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Review

Patient-Reported Outcome Measures for Quality of Life in Adult Cochlear Implant Users: ICF-Based Systematic Review

Ecem Kartal Ozcan[1], Oyku Ozbas Kes[1], Mustafa Karabulut[2], Barkin Kose[3]

[1]Department of Audiology, University of Health Sciences Faculty of Gulhane Health Sciences, Ankara, Türkiye
[2]Division of Balance Disorders, Department of Otorhinolaryngology and Head and Neck Surgery, Maastricht University Medical Center School for Mental Health and Neuroscience, Maastricht, Netherlands
[3]Department of Occupational Therapy, University of Health Sciences Faculty of Gulhane Health Sciences, Ankara, Türkiye

ORCID IDs of the authors: E.K.O. 0000-0001-7185-6955, O.O.K. 0000-0003-0951-9602, M.K. 0000-0002-6149-3967, B.K. 0000-0002-2840-3309.

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BACKGROUND: To identify the most commonly used patient-reported outcome measures (PROMs) for assessing quality of life (QoL) in adults with cochlear implants (CIs) and to examine how well these PROMs reflect domains defined by the International Classification of Functioning, Disability, and Health (ICF) framework.

METHODS: A systematic search was conducted in PubMed and Web of Science. Studies were included if they were in English, involved adults with bilateral severe-to-profound sensorineural hearing loss, and used standardized PROMs to assess QoL. Studies including patients with residual hearing (e.g., bimodal users, SSD (Single side deafness), or AHL (Asymmetric Hearing Loss)), using non-validated tools or focusing solely on aspects like depression or hearing handicap were excluded. Identified PROMs were linked to ICF categories for analysis.

RESULTS: Of 935 records, 40 studies met inclusion criteria. Thirteen different PROMs were identified. The Nijmegen Cochlear Implant Questionnaire (NCIQ) was most frequently used, followed by the Glasgow Benefit Inventory (GBI) and Health Utilities Index–Mark 3 (HUI-3). The most frequently covered ICF domain was "activities and participation." The NCIQ addressed the widest range of sub-domains, while GBI and HUI-3 addressed the fewest. Four PROMs, including GBI and EQ-5D, lacked any coverage of environmental factors.

CONCLUSION: The NCIQ is the most used PROM for QoL assessment in CI users. However, many PROMs neglect key areas like environmental factors. Patient-reported outcome measures not aligned with the ICF may miss important real-life challenges. Using the ICF framework can improve the relevance and completeness of PROMs in this population.

KEYWORDS: Cochlear implant, disability and health, International Classification of Functioning, Disability, and Health, patient-reported outcome measure, PROM, quality of life, questionnaire

INTRODUCTION

Cochlear implants (CIs) are now indicated for a broader range of hearing loss, including moderate-to-profound sensorineural hearing loss, especially in cases where traditional hearing aids are ineffective.[1,2] Cochlear implants substantially improve auditory skills, speech perception, and intelligibility for recipients.[3,4] However, challenges remain in several areas such as musical perception,[5-7] comprehension in noisy environments,[1,8] and active participation in prolonged conversations.[9,10] These challenges can impact the physical, social, and emotional well-being of CI users, which consequently affects their overall quality of life (QoL).

To understand the complex nature of QoL among adult CI users, both clinical performance measures and patient-reported outcomes are needed. While clinical measures mainly focus on hearing abilities, they may not fully capture the daily challenges. Therefore, incorporating patient-reported outcome measures (PROMs) becomes crucial.[11-14] These assessments provide patient-centered insights,[15,16] data on how communication difficulties and background noise influence daily activities.[17,18] Using these

Corresponding author: Mustafa Karabulut • **E-mail:** mustafa.karabulut@mumc.nl
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measurements presents a broad range of insights into the daily activities of CI users,[12,13,19,20] which demonstrate the need for a more balanced evaluation approach.[21]

The QoL is a broad, multidimensional concept that refers to the well-being and life satisfaction of individuals. In hearing-related fields, it can be evaluated through specific areas (e.g., tinnitus, speech intelligibility, speech comprehension in noise, etc.) or by assessing multiple aspects simultaneously. As such, the QoL assessment is not a simple task and requires significant effort and collaboration among diverse healthcare professionals.[21,22] In addition, evaluating QoL in a standardized manner is important. In this context, the International Classification of Functioning, Disability, and Health (ICF), developed by the World Health Organization, provides a standardized framework.[23] This framework integrates biological, psychological, and social aspects to establish a universal structure for understanding health-related conditions. The QoL is a key component of this framework, which offers valuable insights during assessment.[24] Thus, aligning PROMs with the ICF framework helps reflect how health conditions affect body functions, activities and participation, and environmental factors in individuals. While the ICF provides a universal framework, its application in specific populations requires careful consideration. For CI users, outcome measures should not only follow general frameworks like the ICF but also reflect the unique experiences, needs, and priorities of this specific group. However, the wide variation in domains covered by existing PROMs makes it difficult to assess QoL in a consistent way. Although many PROMs exist, and the ICF can be used as a reference model, it is still unclear how well these tools match the ICF framework. This gap demonstrates the need for a systematic evaluation of currently used PROMs in this population. Therefore, this study aimed to identify the most commonly used PROMs for assessing QoL in adult CI users and to examine how well these tools cover the domains defined in the ICF.

METHODS

Registration and Protocol

This systematic review was reported following the Preferred Reporting Items for Systematic Review and Meta-Analysis guidelines.[25] The protocol for this review was registered in the PROSPERO (International Prospective Register of Systematic Reviews) database (CRD42023461749). As this is a systematic review based on publicly available data, ethical approval was not necessary.

