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Oberursel, den 31.08.2024

Deutsche Stiftung Tinnitus und Hören Charité'  
Luisenstraße 13  
10117 Berlin

### **Forschungspreis „Tinnitus und Hören“ 2024**

Sehr geehrter Vorstand, sehr geehrtes Kuratorium,

hiermit bewerbe ich mich mit Studien zur Hörrehabilitation von hochgradig schwerhörigen oder ertaubten Patient:innen mittels Cochlea Implantat (CI) im hohen Lebensalter um den Forschungspreis „Tinnitus und Hören“ 2024. In meinen Untersuchungen lag der Schwerpunkt auf Patient:innen ab dem 65. Lebensjahr. In den kommenden Wochen werden diese Arbeiten für meine kumulative Habilitation eingereicht werden.

In meinen Studien lag der Fokus insbesondere auf der Betrachtung der Lebensqualität im zeitlichen Verlauf nach der Implantation. Hierbei wurden insbesondere auch die Auswirkungen auf ein bereits vorhandenes Ohrgeräusch, aber auch kognitive Funktionen gelegt.

Begeistert von der Aktualität und insbesondere der klinischen Bedeutung, aber vor allem angetrieben von der Hoffnung der Verbesserung der Therapie schwerhöriger und ertaubter Patient, würde ich mich über eine positive Beurteilung dieser Bewerbung sehr freuen.

Mit freundlichen Grüßen

A handwritten signature in black ink, reading 'Christian Issing'. The signature is fluid and cursive, with the first name 'Christian' written in a larger, more prominent script than the last name 'Issing'.

Dr. Christian Issing

Anlagen:  
Zusammenfassung der Publikationen  
Curriculum Vitae  
Publikationsliste  
Publizierte Arbeiten  
Formblatt

## **Zusammenfassung der für den Forschungspreis „Tinnitus & Hören“ 2024 eingereichten Publikationen**

Seit über drei Jahrzehnten werden Cochlea Implantate (CI) für die Hörrehabilitation von hochgradig schwerhörigen oder ertaubten Patient:innen erfolgreich eingesetzt und stellen inzwischen den Goldstandard der Therapie dar. Zunehmend werden auch ältere postlingual ertaubte Patienten ohne Altershöchstgrenze in Deutschland erfolgreich implantiert, wenn eine Hörrehabilitation durchführbar und eine Nutzung des Implantats absehbar sind. Bisher erfolgten die Indikationsstellung sowie die Beurteilung des Behandlungserfolgs primär durch audiologische Kriterien. Im klinischen Alltag lassen sich jedoch weitere, über die reine Verbesserung des Sprachverstehens hinausgehende Effekte, unter anderem auf die Lebensqualität, Kognition oder die Belastung durch einen bereits vorbestehenden Tinnitus beobachten.

Im Rahmen meiner publikationsbasierten Dissertation sowie einer hierauf aufbauenden Folgestudie („Cochlear implant therapy improves the quality of life and social participation in the elderly: a prospective long-term evaluation“, 2024) habe ich mich auf die kurz- /mittelfristigen und nun auch auf die langfristigen Auswirkungen der Hörrehabilitation mittels CI auf die Lebensqualität bei Patienten ab dem 65. Lebensjahr konzentriert. In diese prospektive Beobachtungsstudie konnten initial 34 Patient:innen zwischen dem 65. und 86. Lebensjahr eingeschlossen werden, die erstmalig unilateral mit einem CI versorgt wurden. Die Patienten wurden präoperativ, ein Monat postoperativ bei Erstanpassung sowie sechs Monate postoperativ im Rahmen einer klinischen Verlaufskontrolle untersucht. Im Verlauf konnten etwa sechs Jahre nach erstmaliger CI Versorgung 31 der ursprünglich 34 Patient:innen nun zwischen dem 71. und 92. Lebensjahr für die Folgeuntersuchung eingeschlossen werden.

