Iran J Public Health, Vol. 55, No.1, Jan 2026, pp.53-62

Review Article

The Evaluation of the Effects of Cochlear Implant Treatment on Quality of Life and Costs: A Systematic Review

#Meryem Koçaş [1], #Arzu Yiğit [2]

1. *Department of Medical Services and Techniques, Health Services Vocational School, Muş Alparslan University, Muş, Türkiye*
2. *Department of Health Management, Faculty of Economics and Administrative Sciences, Süleyman Demirel University, Isparta, Türkiye*

***Corresponding Author:** Email: m.kocas@alparslan.edu.tr
#These authors contributed equally to this work.

(Received 15 Jun 2025; accepted 10 Sep 2025)

Abstract

Background: We aimed to systematically examine the effects of Cochlear Implant Treatment (CIT) on quality of life and costs and to raise awareness of its economic and clinical value.

Methods: A systematic scan was conducted for relevant published studies over Google Scholar, PubMed, ScienceDirect, Springer Link, and Web of Science electronic databases. The search covered studies published between January 2009 and December 2024. Literature search and data extraction were conducted by two researchers and the Drummond Checklist was used to assess the risk of bias and applicability of the included literature. The study was conducted following the PRISMA-2020 guidelines.

Results: Overall, 11 studies were included in the study. When these studies were evaluated, it was found that most of them were conducted in 2021, children were the most preferred sample group, and these studies focused on unilateral Cochlear Implant Treatment. The lowest quality of life value was 0.452 and the highest was 0.93. Cost-effectiveness analyses were used in the studies to determine the cost-effectiveness of cochlear implants, and the Markov Model was preferred. The Incremental Cost-Effectiveness Ratio (ICER) was employed as the outcome measure highly cost-effective in lower-income settings such as Taiwan, while higher ICER values were observed in high-income countries such as the USA.

Conclusion: Cochlear implant treatment improves quality of life and is generally cost-effective for both children and adults, as supported by the majority of studies.

Keywords: Hearing loss; Cochlear implant; Quality of life; Cost-effectiveness; Systematic review

Introduction

Hearing loss is the most common sensory disorder affecting 5% of the world's population (1,2) and means the decrease in an individual's ability to hear environmental sounds because of damage to the outer, middle, inner ear, and acoustic nerve (3). Hearing loss is classified as mild (26-40 dB), moderate (41-60 dB), severe (61-80 dB), profound (81 dB and above) (4). Hearing losses occur in various forms as sensorineural, conductive, age-related, and mixed (5). CIT is employed to restore auditory stimulation in selected patients who have advanced sensorineural hearing loss (6). CIT is the

DOI: https://doi.org/10.18502/ijph.v55i1.20972

surgical placement of an implant in the ear. With the implant within the ear, the sound is received by the microphone and then sent to the speech processor, which processes it and converts it into electrical signals (7).

The primary aim of CIT is to develop auditory skills. The most important criterion for this aim is the age of implant application. The most appropriate period for in children is between the ages of 2 and 4, and it is stated that more effective results are obtained compared to adults (8). The treatments aim to provide the best benefit to the society and the patient. Based on this purpose, decisions must be made regarding the benefits and costs of health technologies. Making the most appropriate decision is important for people receiving health services (9). Economic evaluation methods are used to compare treatment options in the evaluation of healthcare technologies. Among these, Cost-Effectiveness Analysis and Cost-Utility Analysis, which allow comparing the costs of achieving certain non-monetary goals (e.g. lives saved, etc.), come to the fore (10).

The ICER**,** employed in making cost-effectiveness analysis calculations and is calculated by dividing the cost difference between two treatments by the difference between the effects of the treatments. If a treatment is more effective and less costly, this treatment method is chosen (10). CIT is an important option for individuals with hearing loss to regain or improve their hearing ability. The cost-effectiveness of this treatment requires study and evaluation.

Purpose and Importance of the Study

The evaluation of the cost-effectiveness of the treatment methods is important in terms of the benefits it provides to society and the healthcare system. In this context, the results of the present study will contribute to the more effective use of resources allocated to healthcare services as a guide for those working in both health economics and public healthcare. In this context, the aim was to systematically review the effects of CIT on quality of life and costs in both children and adults and raise awareness.