MAIN POINTS

- The Nijmegen Cochlear Implant Questionnaire is the most widely used tool for assessing quality of life (QoL) in cochlear implant users, followed by the Glasgow Benefit Inventory and the Health Utilities Index–Mark 3.
- Most tools focus on activities and participation constructs; however, many overlook important domains from environmental factors, which leave key aspects of QoL unaddressed.
- Integrating the International Classification of Functioning, Disability, and Health model can help ensure that patient-reported outcome measures capture real-life experiences more aligned with a globally accepted health framework.

Data Sources and Searches

The most recent systematic search took place on April 10, 2024, and included the following databases: PubMed and Web of Science. The search aimed to explore the relationship between "Adults" and "Cochlear Implant" (Population), "Patient-reported outcome measures" (Intervention/Interest), "Quality of Life" (Outcome) (Supplementary Table 1, Supplemental material 1). The search queries were crafted by the third author (M.K.). No filters were implemented (Supplementary Table 2, Supplemental material 1).

Study Selection

The selected articles underwent a rigorous screening process based on predefined inclusion and exclusion criteria (refer to the criteria below). All publications were initially imported into EndNote X9 software, and duplicates were identified and removed. The first 2 authors (E.K.O. and O.O.K.) screened the articles based on their titles and abstracts (stage 1). Subsequently, the full-text articles were carefully read in their entirety (stage 2). Inconsistencies in applying the inclusion and exclusion criteria between the reviewers were discussed in consensus meetings, and agreement was reached for all cases. Additionally, to ensure that no relevant articles were overlooked, the references of the articles included after stage 2 were screened, and eligible references were included if they met the criteria.

Inclusion and Exclusion Criteria

The inclusion and exclusion criteria are outlined in Table 1. To ensure clinical consistency and relevance of the included studies, strict inclusion and exclusion criteria were applied. Regarding study design, the studies encompassing full-text clinical trials and case–control studies, all written in English, were included. As for the population, only studies that included patients with bilateral severe-to-profound sensorineural hearing loss who had received a cochlear implant in at least 1 ear were considered for inclusion.

Table 1. Inclusion and Exclusion Criteria

	Inclusion Criteria	Exclusion Criteria
Study design	• Randomized controlled trials • Cohort studies • Cross-sectional study • Case–control studies Language: English	• Systematic reviews • Meta-analyses • Editorials • Case reports • Conference proceedings • Letter to editors • Abstract only • Validity and reliability studies • Other languages
Population	• Cochlear implant users Age: ≥ 18 years old	• Healthy subjects • Central auditory disorders • Auditory brainstem implant users • Middle ear implant users • Bone anchored hearing aid users • Animal studies Age: < 18 years old
Outcome	• PROMs evaluating: • Quality of life	• Non-valid PROMs • PROMs that were not performed reliability and validity • PROMs not evaluating quality of life

PROM, patient-reported outcome measure.

Although this study did not aim to analyze PROM outcomes, studies involving patients with residual hearing (e.g., bimodal, single-sided deafness, or asymmetric hearing loss) were excluded as the selection of PROMs in such populations might vary depending on differing auditory profiles. Regarding the outcomes, both general QoL measures and CI-specific instruments were included. However, PROMs that focused exclusively on single domains such as depression, anxiety, loneliness, personality, hearing handicap, or auditory perception (e.g., sound quality) were excluded, as they do not adequately capture the multidimensional nature of QoL. Additionally, studies that reported non-standardized PROMs, lacked evidence of reliability and validity, or did not assess QoL were excluded from the analysis. These criteria were established to maintain sample homogeneity and enhance the clinical interpretability of the findings. The relevant data were extracted from the included articles by both reviewers (Supplementary Table 3, Supplemental material 1). The most cited PROM instruments were identified. After that, the items of each PROM instrument were examined based on ICF.

International Classification of Functioning, Disability, and Health Linking

The ICF provided a guide for organizing the PROM items into standardized domains. Identified measures were linked according to the linking rules established by Cieza et al.[26] Initially, the items and response options in each PROM were extracted. Each item was analyzed to identify its main and additional concepts. The main concept referred to the primary focus of the item, while additional concepts included other relevant information. These identified concepts were then linked to the most precise ICF category. Items not covered by the ICF were labeled as "Not covered (Nc)" and those with insufficient information to determine an ICF code were marked as "Not definable (Nd)."[26] Annotations were noted if necessary. The extracted data and linking details are available in the Supplemental material 2. Here, certain items were originally classified at the fourth level (e.g., "Auditory perception" [b1560]) since they could be directly linked to the ICF codes, while others were classified at the third level (e.g., "Perceptual factors" [b156]) in case a direct code linkage was not possible. To maintain consistency in the analysis, the items initially categorized at the fourth level were adjusted to the third level during the analysis. The second and third authors, experienced in ICF and linking methodology, conducted the linking process. All PROM items were compared. Any inconsistencies in applying the ICF linking procedure between the reviewers were resolved through consensus meetings, and agreement was reached in all cases.

Quality Assessment

The risk of bias assessment was not applicable in this study, as it primarily focused on collecting PROMs rather than patient-specific data. Consequently, considerations such as selection bias or attrition bias did not arise. Furthermore, since only standardized PROMs were included, there was no need to evaluate detection bias related to the reliability or validity of the questionnaires.

Interrater agreement was evaluated using Cohen's kappa. This measurement was performed after the full-text selection and the ICF linking procedure. The kappa values were categorized as follows: no agreement (kappa < 0), none to slight (0.01-0.20), fair (0.21-0.40), moderate (0.41-0.60), substantial (0.61-0.80), and almost perfect agreement (0.81-1.00).

RESULTS

A total of 1134 articles were retrieved. After removing duplications (199 studies) via Endnote, a total of 935 citations were screened on title and abstract. After the second screening phase, 40 articles fulfilled the inclusion and exclusion criteria (Figure 1).