Zur Beurteilung der Lebensqualität wurde die World Health Organization Quality-of-Life Scale – old (WHOQL-OLD) verwendet. Die Multidimensionalität der Lebensqualität wird in diesem speziell für Menschen ab dem 60. Lebensjahr entwickelten Fragebogen mit Hilfe von sechs Teilbereichen - sogenannten Facetten - widerspiegelt, die zusammen einen Gesamtscore bilden. Es kam zu einer hochsignifikanten Verbesserung des Einsilbersprachverstehens von präoperativ  $14,7 \pm 19,9\%$  auf  $56,5 \pm 24,1\%$  sechs Monate postoperativ ( $p = 0,001$ ), die sich auch sechs Jahre postoperativ mit  $59,5 \pm 24,8\%$  ( $p = 0,341$ , verglichen mit 6 Monate postoperativ) stabil zeigte. Darüber hinaus kam es zu einer ebenfalls hochsignifikanten Verbesserung des Gesamtscores der Lebensqualität. Der Punktwert stieg von  $60,0 \pm 15,7$  Punkten präoperativ auf  $66,8 \pm 12,2$  Punkte sechs Monate postoperativ an ( $p = 0,001$ ) und blieb mit  $64,2 \pm 10,6$  Punkten sechs Jahre postoperativ ( $p = 0,12$ , verglichen mit 6 Monate postoperativ) stabil. Auch bei den Facetten „Sinnesfunktionen“ und „Partizipation“ kam es sechs Monate postoperativ zu einem signifikanten Anstieg der Punktwerte ( $p > 0,05$ ), der sich auch sechs Jahre nach der CI-Versorgung weiterhin stabil zeigte ( $p > 0,05$ , verglichen mit 6 Monate postoperativ). Vergleicht man unsere Studienkohorte mit einer durchschnittlichen deutschen Altenbevölkerung, so lässt sich bei der Facette „Partizipation“ bereits sechs Monate postoperativ kein signifikanter Unterschied mehr nachweisen ( $68,97$  Punkte bei der durchschnittlichen Altersbevölkerung vs.  $70,6$  Punkte sechs Monate postoperativ in unserer Studienkohorte). Dabei repräsentiert diese Facette am deutlichsten den Rehabilitationserfolg des CI. Betrachtet man nun die Ergebnisse sechs Jahre postoperativ mit  $74,2 \pm 14,4$  Punkten ( $p = 0,1$ ), so wird die Allgemeinbevölkerung in der Facette „Partizipation“ sogar leicht übertroffen.

Damit konnten wir nicht nur einen deutlichen Zugewinn im Sprachverstehen und im Gesamtscore der WHOQOL-OLD innerhalb von nur sechs Monaten postoperativ nachweisen, sondern unsere Studienkohorte übertrifft bei der „Partizipation“ sogar nach nur sechs Monaten die durchschnittliche Altenbevölkerung. Dabei hat diese Facette eine herausragende Bedeutung als Maß der Versorgungsqualität: Sie spiegelt den für die Patient:innen direkt erlebbaren Behandlungserfolg, die

wiederhergestellte soziale Teilhabe am gesellschaftlichen Leben wieder. All diese Effekte der Verbesserung des Sprachverstehens, als auch der Lebensqualität bleiben dabei über viele Jahre auch bei diesem betagten Patientengut stabil.

In unserer Querschnittsstudie „Long-term effects on the Quality of Life following Cochlear Implant Treatment in Older Patients“ (2022) fokussierten wir uns auf die Langzeitergebnisse. Es konnten 84 Patient:innen zwischen dem 65. und 101. Lebensjahr eingeschlossen werden, die seit mindestens einem, jedoch höchstens zehn Jahren erstmalig unilateral mit einem CI versorgt worden waren. Die Kohorte wurde nach der Implantationsdauer in drei Gruppen (Gruppe I: 1-3 Jahre; Gruppe II: 4-6 Jahre und Gruppe III: 7-10 Jahre nach Implantation) eingeteilt. Zwischen den drei Gruppen ließ sich weder beim WHOQOL-OLD Gesamtscore noch bei den einzelnen Facetten ein signifikanter Unterschied feststellen ( $p > 0,05$ ).

Somit kommt es nicht nur zu einer zügigen Verbesserung der Lebensqualität auch bei älteren Patient:innen, sondern die Effekte der Hörrehabilitation sind auch über viele Jahre stabil, was wir sowohl in dieser Querschnittsstudie als auch der eingangs beschriebenen longitudinalen prospektiven Studie belegen konnten.

Neben den direkten Folgen der hochgradigen Hörstörungen leiden etwa 70 – 90% dieser betagten Patientengruppe zusätzlich an einem Tinnitus. Bei vielen kommt es zu massiven Einschränkungen im Alltag oft mit einer deutlichen Einschränkung der Lebensqualität. In zwei Studien haben wir die Kurz- und Langzeiteffekte in Bezug auf einen vorbestehenden Tinnitus untersucht: „Eine Cochlea-Implantat-Versorgung reduziert langfristig die Tinnitusbelastung bei älteren Patienten“ (2024).

Es konnten initial 16 Patient:innen ab dem 65. Lebensjahr in diese prospektive longitudinale Studie eingeschlossen werden, von denen sechs Jahre postoperativ 15 Patient:innen nachverfolgt werden konnten und mit dem Mini-Tinnitus-Fragebogen (Mini-TF12) befragt wurden. Der präoperative Punktwert wies eine große Streuung auf und betrug  $6,9 \pm 6,5$  Punkte. Sechs Monate nach CI-Operation fiel der Punktwert hochsignifikant auf  $4,3 \pm 3,3$  ab ( $p = 0,001$ ) und blieb sechs Jahre postoperativ mit  $3,9 \pm 3,6$  Punkten ( $p = 0,689$ , verglichen mit 6 Monaten postoperativ) konstant niedrig. Bei Betrachtung der Tinnitusbelastung in Kategorien, zeigte sich präoperativ bei vier Patient:innen (11,7%) eine sehr hohe Tinnitusbelastung der Kategorie 3 oder 4. Bereits nach nur sechs Monaten lag in keinem Fall mehr eine Tinnitusbelastung der Kategorien 3 oder 4 vor. Dies blieb auch bei der Verlaufskontrolle sechs Jahre postoperativ stabil.