Materials and Methods

A systematic review is a comprehensive synthesis of previous studies conducted with similar methods (11). The study was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA-2020) Guide. The adoption of the PRISMA 2020 Guide in studies ensures that systematic reviews are reported more transparently, completely, and accurately (12). PROSPERO is a system where the international registration number is obtained for systematic reviews. This number also allows the subsequent use of the review and monitoring its effects (13). Before starting the study, the registration number of CRD420250654074 was obtained on PROSPERO.

The study question was determined based on PICOS. A study question must clearly define the Participants (P: Population), Interventions (I: Interventions), Comparison groups (C: Comparisons), Outcomes (O: Outcomes), and Study designs (S: Study designs) (Table 1). These components of the study question are briefly called PICOS.

Study questions

- ✓ What are the effects of CIT quality of life?
- ✓ What are the cost-effectiveness results of CIT for people with hearing loss?

Study Strategy

The use of various databases to collect the necessary data strengthens the study (14). In this context, a review was conducted on 4 different databases (Google Scholar, PubMed, ScienceDirect, and Springer Link). The databases used were preferred because they allow full text and open access. The search covered studies published between January 2009 and December 2024. The keywords used were ("Hearing loss" AND "cochlear" AND "cost-effectiveness" AND "Markov" AND "QALY"). For this reason, the study was conducted with studies accessed with these English keywords. In this context, inclusion and exclusion criteria were determined.

Inclusion Criteria: People with hearing loss, cochlear implant treatment, hearing aid treatment, original research articles, cost-effectiveness and cost-utility analyses that used decision models

Exclusion Criteria: People without hearing loss, interventions not related to hearing loss, no data in the review, editorials, systematic reviews, case reports, letters, commentaries, trial-based analyses that did not use decision models.

Table 1: Formulation of the Study Question and Determination of the Keywords

PICOS	Definition / description	Keywords
Population	People with Hearing Loss	"Sensorineural hearing loss", "hearing loss"
Interventions	Cochlear implantation	"cochlear", "cochlear implantation"
Comparison	Hearing aid or no treatment	"Hearing aid", "no intervention"
Outcome	Cost-effectiveness, QALY, DALY	"cost-effectiveness", "QALY", "ICER" "DALY"
Study Types	Original research articles Cost-effectiveness and cost-utility analyses that used decision models	"cost-effectiveness analysis", "decision analytic model"

Quality Assessment

In this context, the quality assessment of the studies was made by taking into account the quality assessment list presented by Drummond & Jefferson (15). Drummond Checklist consists of items such as study questions, definition of interventions, study design, determination of costs and outcomes, measurement of outcomes, evaluation of outcomes, discount rates, sensitivity analyses, budget impact analyses, discussion of results in the context of policy relevance and existing literature (16).

The quality assessment of studies is made by scoring them as poor (1-3 points), moderate (4-7 points), and good (8-10 points) in terms of economic evaluation. As a result of the assessment, studies with moderate or good scores were included in the study (16). Studies that failed to meet minimum quality thresholds (i.e., scoring below 4) were excluded. Additionally, efforts were made to minimize selection bias by applying clearly defined inclusion and exclusion criteria during the literature screening process. The quality assessment of the included studies, conducted using the Drummond Checklist by two independent reviewers (D1 and D2), is presented in Appendix 1(Not published). The consistency between the two reviewers was analyzed using Cohen's Kappa statistic. The results generally indicate a high level of agreement between the reviewers. Kappa values ranged from 0.79 to 1.00, indicating a level of agreement from "good" to "excellent." These findings demonstrate that the assessment process was reliable and consistent, thereby supporting that the quality evaluations of the studies are based on a solid foundation.

Results

A total of 439 records were identified through database searching. As a result, 11 studies were included in the final review.

The PRISMA 2020 flow diagram is shown in Fig. 1 (12).