A total of 1731 adults, 936 females (54%) and 795 males (46%) (10 studies did not report female-male distribution) were described, with study sample sizes ranging from 6 to 150. Study participants were between 18 and 90 years of age. A more detailed overview of patient characteristics can be found in Supplementary Table 3, Supplemental material 1.

In this systematic review, 13 different PROMs were identified that assessed the QoL in adult CI users. The most frequently used PROMs were Nijmegen Cochlear Implant Questionnaire (58%), Glasgow Benefit Inventory (23%), and Health Utility Index-3 (18%). Other PROMs include, among others, World Health Organization Quality of Life-BREF (Brief Version), European Quality of Life Five Dimensional Questionnaire, Cochlear Implant Quality of Life-35 Profile (CIQOL-35), 36-Item Short Form Survey (SF-36), Glasgow Health Status Inventory (GHSI), World Health Organization Quality of Life-OLD (Older Adults), Health Utility Index-2 (HUI-2), Assessment of Quality of Life-8 Dimensions, Cochlear Implant Quality of Life-10 (CIQOL-10), and the 15D Health-Related Quality of Life (15D QoL) (Table 2).

Figure 2 shows the distribution of ICF categories and sub-domains across all included PROMs. Although 13 PROMs were considered, only 10 were evaluated, with the more comprehensive questionnaire selected from each of the 3 pairs (GBI vs. GHSI; HUI-3 vs. HUI-2; CIQOL-35 Profile vs. CIQOL-10). From these 10 PROMs, the most frequently examined domain was activities and participation (47%), with the sub-domain of "interpersonal interactions and relationships" being the most extensively investigated. For body functions (34%), the primary sub-domain was "mental functions." Environmental factors accounted for 19% of the codes, with the "support and relationships" sub-domain being the most prominent. There was no item across the PROMs that directly addressed or corresponded to body structure. Additionally, the terms "Not covered" and "Not definable" were reported in 32 and 19 items, respectively. An overview of the distribution of items across ICF domains including activities and participation, body functions, and environmental factors is available in Supplemental Material 2.

According to the ICF framework, there are a total of 22 predefined sub-domains across the categories of activities and participation, body functions, and environmental factors.[23] Figure 3 shows the frequency distribution of domains across the 10 PROMs. The Nijmegen Cochlear Implant Questionnaire (NCIQ) included the highest number of sub-domains (n = 14), while HUI-3 and GBI contained the least (n = 6). All PROMs assessed activities/participation and body functions, but environmental factors were not examined in 4 of the PROMs: GBI, European Quality of Life Five Dimensional Questionnaire (EQ-5D), SF-36, and 15D QoL.

Cohen's kappa analysis revealed a substantial level of interrater agreement on full-text selection with a value of 0.831.

DISCUSSION

This review aimed to identify and compare existing PROMs used to assess QoL in adult CI users, using the ICF as a guiding framework.

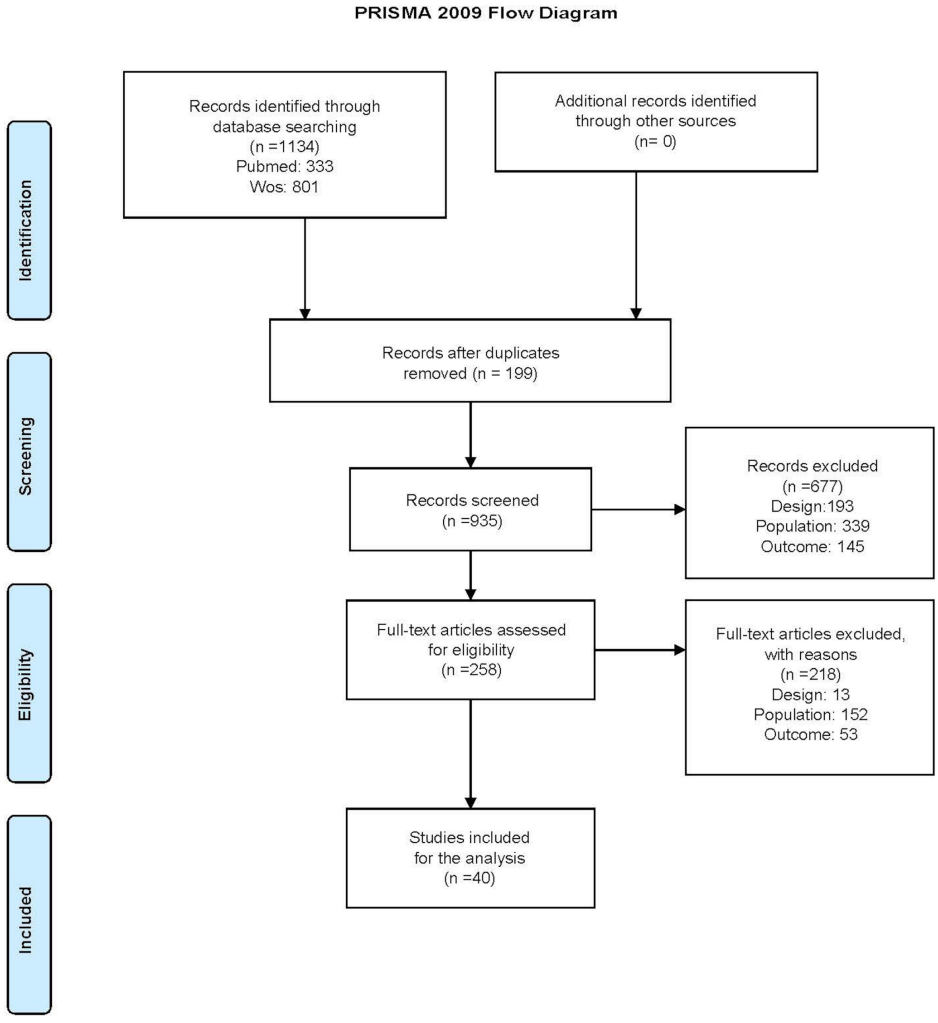


Figure 1. Flowchart of the study selection process.