Somit kommt es innerhalb von nur einem halben Jahr nach der CI-Versorgung zu einer deutlichen Reduktion der Tinnitusbelastung, die für viele Jahre stabil niedrig bleibt. Insbesondere die Patient:innen mit einer sehr hohen Belastung durch den Tinnitus profitieren deutlich und langanhaltend von der Hörrehabilitation mittels CI.

Zusammenfassend konnten die Ergebnisse unserer Studien neben einer hochsignifikanten Verbesserung des Einsilbersprachverstehens eine zügige, langanhaltende und signifikante Verbesserung der Lebensqualität nach erstmaliger unilateraler Hörrehabilitation mittels CI bei über 65-jährigen Patient:innen nachweisen. Dabei profitieren die Patient:innen insbesondere in der Facette „Partizipation“ und erreichen bzw. übertreffen hier sogar die altersgleiche Allgemeinbevölkerung. Die Belastung durch einen bereits präoperativ bestehenden Tinnitus - insbesondere bei Patient:innen mit einer sehr hohen Belastung durch den Tinnitus – reduziert sich innerhalb von nur sechs Monaten deutlich und bleibt über Jahre stabil auf einem niedrigen Niveau.

Damit sind besonders bei älteren Patient:innen die Effekte der Hörrehabilitation viel weitreichender als eine reine Verbesserung des Sprachverstehens. Folgerichtig sollte die Versorgung mit einem CI bei gegebener audiologischer Indikation und zur erwartender Hörrehabilitation ohne Altershöchstgrenze erfolgen.

# Curriculum vitae

**Name:** Issing, Johannes Christian

**Titel:** Dr. med.

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**Staatsangehörigkeit:** deutsch

**Geburtsdatum:** 12.05.1991

**Geburtsort:** Tübingen

**Konfession:** evangelisch

**Familienstand:** verheiratet, zwei Kinder

**Derzeitige Position:** HNO-Facharzt an der Klinik für Hals-, Nasen-, Ohrenheilkunde Uniklinikum Frankfurt

Clinician Scientist am Georg-Speyer-Haus, Institut für Tumorbiologie und experimentelle Therapie, Frankfurt

**Promotion:** 02/2021 publikationsbasierte Dissertation (magna cum laude)  
„Cochlear implant therapy improves the quality of life in older patients – A prospective evaluation study“ (2020)

**Medizinische  
Ausbildung:**

10/2010 – 11/2017 Studium der Humanmedizin an der Goethe Universität Frankfurt

Praktisches Jahr:

11/2017 – 03/2018 Chirurgie, Hospital zum heiligen Geist

03/2018 – 07/2018 Hals-Nasen-Ohrenheilkunde, Uniklinik Frankfurt

07/2018 – 10/2018 Innere Medizin, Hospital zum heiligen Geist

12/2017 Erteilung der Approbation als Arzt

seit 12/2017 Assistenzarzt an der Klinik für Hals-, Nasen-, Ohrenheilkunde,  
Uniklinikum Frankfurt

09/2019 Tübinger Nasennebenhöhlenkurs (Grund- und Aufbaukurs)

05-06/2020 Grund- und Aufbaukurs Good Clinical Practice (GCP)

10/2020 DEGUM – Stufe I für das Gebiet Kopf/Hals-Diagnostik

seit 02/2021 Clinician Scientist in der Arbeitsgruppe Dr. Henner Farin am Georg-  
Speyer-Haus, Institut für Tumorbilogie und experimentelle Therapie, Frankfurt

seit 06/2021 Fellow of the DKTK School of Oncology (SoO)

11/2021 Good Clinical Practice (GCP) Update-Kurs

seit 01/2022 FIT-Mentoring Programm

seit 05/2022 Member of YoungOnc Group Frankfurt

08/2022 DEGUM – Stufe II für das Gebiet Kopf/Hals-Diagnostik

03/2023 Zertifikat für Medizindidaktik

08/2023 Facharzt für Hals-, Nasen-, Ohrenheilkunde

seit 06/2024 Advanced Clinician Scientist in der Arbeitsgruppe Dr. Henner Farin am  
Georg-Speyer-Haus, Institut für Tumorbilogie und experimentelle Therapie,  
Frankfurt

**Stipendien/  
Fördermittel:**

06/2010  
e-fellows.net – Stipendium

05/2017

Kongress-Stipendium der Deutschen Gesellschaft für Hals-Nasen-Ohren- Heilkunde, Kopf- und Hals-Chirurgie