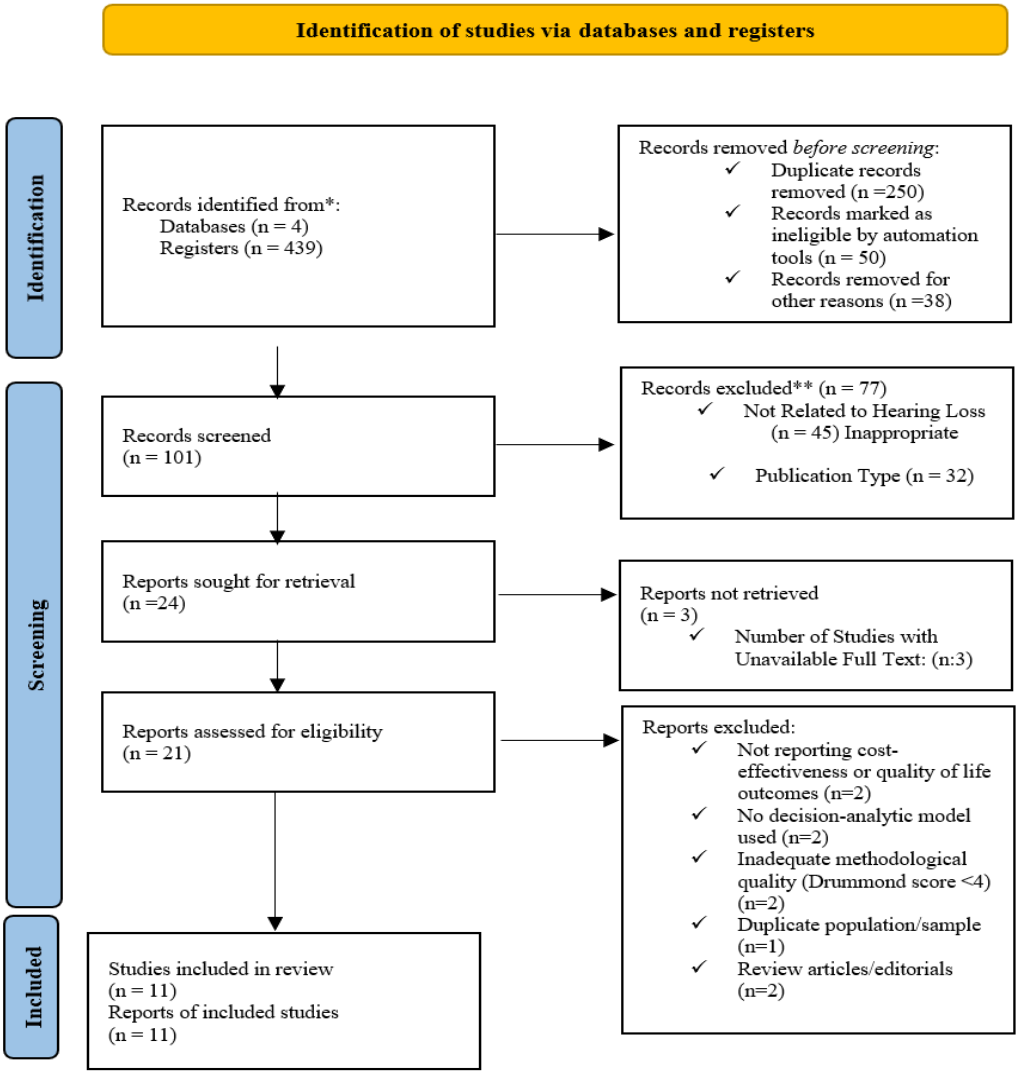

Fig. 1: Flowchart of the Study

When Table 2 is examined, the year with the most publications was 2021. The group with the most studies was children (6 studies). The sample group was selected as children under 1 year old, under 18 years old. Adults over the age of 18 are also included. The studies in Table 3 compare various alternative treatment methods. Most commonly, unilateral cochlear implant and hearing aid treatments are compared, while some studies also examine bilateral implant treatments and no intervention. This variety allows for a comprehensive evaluation of treatment options.