It was found that 13 different PROMs were used across 40 studies, with the NCIQ being the most frequently reported (23 studies), followed by the GBI (9 studies) and the HUI-3 (7 studies). The activities and participation domain emerged as the most frequently addressed category, accounting for 47% of the ICF classifications across PROMs. The NCIQ captured the highest number of sub-domains, whereas the HUI-3 and GBI addressed fewer sub-domains. Four PROMs, including GBI, EQ-5D, SF-36, and 15D QoL did not cover any items from environmental factors.

The frequent use of the NCIQ in the included studies is likely due to several factors: it has been available for a long time, is specifically designed for CI users, and covers a broad range of relevant areas, which capture 14 out of 22 ICF sub-domains of the ICF framework. Moreover, its translation into multiple languages and strong presence in the literature have further contributed to its widespread use.[27-30] While these features point to a detailed structure, it is important to recognize that the NCIQ's length, including 60 items, may result in wider domain coverage without improving measurement quality. In fact, longer instruments like the NCIQ are often associated with response fatigue, lower completion rates, and limited clinical feasibility.[31] Moreover, recent studies have also raised concerns regarding the NCIQ's measurement precision, readability, and consistency with current psychometric standards.[32,33] Furthermore, it was observed that although the GBI and HUI-3 were also among the most commonly used PROMs, they each covered only 6 out of 22 ICF subdomains. The limited coverage may be due to their original focus: the GBI is CI-specific but mainly evaluates the surgical impact, while the

Table 2. The Frequency of Patient-Reported Outcome Measures Assessing Quality of Life in Adult Cochlear Implant Users in Included Studies (n = 40 Studies)

Nijmegen Cochlear Implant Questionnaire (NCIQ)	23
Glasgow Benefit Inventory (GBI)	9
Health Utility Index-3 (HUI-3)	7
World Health Organization Quality of Life-BREF (WHOQOL-BREF)	4
European Quality of Life Five Dimensional Questionnaire (EQ-5D)	3
Cochlear Implant Quality of Life-35 Profile (CIQOL-35 Profile)	2
36-Item Short Form Survey (SF-36)	2
Glasgow Health Status Inventory (GHSI)	2
World Health Organization Quality of Life-OLD (WHOQOL-OLD)	1
Health Utility Index-2 (HUI-2)	1
Assessment of Quality of Life- 8 Dimensions (AQoL-8D)	1
Cochlear Implant Quality of Life-10 (CIQOL-10)	1
15D Health-Related Quality of Life (15D QoL)	1