06/2020

Horst Westenberger Stiftung – Frankfurter Stiftung für Krebsforschung;  
Projekttitle:

„Organoide als Modell zur Tumorgenese im Kopf-Hals-Bereich“  
„Auswirkungen von Kopf-Hals- Tumoren auf die Lebensqualität“

11/2020

Projektförderung des Frankfurt Cancer Institute, als Ko-Antragsteller mit Dr. Henner Farin; Discovery & Development Program; Projekttitle: „Clinical biobank of organoids from squamous cell carcinoma of the head and neck (HNSCC) to study oncogenic signaling and therapy response in vitro“

02/2021

Personenförderung des Mildred-Scheel-Nachwuchszentrum (MSNZ) als Clinician Scientist Projekttitle: „Patient-derived tumor organoids from head and neck squamous cell carcinoma as a co-clinical research platform“

12/2022

Horst Westenberger Stiftung – Frankfurter Stiftung für Krebsforschung;  
Projekttitle: „HNSCC Organoide als Modell zur Evaluation von Resistenzmechanismen“

11/2023

DFG Nachwuchsakademie: Forschung zur Weiterentwicklung der Kopf-Hals-Onkologie. Projekttitle: „Eine Biobank von Kopf-Hals-Organoiden als präklinische Plattform zur Therapietestung“

05/2024

Personenförderung des Mildred-Scheel-Nachwuchszentrum (MSNZ) als Advanced Clinician Scientist Projekttitle: „Head and neck cancer organoids for modelling of subtype-specific therapy responses“

**Klinische Forschung:** Seit 2015 Einfluss der CI-Versorgung auf die Lebensqualität, Tinnitus und Schwindel im hohen Lebensalter

Seit 2017 Langzeitauswirkungen der CI-Versorgung auf die Lebensqualität im hohen Lebensalter

2015-2021 Einfluss der CI-Versorgung auf kognitive Funktionen im hohen Alter

Seit 2022 TOTO Studienarzt

Aktuell Betreuung von drei weiteren klinischen Studien u.a. zum Einfluss der Therapie von Kopf-Halskarzinomen auf die Lebensqualität

**Experimentelle  
Forschung**

Seit 2019 Organoide von Kopf-Halskarzinomen als präklinisches Tumor Modell

Initiierung, Aufbau und Charakterisierung einer Kopf-Hals-Organoid Biobank am UCT Frankfurt

Entwicklung von präklinischen Assays zur Evaluation der Strahlensensibilität von Kopf-Hals-Karzinomen an Organoidmodellen

Onkogene Modifikation von Kopf-Hals Organoiden als Modell der Tumorgenese

*Obermund, den 31.08.2024*

*Chetan Rij*

### Publikationsliste (Auswahl):

- **Issing C**, Baumann U, Pantel J, Stöver T. Cochlear Implant Therapy Improves the Quality of Life in Older Patients—A Prospective Evaluation Study. *Otology & Neurotology*. 2020;41(9):1214-21.
- **Issing C**, Baumann U, Pantel J, Stöver T. Die Hörrehabilitation mittels Cochlea-Implantat – eine Möglichkeit der Tinnitus-Reduktion im Alter. *Laryngo-Rhino-Otol*. 2021;100:285-290.
- **Issing C**, Baumann U, Pantel J, Stöver T. Impact of Hearing Rehabilitation Using Cochlear Implants on Cognitive Function in Older Patients. *Otol Neurotol*. 2021;42:1136-1141.
- Issing PR, Köhler T, Tebben H, Wenger M, **Issing C**. Die Behandlung von Schilddrüsenmalignomen aus HNO-ärztlicher Sicht. *Laryngo-Rhino-Otologie*. 2021 Nov;100(1):889-895.
- Issing PR, Atanasova-Koch S, Schneider J, **Issing C**. Der Stellenwert der subtotalen Petrosektomie im Rahmen der Cochlea Implantation. *Laryngorhinootologie*. 2021; epub ahead of print.
- Loth A, Vazzana C, Leinung M, Guderian D, **Issing C**, Baumann U, Stöver T. Quality control in cochlear implant therapy: clinical practice guidelines and registries in European countries. *Eur Arch Otorhinolaryngol*. 2022 Oct;279(10):4779-4786
- **Issing C**, Holtz S, Loth AG, Baumann U, Pantel J, Stöver T. Long-term effects on the Quality of Life following Cochlear Implant Treatment in Older Patients. 2022 Nov; 279(11):5135-5144
- von der Grün J, Winkelmann R, Burck I, Martin D, Rödel F, Wild PJ, Bankov K, Weigert A, Kur IM, Brandts C, Filmann N, **Issing C**, Thönissen P, Tanneberger AM, Rödel C, Ghanaati S, Balermipas P. Neoadjuvant Chemoradiotherapy for Oral Cavity Cancer: Predictive Factors for Response and Interim Analysis of the Prospective INVERT-Trial. *Front Oncol*. 2022 Mar 24;12:817692.
- Klamming GJ, **Issing C**, Burck I, Herr C, Endemann E, Stöver T, Wild PJ, Winkelmann R. Painful Swelling of the Left Parotid Gland due to Synchronous Occurrence of Pleomorphic Adenoma and Warthin's Tumor (Papillary Cystadenoma Lymphomatosum). *JCR*. 2023
- **Issing C**, Loth AG, Sakmen KD, Guchlerner L, Helbig S, Baumann U, Pantel J, Stöver T. Cochlear Implant Therapy Improves Quality of Life and social Participation in the Elderly – a prospective long-term evaluation. *Eur Arch Otorhinolaryngol*. 2024 Jul; 281(7):3453-3460.



