.5	6.02±6.23	12.32±34.35	9.80±8.95	0.054
Annual total health expenditure Mean ± SD	204.2±230.9	127.5±89.6	290.5±259.6	712.4±963.1	0.000*
Share of annual total health expenditure in income Mean ± SD	0.044±0.051	0.0303±0.036	0.058±0.057	0.14±0.14	0.000*

SD: Standard deviation, \*Significant at 0.05 according to the Kruskal-Wallis test, \*\*(\$1 is approximately 8.5 Turkish Liras; the monthly minimum wage in Turkey is approximately 332.4 dollars, August 2021)

expenditures of families participating in the pediatric CI program has shown that those who were in the first two years of the program or who live far from the implant center spent more time and incurred higher costs. The study also reported that the largest out-of-pocket cost was travel expenses, with 44% and 16% of families receiving financial support for travel expenses (7). Molinier et al. (5) estimated that annual travel costs accounted for 7% of the total direct costs.

Transportation and food expenses and loss of workforce during hospital appointments are a burden on family economy. Nevertheless, 93.3% of the participants and the parents stated that they believed the expenditures for hearing loss or for hospital appointments were necessary for effective communication in the current study. 76.3% of the participants spent more than 1 hour at the hospital. Failures in the hearing devices, connection problems of equipment, and previous appointments taking longer than expected can increase time spent in the hospital. The use of objective fitting methods in patients without a clear behavioral response may also prolong this time. As a result, patients with hearing loss spend a particular time and costs while traveling for treatment. Time and travel costs can be reduced by expanding comprehensive audiology services across the country, providing financial assistance to families living away from the center, or by expanding remote health services.

Kochkin (17) reported that the income levels declined in both treated and untreated hearing loss groups as their hearing loss worsened, and this income decline is reduced by half in HA owners. As we expected, the annual expenditure of HA users were lower compared to that of CI users, not counting the earmold and the average expense for the device. Because earmolds are usually not required for CI users and the full cost of the CI is covered by the SSI in Turkey (excluding upgrade and change of processor costs). A study investigating the cost of hearing devices in a middle-income country reported that the short-term costs were higher for a CI than for an HA, but higher in the long-term for individuals using HA. This was explained by the fact that while individuals using an HA have to replace the device every 5 years, those using a CI only have to pay for the treatment or the rehabilitation costs for the first 6 years after implantation (18). Additionally, that alternative expenditures were higher in the pediatric group than in the adult group was a result that we expected and supported our hypothesis (Table 2). Currency fluctuations can increase expenditures related to hearing loss and HAs. Long-term studies, such as panel data or time series analysis, can be planned to better understand the effect of the exchange rate, changing over time, on hearing loss-related expenses.

It has been previously shown that children from families with higher estimated incomes had faster rates of receptive language development but slower rates of expressive language

development compared to children from families with lower estimated incomes (19). Spending a large portion of the family budget on basic living expenditures can negatively affect the language development of a person who have hearing loss by limiting the time and costs spent on hearing loss. Besides, as this continues for a long time, families may be exposed to high time and travel costs. Therefore, future research should well investigate the impact of direct and indirect costs of HAs on the family budget, in addition to a comprehensive analysis of direct medical and rehabilitation costs.

This study may have had some possible limitations while investigating the expenditures related to hearing loss. Firstly, it is possible that some patients or parents may have reported their expenses higher than the actual. Secondly, while our research emphasized the expenses related to the hearing devices, it may have compromised our findings' accuracy due to the retrospective nature of the study. This was because some patients may not have remembered the costs correctly and instead reported overall estimates. It is also necessary to expand the research to other parts of the country to reach more specific conclusions. Additionally, we planned to compare a cohort and a group with controlled variables in our next study to avoid biased interpretations, as it would be nearly impossible to compare all variables in our study.

## Conclusion

Hearing loss is an important problem that negatively affects all developmental areas of individuals. Deaf individuals not only lose their hearing, but also experience secondary problems caused by hearing loss. These problems are speech disorder, voice disorder, social isolation, psychological, academic, occupational, and economic problems. The treatment of sensorineural hearing loss is costly, laborious, and long-term. It also causes many economic, social, and emotional problems for patients and their families. The basic approach in eliminating these problems is the early diagnosis and treatment of hearing loss. In addition, the inclusion of children or adults with CIs in the auditory rehabilitation program is of great importance for post-implant success. The development of auditory skills should be followed closely by the audiologist and should be a part of routine control. The given auditory exercises should be adapted to daily life. However, financial expenditures are required for the methods to be applied in this process. Although partial support is provided by the state in line with social health plans, there are cases where the individuals themselves have to spend out-of-pocket.

Out-of-pocket expenditures may cause individuals/households to not receive the health services they need, face the risk of unforeseen expenditures when they want to receive them and may lead to shortage of money. So, it is necessary to understand the effects of direct and indirect expenditures related to hearing loss on the family economy

to include these costs in payment programs. To overcome financial problems and to create equal opportunities for disadvantaged groups, support from municipalities/non-governmental organizations and state funds to families/users for expenses outside the scope of social security will minimize the restrictions created by disability.

**Ethics Committee Approval:** The study was approved by the clinical research ethics committee of Cerrahpaşa Medical Faculty (Approval no. 11/06/2020-70543).

**Informed Consent:** The written consent of all participants (or their parents) was obtained after they were informed about the study.

**Peer-review:** Externally peer-reviewed.

### Authorship Contributions

Concept: B.D., C.B., E.K., R.D., M.A., Y.Z.Y., A.A., Design: B.D., C.B., E.K., R.D., Y.O., Y.Z.Y., A.A., Data Collection and/or Processing: B.D., R.D., Y.O., M.A., Analysis and/or Interpretation: B.D., C.B., E.K., R.D., Y.Z.Y., A.A., Literature Search: B.D., R.D., Y.O., M.A., Writing: B.D., C.B., R.D.

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### Main Points

- Participants' health expenditures related to hearing loss were approximately 4.5% of their annual income.
- Approximately 5.8% of the annual income of cochlear implant users and approximately 3% of the annual income of hearing aid users were spent on hearing loss-related expenditures.
- While the rate of health expenditures for pediatric patients was over 5%, this rate was about 2.7% for adult patients.

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