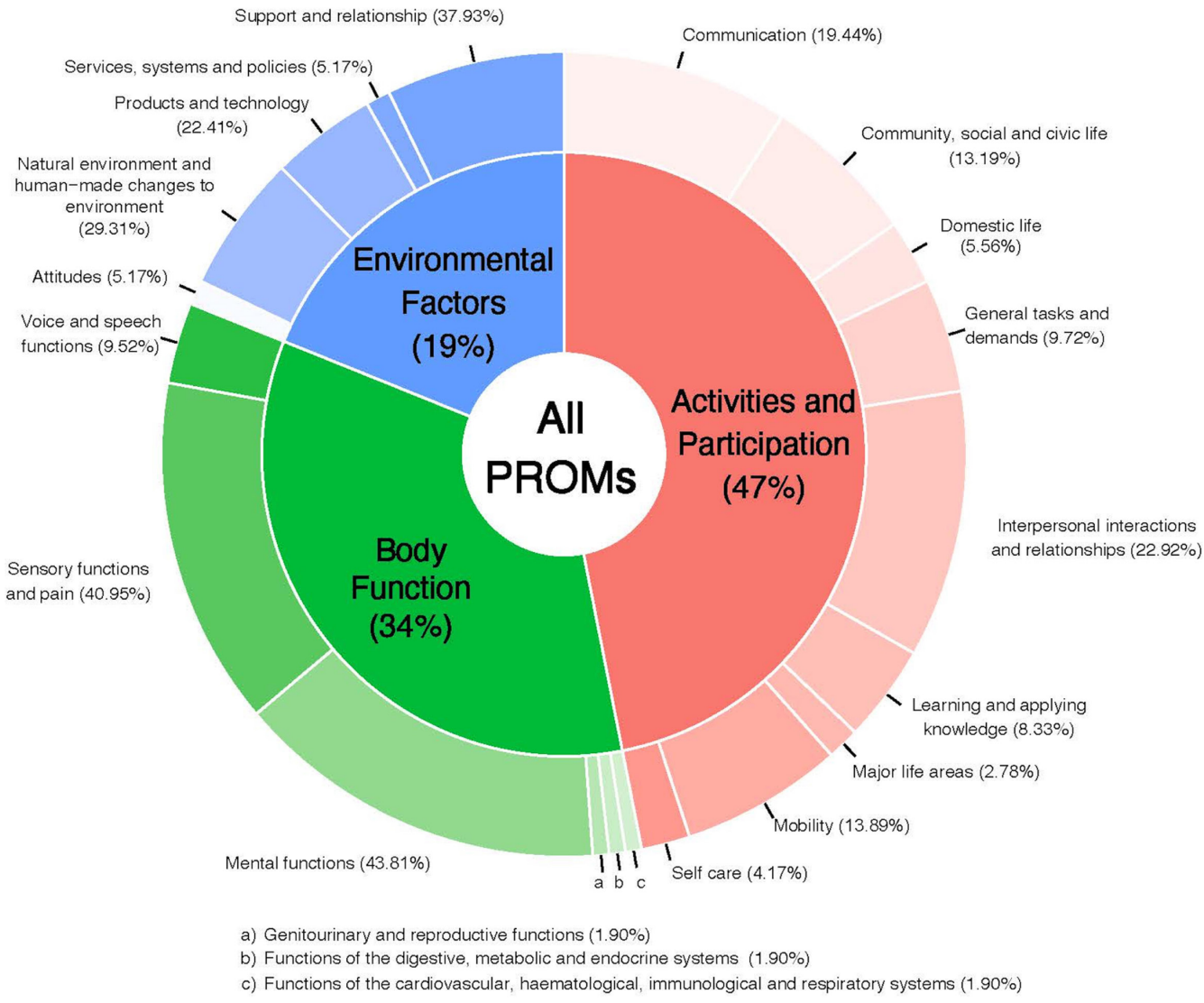


Figure 2. Pie-donut chart illustrating the ICF categories and domains in all PROMs assessing quality of life in adult cochlear implant users.

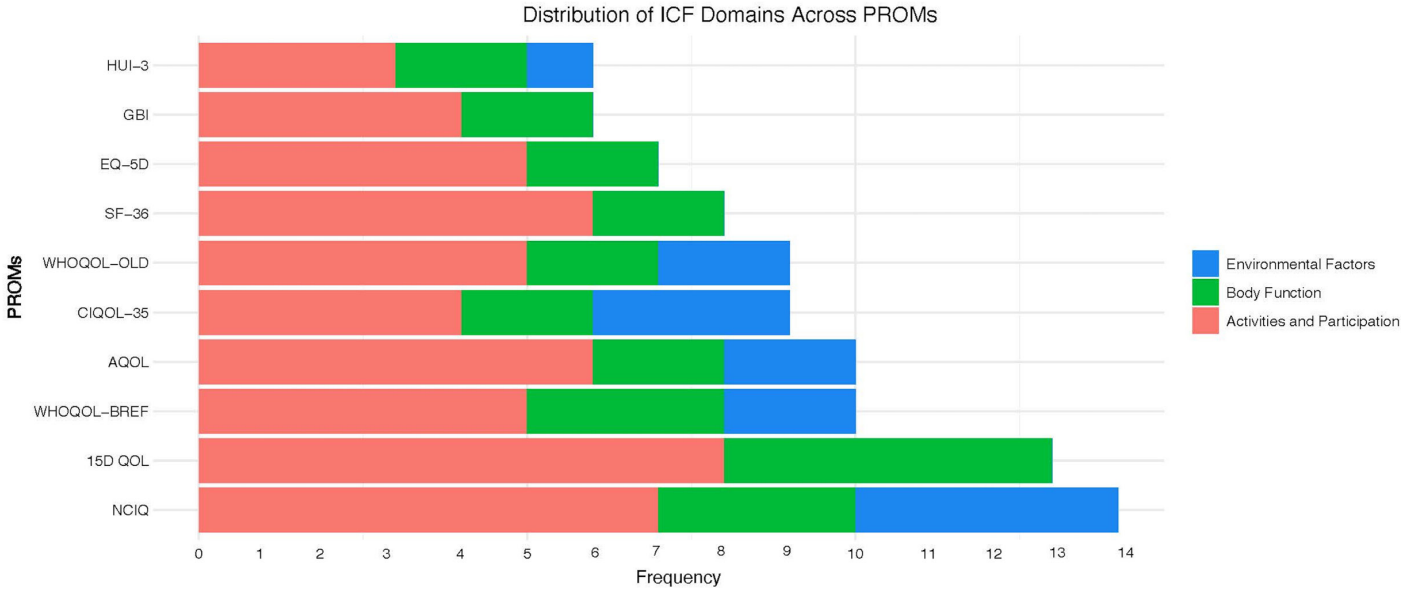


Figure 3. Stacked bar chart illustrating the frequency distribution of ICF categories in all PROMs.

HUI-3 is a generic QoL PROM not tailored to the specific needs of CI users. As a result, these instruments may not fully reflect the broad experiences of this population, despite their popularity and ease of use.

In contrast, newer tools like the CIQOL-35 and CIQOL-10 show good psychometric properties and offer a shorter but still conceptually complete structure. For example, in the current study, the CIQOL-35, despite having fewer items, covers 9 distinct domains and includes all 3 main ICF constructs. This suggests that it is possible to achieve broad domain coverage without placing too much burden on respondents. Although the CIQOL instruments are still not widely used in the literature,[34,35] likely because they are relatively new and not yet widely shared, their inclusion in the updated minimum speech test battery shows that they are gaining recognition and may be used more in the future.[36] Overall, these findings reflect a clear shift away from older, longer questionnaires toward tools that are more efficient, reliable, and focused on the patient, and that better match current clinical and research needs.

Among the ICF domains, activities and participation was the most frequently addressed category across the PROMs, making up 47% of all coded items, which is consistent with the previous study.[34] This likely reflects both the broad scope of this domain, which includes many aspects of daily life and social activities, and the main goal of many PROMs: to assess how hearing loss affects a person's ability to take part in their environment. Within this domain, the sub-domain interpersonal interactions and relationships was most commonly explored, with items like "conversation," "recreation and leisure," and "basic interpersonal relationships" appearing often. These areas are especially important for the daily life and social inclusion of CI users and are key to understanding their QoL. In addition, body functions were also frequently covered, especially emotional and cognitive functions, showing their importance for psychological adjustment. In contrast, environmental factors were less often examined and focused on mostly additional concepts such as social support and interpersonal settings. Here, the ICF framework was used as an important tool to analyze the content of PROMs in a standardized way. It allowed for the comparison of different PROMs and helped identify which domains were well covered and which were underrepresented. By linking each PROM item to the ICF classification system, the results could be described using a shared international language.[37] This supports clearer communication among clinicians, researchers, and policymakers.[38,39] It also makes it easier to compare findings across studies and populations, helping to identify both common patterns and specific challenges. These advantages can indicate the practical value of the ICF in supporting the selection, improvement, and development of PROMs that aim to measure QoL in CI users.[40]