- Levi A, Leinung M, Helbig S, Guderian D, Issing C, Weißgerber T, Hartmann M, Stöver T, Loth AG. Thematic coverage and readability of online patient information on cochlear implant care. Eur Arch Otorhinolaryngol. 2024 May 6; Epub ahead of print
- **Issing C**, Loth AG, Sakmen KD, Pantel J, Baumann U, Stöver T. Eine Cochlea Implantat-Versorgung reduziert langfristig die Tinnitusbelastung bei älteren Patienten. Laryngo-Rhino-Otol. 2024 2024 Jun 6; Epub ahead of print

### **Kongressbeiträge (Auswahl):**

- **Issing C**, Baumann U, Pantel J, Stöver T. Einfluss der Cochlear-Implant Versorgung auf die Lebensqualität beim alten Menschen. Laryngo-Rhino-Otol. 2018;97(S 02):10065. (Poster, Deutscher HNO-Kongress)
- **Issing C**, Baumann U, Pantel J, Stöver T. Die Cochlea Implant Versorgung verbessert die Kognition und reduziert Depressionen im hohen Lebensalter. Laryngo-Rhino-Otol. 2019;98(S 02):11168. (Vortrag, Deutscher HNO-Kongress)
- **Issing C**, Baumann U, Pantel J, Stöver T. Einfluss der Cochlea Implantat Versorgung auf Tinnitus und Schwindel beim alten Menschen. Laryngo-Rhino-Otol. 2020; 99(S 02): S189 (Vortrag, Deutscher HNO-Kongress)
- **Issing C**, Stöver T, Brandts F, Farin H. Organoide aus Tonsillen- und Kopf-Hals-Karzinomgewebe. 2021 (Poster, Deutscher HNO-Kongress)
- **Issing C**, von der Grün J, Menche C, Rödel F, Brandts C, Wild P, Stöver T, Farin H. Patient-derived tumor organoids from head and neck squamous cell carcinoma. 2021 (Vortrag, MSNZ/EKFK Kolloquium 2021)
- **Issing C**, von der Grün J, Menche C, Rödel F, Brandts C, Wild P, Stöver T, Farin H. Patient-derived tumor organoids from head and neck squamous cell carcinoma. 2021 (Poster, Flash Talk, Mildred Scheel Career Center Meeting 2021)
- **Issing C**, Baumann U, Pantel J, Stöver T. Verbesserung der Lebensqualität durch die Hörrehabilitation mittels Cochlea Implantat bei hochbetagten Patienten. Laryngo-Rhino-Otol. 2022; 101(S 02): S101 (Vortrag, Deutscher HNO-Kongress)
- **Issing C**, Baumann U, Pantel J, Stöver T. Die Hörrehabilitation mittels Cochlea-Implantat eine Möglichkeit der langfristigen Verbesserung der Lebensqualität bei alten Menschen. Laryngo-Rhino-Otol. 2023; 102(S 02): S97 (Vortrag, Deutscher HNO-Kongress)

- **Issing C**, Baumann U, Pantel J, Stöver T. Langzeitergebnisse der Tinnitusbelastung bei alten Menschen nach Hörrehabilitation mittels Cochlea Implantat. Laryngo-Rhino-Otol. 2024 (Vortrag; Deutscher HNO-Kongress)

# Förder- richtlinie

**Forschungspreis Tinnitus & Hören**

Deutsche Stiftung Tinnitus und Hören Charité





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# Förderrichtlinie für die Vergabe des Forschungspreises „Tinnitus & Hören“.

## 1. Selbstverständnis

Die Stiftung wurde 2011 gegründet. Sie versteht sich als Agentin der Aufklärung und der Prävention. Vor allem aber ist sie ein Instrument, um die Erforschung der Leiden am Ohr und die Wissenschaftskommunikation zu unterstützen. Zur Erfüllung ihres Stiftungszwecks führt die Stiftung keine eigenen Forschungsprojekte durch, sondern ist rein fördernd tätig. So vergibt sie gemäß § 2, Absatz 8 der Satzung Preise an Projekte und Personen, die sich durch Exzellenz und Innovation auszeichnen.