Table 2: General Information on Studies

Reference No.	Yıl	Working Group	Number of Participants	Country	Alternative-1	Alternative-2	Alternative-3
(17)	2019	Child	<18 yaş	Singapore	* Simultaneous and Sequential Cochlear Implant Treatment	* Hearing Aid Treatment	* No hearing aid
(18)	2022	Adult	259	The UK	* Unilateral Cochlear Implant Treatment	* Hearing Aid Treatment	* No hearing aid
(19)	2021	Adult	91	USA	* Unilateral Cochlear Implant Treatment	* No Intervention	-
(20)	2020	Child	403	Taiwan	* Cochlear Implant Treatment	* Bilateral Hearing Aid Treatment	-
(21)	2016	Adult	Over 18 years old	Australia	* Unilateral Cochlear Implant Treatment	* Sequential Bilateral Cochlear Implant Treatment	
(22)	2021	Adult	40	Sweden	* Unilateral Cochlear Implant Treatment	* Hearing Aid Treatment	-
(23)	2019	Adult	100	Switzerland	* Unilateral and Sequential Cochlear Implant Treatment	* Hearing Aid Treatment	-
(24)	2017	Child	29	China	* Unilateral Cochlear Implant Treatment	* Hearing Aid Treatment	* No hearing aid
(25)	2017	Child	1 year old group	Spain	* Unilateral Cochlear Implant Treatment	* Simultaneous Bilateral Cochlear Implant Treatment	-
(26)	2015	Child	121	Nicaragua	* Cochlear Implant Treatment	* Hearing Aid Treatment	-
(27)	2010	Child	180	The UK	* Unilateral Cochlear Implant Treatment	* Bilateral Cochlear Implant Treatment	-

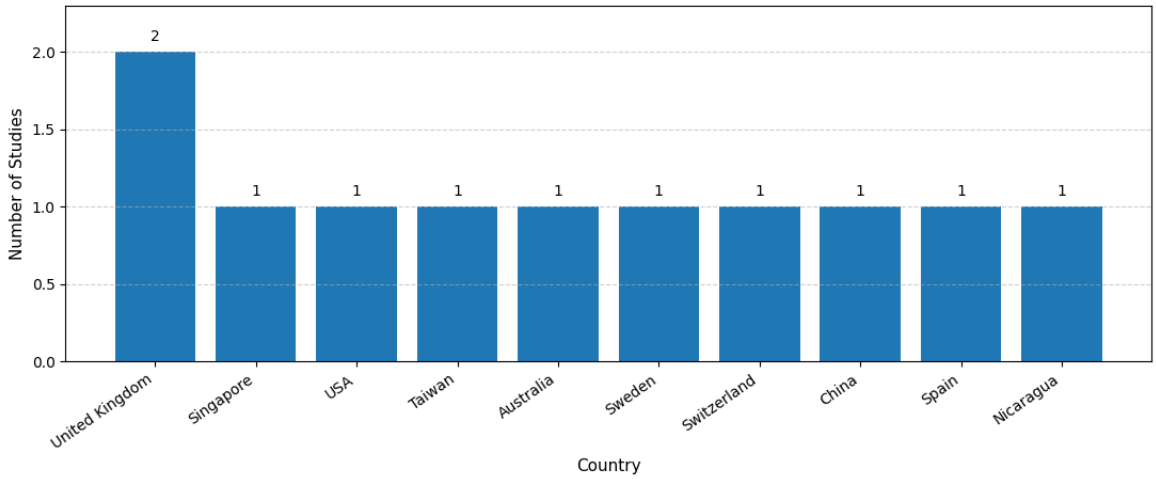

Fig. 2: Distribution of the number of studies according to countries

When Fig. 2 is examined, the included studies were conducted in various countries. Notably, only two studies were carried out in the United Kingdom, while the others originated from countries such as the United States, Sweden, Switzerland, Australia, Singapore, Taiwan, China, Spain, and Nicaragua. This indicates that research on the cost-effectiveness of cochlear implant therapy is being conducted on a global scale.

Most studies applied cost-effectiveness or cost-benefit analysis, predominantly using decision-analytic models, with discount rates ranging from 0% to 5%, most commonly 3%. The healthcare system perspective was the most frequently adopted approach, although several studies did not explicitly report an analytical perspective. Quality-of-life outcomes were primarily measured using QALY, while incremental benefits were reported in a limited number of studies. In addition, one study reported outcomes using DALY, particularly in a low-income setting, indicating that cochlear implantation can also be a cost-effective intervention when disease burden–based measures are applied. Across the included studies, quality-of-life gains associated with CIT were consistently positive, ranging from 0.452 to 0.93, indicating substantial health benefits following implantation.