Although all PROMs addressed activities and participation as well as body functions, 4 tools, including GBI, EQ-5D, SF-36, and 15D QoL did not include items related to environmental factors. Despite this limitation, it was found that the GBI was the second most frequently used PROM among adult CI users. This may reflect its strong clinical relevance, simplicity, and its focus on perceived benefit following interventions like cochlear implantation.[41-44] However, since these tools were originally developed to assess general health, they do not fully account for contextual influences or the specific challenges faced by adult CI users. As a result, their ability to capture the complete impact of cochlear implantation on QoL is limited. These findings highlight the need for PROMs that are not only consistent with frameworks like the ICF, but also efficient, easy to use, and tailored to the CI population. While the ICF offers a useful structure, developing effective PROMs also requires direct input from users.[45] According to COSMIN (COnsensus-based Standards for the selection of health Measurement INstruments) standards, involving patients through methods like cognitive interviews and repeated feedback helps ensure that the tools reflect real-life concerns, priorities, and everyday language.[46] For adult CI users, PROMs must therefore be both theoretically sound and based on lived experience in order to accurately reflect their QoL.

This study has several limitations. First, the reported frequency of PROMs (Table 2) is influenced by how long each tool has been available. For instance, the NCIQ has been in use for over 25 years, whereas the CIQOL tools were only developed recently. This largely explains the more frequent use of the NCIQ compared to newer PROMs. Second, many of the included studies did not explain why they chose specific PROMs. This may reflect an assumption that researchers and/or clinicians were already familiar with these tools or that standard measures were being used, which limited the ability to fully interpret their findings. In addition, some studies lacked important methodological details. For example, they did not report the degree of hearing loss in the non-implanted ear for unilateral CI users. Lastly, this review focused only on adult CI users with bilateral severe-to-profound sensorineural hearing loss. Therefore, the findings may not apply to individuals with different hearing profiles, such as those with residual acoustic hearing, single-sided deafness, asymmetric hearing loss, or bimodal hearing configurations. As cochlear implant candidacy criteria continue to expand, this limits the generalizability of the present results to the broader CI population.

CONCLUSION

This review found 13 PROMs used to measure QoL in adult CI users. The NCIQ was the most used and covered the most ICF sub-domains, followed by GBI and HUI-3. Many of these PROMs can show strong design features, such as good psychometric properties, cultural adaptability, and user involvement. However, these strengths alone may not be enough. Without alignment to a clear conceptual framework like the ICF, PROMs may fail to fully capture the complex and multidimensional nature of QoL. It was found, for example, that several PROMs missed key ICF areas, especially environmental factors, which are essential to understanding real-life challenges. Integrating the ICF can therefore help improve the structure and content of PROMs, which can allow for capturing the full range of experiences and challenges related to QoL in adult CI users. Future research should consider adapting or developing CI-specific PROMs in line with both the COSMIN criteria and the ICF framework to ensure more accurate and comprehensive assessment in this population.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: As this is a systematic review based on publicly available data, ethical approval was not necessary. This systematic review was reported following the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines. The protocol for this review was registered in the PROSPERO database (CRD42023461749).

Peer-review: Externally peer-reviewed.

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SUPPLEMENTAL MATERIAL 2

https://docs.google.com/spreadsheets/d/1WbPxqEC6AQAP25knaWp7lZPr12e1cQl388bY-NqNZ2U/edit?gid=776150#gid=150.

Supplementary Table 1. PI(C)O-strategy

Population OR	**AND**	**Intervention/Interest OR**	**AND**	**Outcome OR**
Adult		Patient Reported Outcome Measures		Quality of Life
Young Adult		Surveys and Questionnaires		
Middle Aged		Self-Assessment		
Aged, 80 and over		Survey		
Patients		Questionnaire		
Parents		Scale		
A N D		Inventory		
Cochlear Implant				
Cochlear Prosthesis				
Auditory Prosthesis				
Auditory Implant				

Creating (PIC)O- strategy using search terms based on Medical Subject Headings keywords.