## 2. Zielsetzung und Gegenstand der Förderung

Der Forschungspreis Tinnitus & Hören wird seit 2019 einmal jährlich vergeben. Ziel ist es, innovative Forschungsansätze zu Tinnitus und anderen Hörerkrankungen zu würdigen und bekannt zu machen.

Konkret werden herausragende Leistungen auf dem Gebiet der Ursachenforschung, Früherkennung und Therapie von Tinnitus und Hörschäden ausgezeichnet. Eingereicht werden können

- hochkarätige wissenschaftliche Arbeiten sowie
  - Habilitationen,
- die in den vergangenen zwei Jahren publiziert wurden.

## 3. Zuwendungsempfänger:innen

Der Preis richtet sich an Antragsteller:innen aus Europa; sie können ihre Arbeiten in deutscher oder englischer Sprache einreichen. Bereits Prämierte können sich nach Ablauf von fünf Jahren erneut bewerben. Es sind ausschließlich Eigenbewerbungen möglich, Vorschläge Dritter sind nicht zugelassen.

## 4. Art und Umfang der Zuwendungen

Der mit 10.000 EUR dotierte Preis wird 2024 im Rahmen des Tinnitus-Symposiums am 7. Dezember 2024 verliehen. Ein:e Vertreter:in des Wissenschaftlichen Beirats hält die Laudatio, die/der Preisträger:in erhält anschließend die Möglichkeit, die eigene Forschungsarbeit vorzustellen. Anschließend wird die Urkunde überreicht.

Die Stiftung versendet eine Pressemitteilung und berichtet in Wort und Bild auf ihrer Website, in ihrem Newsletter sowie ihren Social Media Kanälen über die Auszeichnung. In den Folgejahren ist der Sommer-Newsletter der Stiftung den laufenden Forschungsarbeiten der bisherigen Preisträger:innen des Forschungspreises gewidmet.



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## 5. Antragsbedingungen und -verfahren

Es sind folgende Unterlagen beizufügen:

- Kurze Darstellung der Habilitation oder der eingereichten wissenschaftlichen Arbeit sowie ihrer Bedeutung (max. zwei Seiten).
- Curriculum Vitae mit Darstellung des wissenschaftlichen Werdeganges
- Publikationsliste
- Habilitation und/oder publizierte Arbeiten
- Bestätigung, dass die für den Forschungspreis eingereichte Arbeit nicht für einen anderen Preis eingereicht wurde und dass bis zur Entscheidung der Preisverleihung diese Arbeit nicht für einen anderen Preis eingereicht wird (siehe Anlage „Formblatt“).
- Falls an den Arbeiten mehrere Autorinnen und Autoren beteiligt sind
  - ist zu benennen, wer sich als Preisträger:in bewirbt (siehe Anlage „Formblatt“),
  - ist mit Unterschrift zu versichern, dass alle Co-Autorinnen und -Autoren der eingereichten Arbeit mit der Bewerbung um den Forschungspreis einverstanden sind (siehe Anlage „Formblatt“).

## Deadline der Abgabe aller Unterlagen ist in jedem Jahr jeweils der 15. September, 23:59 Uhr.

Die Stiftung bittet um die Zusendung der Bewerbung in zweifacher Form:

Eine Exemplar senden Sie bitte per Post an folgende Adresse:

Deutsche Stiftung Tinnitus und Hören Charité  
Luisenstr. 13  
10117 Berlin

Des Weiteren bittet die Stiftung um die Zusendung einer zweiten, digitalen Version der Bewerbung per E-Mail an: [Forschungspreis@stiftung-tinnitus-und-hoeren-charite.org](mailto:Forschungspreis@stiftung-tinnitus-und-hoeren-charite.org)

Für die rechtzeitige Abgabe der Bewerbung entscheidet das Datum des Poststempels (bei Einsendung per Post) und Datum und Uhrzeit (bei Einsendung per E-Mail).

## 6. Auswahlverfahren und Kriterien für die Preisvergabe

Die Prüfung und Bewertung der eingereichten Unterlagen erfolgt durch den Wissenschaftlichen Beirat der Stiftung. Dieses Gremium setzt sich aus Expert:innen unterschiedlicher medizinischer Fachrichtungen zusammen, die für die Begutachtung von Tinnitus und Erkrankungen des Innenohrs relevant sind. Seine Entscheidung ist verbindlich, der Rechtsweg ist ausgeschlossen.

Am Tag nach Ablauf der Bewerbungsfrist erhält der Wissenschaftliche Beirat über die Geschäftsstelle der Stiftung per E-Mail alle eingereichten Bewerbungen zur Begutachtung (Stiftungssatzung § 2, Absatz 5). Die Bearbeitungsdauer beträgt zwei Monate, der Wissenschaftliche Beirat begründet gegenüber dem Stiftungsvorstand seine Entscheidung schriftlich. Außerdem fügt er eine Ranking-Übersicht an.