The ICER demonstrated considerable variation across countries. CIT was shown to be highly cost-effective in low- and middle-income settings, such as Taiwan (429 USD per QALY) and China (3,714 USD per QALY), whereas higher ICER values were reported in high-income countries, including the United States (45,992 USD per QALY) and Singapore (42,382–57,190 USD per QALY). These differences reflect variations in healthcare system structures, cost components, and economic conditions.

Age-specific analyses indicated that CIT remains cost-effective even in older age groups, particularly among women, which was attributed to longer life expectancy. Overall, despite heterogeneity in methodologies, perspectives, and discount rates, all studies concluded that cochlear implant treatment is a cost-effective intervention, supporting its value in both pediatric and adult populations.

Table 3: Data from included studies

Reference No. .	Perspective	Quality of Life	Outcomes* (ICER)	Conclusion
(17)	Singapore Healthcare Perspective	1 year: 0.066 2–3 years: 0.212 4–54 years: 0.232 55–64 years old: 0.227 65–69 years old: 0.223 70–74 years old:0.211 75–79 years old: 0.195 80–84 years old: 0.167	42,382 $ per QALY gained for simultaneous bilateral Cochlear Implant Treatment 57,190 $ per QALY gained for Unilateral Cochlear Implant Treatment and Sequential Bilateral Cochlear Implant Treatment	It was concluded that patients receiving Cochlear Implant Treatment experienced more QALYs but with higher costs.
(18)	NHS perspective	0.494	16,592 $ per QALY gained	Cochlear Implant Treatment has a 93% chance of being cost-effective.
(19)	-	0.80	45,992 $ per QALY gained	Cochlear Implant Treatment is cost-effective for women up to age 86 and for men up to age 84.
(20)	Taiwan's NHI Program Perspective	+0.232 (incremental benefit)	429 $ per QALY gained	Cost-effective for deaf children.
(21)	Australian Healthcare Perspective	0.765	7,592 $ per QALY gained	Cochlear Implant Treatment is cost-effective.
(22)	Swedish Healthcare Perspective	0.452	14,709 $ per QALY gained	Cochlear Implant Treatment is cost-effective.
(23)	-	+0.28 (incremental benefit)	41,185 $ per QALY gained	Cost-effective up to very old ages (91 years for women and 89 years for men)
(24)	-	0.50-0.61	3,714 $ per QALY gained	Cost-effective for children.
(25)	Spanish Public Healthcare System Perspective	+0.10	14,141 $ per QALY gained	Cochlear Implant Treatment is cost-effective.
(26)	-	+0.22–0.43	5529 $ per DALY gained	Cochlear Implant Treatment is cost-effective.
(27)	-	0.93	30,233 $ per QALY gained	Cochlear Implant Treatment is cost-effective.

Discussion

Although children were generally preferred as the study group, it was found that studies on adults increased in recent years. This was associated with increasing hearing loss because of age. Studies focused on Unilateral CIT. Cost-utility and Cost-Effectiveness Analysis Methods were preferred to calculate the cost-effectiveness of CIT. The Markov Model was preferred the most in studies. The discount rate was generally preferred as 3% and the period was selected as lifelong. Studies took the reimbursement institutions of countries as a

perspective. There were 5 studies that did not specify any perspective.

More than 80% of people who had hearing loss lived in low- and middle-income countries (28). Although hearing loss is very common in low- and middle-income countries, it was found that the studies examined were generally conducted in developed countries.

Better hearing improved individuals' quality of life, ability to communicate verbally, and ability to function independently. They felt less lonely and less hindered by their hearing loss (29). In another study, it was found that although cochlear implants can improve hearing-related quality of life, there was no improvement in the psychosocial effects of hearing loss (30). Although the use of cochlear implants significantly reduced patients' tinnitus-related hearing loss, the quality of life and psychological status of these patients did not show a significant improvement after 6 months of cochlear implant use (31).

A total of nine studies published between 2012 and June 2023 were included. The findings indicated that most cost analyses were conducted in Northern Europe, primarily focused on unilateral cochlear implant treatment. In these studies, the Markov model was commonly used to estimate costs and outcomes, and a discount rate of 3% was generally applied (32).

Although similar findings were reported in earlier reviews, no year restriction was applied in the present study. Overall, 11 studies involving both children and adults were included in the review. Cochlear implant treatment was found to be a cost-effective intervention in both pediatric and adult populations.