Supplementary Table 2. Search queries for each database

WEB OF SCIENCE
(N: 801 hits on 19th of April 2025)
#1 ((((((((((ALL=(Patient Reported Outcome Measures)) OR ALL=(Surveys)) OR ALL=(Questionnaires)) OR ALL=(Visual Analog Scale)) OR ALL=(Self Report)) OR ALL=(Self-Assessment)) OR ALL=(Questionnaire)) OR ALL=(Survey)) OR ALL=(Scale)) OR ALL=(Inventory)) OR ALL=(Self-Reported)
#2 ALL=(Quality of Life)
#3 ((((ALL=(Cochlear Implants)) OR ALL=(Cochlear Implant)) OR ALL=(Cochlear Prosthesis)) OR ALL=(Auditory Prosthesis)) OR ALL=(Auditory Prostheses)
#4 ((((ALL=(Adult)) OR ALL=(Young Adult)) OR ALL=(Middle Aged OR Aged, 80 and over)) OR ALL=(Patients)) OR ALL=(Parents)
#5 #1 AND #2 AND #3 AND #4
PUBMED
(N: 333 hits on 19th of April 2025)
((((((((((("Patient Reported Outcome Measures"[Mesh]) OR ("Surveys and Questionnaires"[Mesh])) OR (("Visual Analog Scale"[Mesh])) OR (("Self Report"[Mesh])) OR (("Self-Assessment"[Mesh])) OR ("Questionnaire" [tiab])) OR ("Survey" [tiab])) OR ("Scale" [tiab])) OR ("Inventory" [tiab])) OR ("Self- Reported" [tiab])) AND ((("Quality of Life"[Mesh]) AND ((((((("Cochlear Implants"[Mesh]) OR ("Cochlear Implant" [tiab])) OR("Cochlear Prosthesis" [tiab])) OR ("Auditory Prosthesis" [tiab])) OR ("Auditory Prostheses" [tiab])))))) AND (((((((("Adult"[Mesh]) OR ("Young Adult"[Mesh])) OR ("Middle Aged"[Mesh])) OR ("Aged, 80 and over"[Mesh])) OR ("Patients"[Mesh])) OR ("Parents"[Mesh])))))) NOT ((((((((((((("Systematic review"[Publication Type]) OR ("Systematic reviews as topic"[Mesh])) OR ("Meta-analysis"[Publication Type])) OR ("Meta-analysis as topic"[MeSH Terms])) OR ("Review"[Publication Type])) OR ("Review literature as topic"[MeSH Terms])) OR ("Systematic review"[tiab])) OR ("Meta-analysis"[tiab])) OR ("Review"[tiab])) OR ("Case Reports" [Publication Type])) OR ("Case Study"[tiab])) OR ("Case Report"[tiab])) OR ("Case Studies"[tiab]))))

Supplementary Table 3. Patient characteristic, article types, and used PROMs in included studies

Authors	Total Number of Participants	Gender	Age (Years)	Type of implantation	PROM	Article Type
Andries 2022	20	10 Female 10 Male	Age at implantation: Mean ± SD: 67.9 ± 8.56 Range: 55 - 82	Unilateral CI	HUI-2 HUI-3 NCIQ	Prospective, longitudinal controlled study
Andries 2024	Not specified	Not specified	Not specified	Bilateral CI	NCIQ	Prospective, Longitudinal study
Arnoldner 2013	32	13 female 19 male	Median: 55.5 Range: 27 - 81	Unilateral CI	SF-36 (SF-6D)	Prospective, cohort study
Aylward 2022	Total: 143	Unilateral CI users: 47 Female 68 Male	Unilateral CI users: Age at implantation: Mean ± SD: 76.1 ± 7.1	Uni/Bilateral CI	NCIQ	Retrospective, cross-sectional study
	Unilateral CI users: 11					
	Bilateral CI users: 28	Not specified	Not specified			
Brill 2023	17	8 Female 9 Male	Mean ± SD: 63.4 ± 15.8 Range: 18.9 - 87.1	Unilateral CI	NCIQ	Prospective, longitudinal cross-sectional study
Brooks 2024	13	Not specified	Not specified	Bilateral CI	CIQoL-35	Retrospective, Cohort study
Calvino 2016	78	43 female 35 male	Age at implantation: Mean ± SD: 52.8 ± 14.0 Range: 23 - 77	Unilateral CI	GBI	Prospective, cohort study
Calvino 2022	63	31 Female 32 Male	<60 years old: Mean ± SD: 48.7 ± 8.3 Range: 23-58 60 years old: Mean ± SD: 70.5 ± 6.2 Range: 60-82	Unilateral CI	NCIQ GBI	Prospective, cohort study
Canale 2021	Total: 46	29 Female 17 Male	Prelingual Group: Mean: 41.5 Range 20 - 55 Postlingual Group: Mean: 57.5 Range: 26 - 75	Uni/Bilateral CI	WHOQOL - Bref	Retrospective, observational study
	Prelingual Group: 24 Postlingual Group: 22					
Cloutier 2014	30	20 Female 10 Male	Mean: 83.2 Median: 83.2 Range: 80 - 90.3	Unilateral CI	GBI	Retrospective, cross-sectional study
Dornhoffer 2022	72	33 Female 39 Male	Mean ± SD: 68.62 ± 15.91	Unilateral CI	CIQOL-35	Prospective, longitudinal cohort study
Farber 2024	Total: 4	2 Female 2 Male	Mean ± SD: 58.5 ± 17.71 Median: 53.5	Uni/Bilateral CI	CIQOL-10	Retrospective, cohort study
	Bilateral CI Users: 1 Unilateral CI Users: 3					
Forli 2019	107	62 Female 45 Male	Aged at implantation: 40-59: Mean ± SD: 50.8 ± 5.9 Aged at implantation: 60-69: Mean ± SD: 64.8 ± 2.9 Aged at implantation: 70+: Mean ± SD: 73.7 ± 3.3	Unilateral CI	GBI	Retrospective, observational study
Imagawa 2024	18	9 Female 9 Male	Mean ± SD: 72.7± 6.96 Median: 73	Unilateral CI	HUI-3	Prospective, Cross-sectional study
Issing 2024	6	Not specified	Not specified	Bilateral CI	WHOQOL-OLD	Prospective, Longitudinal study
Härkönen 2015	15	9 Female 6 Male	Mean: 41 Range: 19-58	Bilateral CI	GBI The 15D QoL	Retrospective, controlled study
Häußler 2019	61	35 Female 26 Male	Age at implantation: Mean ± SD: 62.2 ± 14.5 Range: 20.6 - 88.9	Unilateral CI	NCIQ SF-36	Prospective, cohort study
Ketterer 2020	29	11 Female 18 Male	Mean ± SD: 57.63 ± 12.27 Range: 28 - 80	Bilateral CI	NCIQ	Prospective, cohort study

(*Continued*)

Supplementary Table 3. Patient characteristic, article types, and used PROMs in included studies (*Continued*)