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Die Kriterien des Rankings für die Preisvergabe sind:

- Innovationsgrad der wissenschaftlichen Arbeit
- klinische Relevanz
- Qualität der methodischen Durchführung
- Interdisziplinarität

In Ausnahmefällen kann das Preisgeld auf maximal zwei Preisträger:innen verteilt werden.

### **7. Zuwendungsbedingungen**

Es werden nur vollständige Bewerbungsunterlagen bearbeitet, die fristgerecht und den Antragsbedingungen entsprechend eingesendet wurden (siehe Punkt 5).

Es besteht kein Anspruch auf die Begründung von Ablehnungen. Bewerber:innen haben keinen Rechtsanspruch auf die Auszeichnung.

### **8. Kontinuierliche Berichterstattung über den Entscheidungsprozess und die Preisverleihung bis zur Entgegennahme des Preisgelds**

Die Bewerber:innen erhalten von der Geschäftsstelle der Stiftung die Bestätigung über den Empfang der Bewerbung sowie über die Vollständigkeit der Unterlagen. Spätestens drei Wochen vor der Preisvergabe wird die/der Preisträger:in über die Entscheidung des Gremiums und den Ablauf der Preisvergabe informiert. Innerhalb von einer Woche nach der Preisvergabe wird das Preisgeld an die/den Ausgezeichnete:n überwiesen.

### **9. Datum In-Kraft-Treten**

Die vorliegende Förderrichtlinie der Stiftung Tinnitus und Hören Charité für die Vergabe des Forschungspreis Tinnitus & Hören trat mit Wirkung vom **15.05.2022** in Kraft.

gez. Prof. Dr. Christian Döbel  
Vorsitzender des Wissenschaftlichen Beirats

gez. Prof. Dr. Birgit Mazurek  
Vorsitzende des Stiftungsvorstands



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# Formblatt zur Bewerbung um den Forschungspreis Tinnitus & Hören 2024

Wir bitten Sie, dieses Formblatt auszufüllen, zu unterschreiben und als Scan Ihrer Bewerbung per E-Mail, als Kopie Ihrer Bewerbung per Post beizufügen.

## 1. Bestätigung exklusive Einreichung

☒ Hiermit bestätige ich, dass die für den Forschungspreis Tinnitus & Hören 2024 eingereichte wissenschaftliche Arbeit nicht für einen anderen Preis eingereicht wurde und dass bis zur Entscheidung der Preisvergabe diese Arbeit nicht für einen anderen Preis eingereicht wird.

## 2. Bestätigung Autor:innenschaft

An der von mir für den Forschungspreis Tinnitus & Hören 2024 eingereichten wissenschaftlichen Arbeit waren mehrere Autorinnen und Autoren beteiligt.

☒ Ja

Als Preisträger:in bewirbt sich Dr. Issing, Christian (Name, Vorname)

☒ Hiermit bestätige ich, dass alle Co-Autorinnen und -Autoren der eingereichten Arbeit mit der Bewerbung um den Forschungspreis Tinnitus & Hören 2024 einverstanden sind.

☐ Nein

Oberndorf 31.08.24 Issing, Christian Christian Issing  
Ort Datum Name, Vorname Unterschrift

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# Cochlear implant therapy improves the quality of life and social participation in the elderly: a prospective long-term evaluation

Christian Issing<sup>1</sup> · Andreas G. Loth<sup>1</sup> · Kenan D. Sakmen<sup>1</sup> · Leon Guchlerner<sup>1</sup> · Silke Helbig<sup>1</sup> · Uwe Baumann<sup>1</sup> · Johannes Pantel<sup>2</sup> · Timo Stöver<sup>1</sup>

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## Abstract

**Purpose** In recent years, the number of elderly cochlear implant (CI) candidates is continuously rising. In addition to the audiological improvement, other positive effects of CI treatment can also be observed in clinical routine. The “quality of life” as a parameter of success directly experienced by the patient is increasingly becoming the focus of clinical research. Although there are already clear indications of a rapid and significant improvement in quality of life, there is still a lack of systematic, prospectively collected longitudinal long-term data in patients over the age of 65.

**Methods** This prospective longitudinal observational study included 31 patients between the age of 71 and 92 years who had first been treated unilaterally with a CI 6 years ago. In addition to free-field monosyllable recognition, quality of life was assessed using the World Health Organization Quality-of-Life Scale-old (WHOQL-OLD). The results were compared with the data from our previous study, in which we focused on the short- and medium-term effects on quality of life. In both studies, the same patient population was examined. In addition, these study data were compared with an age-matched average population.

**Results** In speech recognition, there was no significant change from the control 6 months postoperatively compared with the results 6 years postoperatively. No significant changes occurred in the total quality of life score or any of the other six facets of quality of life when comparing the results 6 months postoperatively with the results 6 years postoperatively. In “Social participation”, the CI patients even exceed the values of the age-matched average population 6 years after treatment.