In a systematic review, cochlear implant treatment was shown to be clinically effective in profoundly deaf adults; however, it was not found to be cost-effective (33). In contrast, Bond et al. conducted a systematic review of 24 studies evaluating the cost-effectiveness of cochlear implant treatment in both adults and children and developed an economic model. Their findings indicated that unilateral cochlear implant treatment was a safe and cost-effective intervention for both age groups (34).

Given the increasing costs associated with cochlear implant treatment, further research is needed to better characterize the costs and benefits in terms of recipients' health outcomes, well-being, and contributions to society (6). Although this review identified 11 primary studies and referred to previous systematic reviews, including those by Bond and Crathorne, the overall number of comprehensive economic evaluations assessing the cost-effectiveness of cochlear implants remains limited, particularly in light of the growing global burden of hearing loss.

Conclusion

CIT is widely supported as a cost-effective intervention for both children and adults; however, its benefit value may decrease in very advanced age groups. The substantial variation in PPP-adjusted ICER values across countries reflects differences in healthcare systems, cost structures, and economic contexts. Despite the overall positive findings, the current evidence base is limited by methodological inconsistencies particularly in model transparency, cost definitions, and analytical perspectives.

To strengthen policy relevance and comparability, future studies should adopt standardized reporting frameworks and explicitly tailor analyses to national contexts. In particular, there is an urgent need for high-quality economic evaluations in developing countries such as Türkiye, where context-specific data remain scarce but crucial for resource allocation in hearing healthcare.

Journalism Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgements

This study was not supported by any funding agency or organization.

Conflict of interest

The authors declare that there are no conflicts of interest.

Data availability

All supplementary data not published here will be sent to the respected readers for reasonable application. Please contact the corresponding author.

References

1. Torrente MC, Tamblay N, Herrada J, Maass JC (2023). Hearing loss in school-aged children. *Acta Oto-Laryngologica*, 143 (1): 28–30.
2. Dror AA, Avraham KB (2010). Hearing impairment: a panoply of genes and functions. *Neuron*, 68 (2): 293–308.
3. Cunningham LL, Tucci DL (2017). Hearing loss in adults. *N Engl J Med*, 377 (25): 2465–2473.
4. Kushalnagar R (2019). Deafness and hearing loss. In: *Web Accessibility: A Foundation for Research*. 35–47.
5. Nieman CL, Oh ES (2020). Hearing loss. *Ann Intern Med*, 173 (11): 81-96.
6. Crowson MG, Semenov YR, Tucci DL, Niparko JK (2018). Quality of life and cost-effectiveness of cochlear implants: a narrative review. *Audiol Neurotol*, 22 (4–5): 236–258.
7. Kirtane MV, Mankekar G, Mohandas N, Patadia R (2010). Cochlear implants. *Int J Otorhinolaryngol Clin*, 2 (2): 133–137.
8. Tjellström A, Håkansson BO, Granström G (2001). Bone-anchored hearing aids: current status in adults and children. *Otolaryngol Clin North Am*, 34 (2): 337–364.
9. Tatar M, Wertheimer AI (2010). *Assessment of health technologies—A Model Proposal for Drug Reimbursement Decisions*. MN Medikal & Nobel Printing Publishing.
10. Rudmik L, Drummond M (2013). Health economic evaluation: important principles and methodology. *Laryngoscope*, 123 (6): 1341–1347.
11. Karaçam Z (2013). Systematic review methodology: a guide for preparing a systematic review. *DEU J Nurs*, 6(1): 26–33.
12. Page MJ, Moher D, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. (2021). PRISMA 2020 explanation and elaboration: updated guidance and exemplars for reporting systematic reviews. *BMJ*, 372: 160.
13. PROSPERO (2025). *International Prospective Register of Systematic Reviews*. Available from: https://www.crd.york.ac.uk/prospero/
14. Çınar N (2021). How to write a good systematic review? *Online Turk J Health Sci*, 6 (2): 310–314.
15. Edmunds K, Ling R, Shakeshaft A, Doran C, Searles A (2018). Systematic review of economic evaluations of interventions for high-risk young people. *BMC Health Serv Res*, 18 (1): 660.
16. Drummond MF, Jefferson T (1996). Guidelines for authors and peer reviewers of economic submissions to the BMJ. *BMJ*, 313 (7052): 275.
17. Cheng LJ, Soon SS, Wu DBC, Ju H, Ng K (2019). Cost-effectiveness analysis of bilateral cochlear implants for children with severe-to-profound sensorineural hearing loss in both ears in Singapore. *PLoS One*, 14 (8).
18. Cutler H, Gumbie M, Olin E, Parkinson B, Bowman R, Quadri H, et al. (2022). The cost-effectiveness of unilateral cochlear implants in UK adults. *Eur J Health Econ*, 23 (5): 763–779.
19. Dreyfuss M, Giat Y, Veraguth D, Röösli C, Huber AM, Laske RD (2021). Cost effectiveness of cochlear implantation in single-sided deafness. *Otol Neurotol*, 42 (8): 1129–1135.
20. Fang TY, Cheng LJ, Wu DBC, Wang PC (2020). Cost-effective analysis of unilateral cochlear implantation under the Taiwan national healthcare insurance. *Int J Audiol*, 59 (1): 39–44.
21. Foteff C, Kennedy S, Milton AH, Deger M, Payk F, Sanderson G (2016). Cost–utility analysis of cochlear implantation in Australian adults. *Otol Neurotol*, 37b (5): 454–461.
22. Gumbie M, Olin E, Parkinson B, Bowman R, Cutler H (2021). The cost-effectiveness of cochlear implants in Swedish adults. *BMC Health Serv Res*, 21 (1): 319.
23. Laske RD, Dreyfuss M, Stulman A, Veraguth D, Huber AM, Röösli C (2019). Age dependent cost-effectiveness of cochlear implantation in adults. *Otol Neurotol*, 40 (7): 892–899.
24. Qiu J, Yu C, Ariyaratne TV, Foteff C, Ke Z, Sun Y, et al. (2017). Cost-effectiveness of pediatric cochlear implantation in rural China. *Otol Neurotol*, 38 (6): 75–84.
25. Pérez-Martín J, Artaso MA, Díez FJ (2017). Cost-effectiveness of pediatric bilateral cochlear