Authors	Total Number of Participants	Gender	Age (Years)	Type of implantation	PROM	Article Type
Knopke 2019	86	45 Female 41 Male	70-80 Group: Mean ± SD: 73.30 ± 2.62 Range: 70.1-78.9 80+ Group: Mean ± SD: 83.18 ± 2.90 Range: 80.0-88.9	Unilateral CI	NCIQ	Prospective, longitudinal study
Kobosko 2023	Total: 101 Bilateral CI users: 18 Unilateral CI users: 83	63 Female 38 Male	Mean ± SD: 27.57±7.49 Range: 18-45	Uni/Bilateral CI	NCIQ	Prospective, cohort study
Kraaijenga 2019	Total: 38 UCI/SeqBiCI: 19 SimBiCI: 19	19 Female 19 Male	UCI/SeqBiCI: Median (IQR): 54 (21) SimBiCI: Median (IQR): 52 (27)	Bilateral CI	EQ-5D HUI-3 NCIQ	Randomized controlled study
Lailach 2024	Total: 45	Not specified	Not specified	Uni/Bilateral CI	WHOQOL-Bref NCIQ	Retrospective, cross-sectional study
Lassaletta 2023	58	Not specified	Mean: 58.7 Range: 24.1-84.7	Unilateral CI	HUI-3 NCIQ	Prospective, cohort study
Ledesma 2023	Prelingual Group:9 Postlingual Group: 15	18 Female 6 Male	Mean ± SD: 42.83 ± 15.59	Unilateral CI	WHOQOL - Bref	Prospective, observational cross-sectional study
Mendes 2024	11	Not specified	Mean ± SD: 36.54 ±15.41 Range: 19-70	Bilateral CI	WHOQOL-Bref	Retrospective, cohort study.
Mosnier 2015	Total: 94 Bilateral CI users: 1 Unilateral CI users: 93	49 Female 45 Male	Age at implantation: Mean: 72 Range: 65 - 85 Median: 71	Uni/Bilateral CI	NCIQ	Prospective, longitudinal cross-sectional study
Nijmeijer 2025	89 Under 65: 39 Over 65: 50	44 Female 45 Male	Under 65: Mean ± SD: 54.7± 8.97 Median: 58 Range: 31-64 Over 65: Mean ± SD: 72.4± 4.75 Median:72 Range:65-85	Unilateral CI	NCIQ HUI-3 EQ-5D-5L	Prospective, cohort study
Olze 2012	40	29 Female 11 Male	Age at implantation: Mean ± SD: 50.3 ± 14.5 Range:18 - 71 Age at second implantation: Mean ± SD: 53.8 ± 14.0 Range: 26 - 73	Bilateral CI	NCIQ	Retrospective, observational study
Olze 2011	32	24 Female 8 Male	Age at implantation: Mean ± SD: 48.4 ± 17.4 Range: 19 - 77	Unilateral CI	NCIQ	Retrospective, observational study
Ovari 2022	Total: 18 Bilateral CI users: 4 Unilateral CI Users: 14	Not specified	Bilateral CI users: Mean ± SD: 44.75 ± 14.9 Range: 28 - 64 Profound to severe hearing loss in contralateral ear: Mean ± SD: 58.75 ± 13.85 Range: 38-79	Uni/Bilateral CI	NCIQ	Retrospective, observational study
Philpott 2025	80	35 Female 45 Male	Mean ± SD: 65± 10.5	Unilateral CI	NCIQ	Prospective, observational study
Ramakers 2016	38	Not specified	Age at implantation: Median: 53 Range: 18-70	Uni/Bilateral CI	EQ-5D HUI-3	Prospective, cohort study

(*Continued*)

Supplementary Table 3. Patient characteristic, article types, and used PROMs in included studies (*Continued*)

Authors	Total Number of Participants	Gender	Age (Years)	Type of implantation	PROM	Article Type
Ramos-Macías 2016	Total: 150 Age at implant 18 - 60: 100 Age at implant 60+: 50 Unilateral CI users: 104 Bilateral CI users: 46	80 Female 70 Male	Age at implantation 18-60: Mean ± SD: 41.5 ± 7.73 Age at implantation 60+: Mean ± SD: 69.4 ± 9.68	Uni/Bilateral CI	GHSI	Prospective, observational study
Rostkowska 2021	104	58 Female 46 Male	Age at implantation: Mean ± SD: 54.4 ± 12.4 Range: 28 - 70	Unilateral CI	AQoL-8D	Prospective, cohort study
Rumeau 2015	26	17 Female 9 Male	Age at implantation: Mean ± SD: 49 ± 13 Range: 21 - 71	Unilateral CI	GBI NCIQ	Retrospective, observational study
Sanchez-Cuadrado 2021	Total:36 Patients with Meniere Disease: 18 Patients without Meniere Disease: 18	18 Female 18 Male	Age at implantation: Patients with Meniere Disease: Mean ± SD: 59.7 ± 9.9 Patients without Meniere Disease: Mean ± SD: 59.9 ± 9.9	Uni/Bilateral CI	NCIQ GBI	Retrospective, controlled study
Sivonen 2021	27	Not specified	Mean ± SD: 44.2 ± 11.3 Range: 19.6 - 64.8	Bilateral CI	GBI GHSI	Prospective, cohort study
Straatman 2014	28	19 Female 9 Male	Age at implantation: Mean: 37 Range: 18 - 50	Unilateral CI	NCIQ GBI HUI-3	Retrospective, observational study
Vandenbroeke 2025	25	9 Female 16 Male	Mean ± SD: 69.8± 8.6	Unilateral CI	NCIQ	Prospective, Longitudinal study
Völter 2020	71	47 Female 24 Male	Middle-aged: Mean ± SD: 57.33 ± 4.48 Range: 50 - 64 Older-aged: Mean ± SD: 72.33 ± 5.27 Range: 65 - 84	Unilateral CI	NCIQ	Prospective, cohort study