implantation in Spain. *Laryngoscope*, 127 (12): 2866–2872.
26. Saunders JE, Barrs DM, Gong W, Wilson BS, Mojica K, Tucci DL (2015). Cost effectiveness of childhood cochlear implantation and deaf education in Nicaragua: a disability adjusted life year model. *Otol Neurotol*, 36 (8): 1349–1356.
27. Summerfield AQ, Lovett RE, Bellenger H, Batten G (2010). Estimates of the cost-effectiveness of pediatric bilateral cochlear implantation. *Ear Hear*, 31 (5): 611–624.
28. Wilson BS, Tucci DL, Merson MH, O'Donoghue GM (2017). Global hearing health care: new findings and perspectives. *Lancet*, 390 (10111): 2503–2515.
29. Cuda D, Manrique M, Ramos Á, Marx M, Bovo R, Khnifes R, et al. (2024). Improving quality of life in the elderly: hearing loss treatment with cochlear implants. *BMC Geriatr*, 24 (1): 16.
30. Bukhari AF, Zawawi F (2024). The impact of hearing loss and cochlear implantation on the quality of life in children. *Int J Pediatr Otorhinolaryngol*, 184: 112069.
31. Fan S, Zhang C, Chen M, Mao J, Li S (2024). The impact of cochlear implantation on quality of life and psychological status in single-sided deafness or asymmetric hearing loss. *Eur Arch Otorhinolaryngol*, 281 (1): 95–105.
32. Gatto A, Tofanelli M, Valentinuz G, Mascherin A, Costariol L, Rizzo S, et al. (2024). Cochlear implant cost analysis in adults: a European narrative review. *Eur Arch Otorhinolaryngol*, 281 (9): 4455–4471.
33. Crathorne L, Bond M, Cooper C, Elston J, Weiner G, Taylor RS, et al. (2012). A systematic review of the effectiveness and cost-effectiveness of bilateral multichannel cochlear implants in adults. *Clin Otolaryngol*, 37 (5): 342–354.
34. Bond M, Mealing S, Anderson R, Elston J, Weiner G, Taylor RS, et al. (2009). The effectiveness and cost-effectiveness of cochlear implants for severe to profound deafness. *Health Technol Assess*, 13 (44): 1–330.