**Conclusion** Improvement in the quality of life and especially in social participation appears stable over many years in elderly patients after hearing rehabilitation with a CI.

**Keywords** Cochlear implant · Quality of life · Elderly · Older patients · Long-term results

## Introduction

The cochlear implant (CI) has been successfully used for hearing rehabilitation of deaf and severely hearing-impaired patients for over three decades. While initially, only

completely deaf patients were treated with a CI, the indication for a CI has been successfully extended [1–3]. Severe hearing loss is one of the most common chronic conditions in the elderly population [4–6]. As a result of demographic change in Europe, the proportion of elderly and very aged CI candidates has been steadily increasing in recent years. With a comparable—but more variable—improvement in speech comprehension compared to younger patients, CI treatment in Germany is offered without an age limit for suitable CI candidates [7–10]. Moreover, an increasing number of studies demonstrate not only the stability of monosyllable recognition but even in many cases, an improvement after more than 1 year postoperatively [11–13]. Especially in elderly patients, further effects beyond the audiological measurable improvements can usually be observed in clinical routine. Due to the specific psychosocial situation of higher age with

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common loss of social interaction and an increasing physical impairment, this age group benefits from hearing rehabilitation in particular. The influence of hearing rehabilitation on social participation and, therefore, on the quality of life, previously significantly limited by the hearing disorder, is ultimately the CI-treatment success directly experienced by the patient. Consequently, the assessment of the quality of life has developed into an important instrument for evaluating the success of treatment and has now also been implemented in the German Whitebook on Cochlear Implant Care, the German Cochlear Implant Guideline and in the German Cochlear Implant Registry [15–18].

In the literature, there are numerous indications for a rapid and significant improvement in the quality of life in the elderly related to CI treatment. Innumerable studies use questionnaires to assess health-related quality of life, such as the widely used Nijmegen Cochlear Implant Questionnaire. Apart from a lack of validation for elderly patients, a valid comparison with an age-matched healthy general population is impossible. Most studies focus on the short- and medium-term effects of hearing rehabilitation on the quality of life [19–25]. Consequently, the aim of this prospective longitudinal study was to observe the same patient population several years after CI implantation and to compare the study cohort with an age-matched healthy general population.

## Patients and methods

### Study design

This prospective long-term study is a follow-up to our previous study (Issing et al. [19]). For the initial study, candidates were recruited at our institution from the third quarter of 2015 until the third quarter of 2017. For the presented study, patients already recruited into the initial study of 2020 were followed up at annual checkups about 6 years postoperatively after initial unilateral CI treatment. Data for this study were collected from the second quarter of 2022 through the first quarter of 2023. The data from this study were compared with the results of our initial study (Issing et al. [19]). The study was conducted in accordance with the Declaration of Helsinki 1964, and with approval of the local ethical review committee (105/15). All patients gave their written informed consent for inclusion before they participated in this study.

### Patients

Thirty-one patients (12 men and 19 women) of the 34 patients (13 men and 21 women) initially 2020 recruited

could be included in this study. One patient was excluded as the CI had to be explanted due to implant infection; two patients could not participate in the survey due to health problems not related to the CI.

### Freiburg monosyllabic speech test (FMS)

Audiological data collected during the 6 year CI after-care as part of routine clinical practice were analyzed. The Freiburg monosyllabic speech test (FMS) at 65 dB SPL was used to evaluate the monosyllable recognition in the free field. For the continuous monitoring of monosyllable recognition over the years, the ear (first) treated with a CI was continuously evaluated with the FMS, and the other ear was masked by broadband noise or mechanical blocking.

### Quality of life assessment

Our study aimed to assess the quality of life over the years in patients who had been treated with a CI for the first time. To be able to compare the results with our previous study, we used the German version of the World Health Organization Quality-of-Life Scale—old (WHOQL-OLD) according to Conrad et al. [26].

This tool is well validated for older adults from the age over 60 years and reflects the multidimensionality of the quality of life over different dimensions with so-called facets. The questionnaire consists of 24 multiple-choice questions, each with five response categories. The total quality of life score is formed from the individual facets. Six facets are distinguished in detail:

#### “Sensory abilities”

Central to our study, this facet generally captures patients’ assessment of their sensory functions (such as hearing, seeing, or tasting) [26].

#### “Autonomy”

The ability to live independently and self-determined is assessed by this facet [26].

#### “Past, present and future activities”

This facet captures achievements already made in life, current activities, and those planned for the future [26].

### “Social participation”

Social participation in daily life as an essential factor for the quality of life is assessed here [26].

### “Death and dying”

This facet includes attitudes and fears regarding one's death or the death of loved ones [26].

### “Intimacy”

Interpersonal closeness and the importance of companionship are captured with this facet [26].

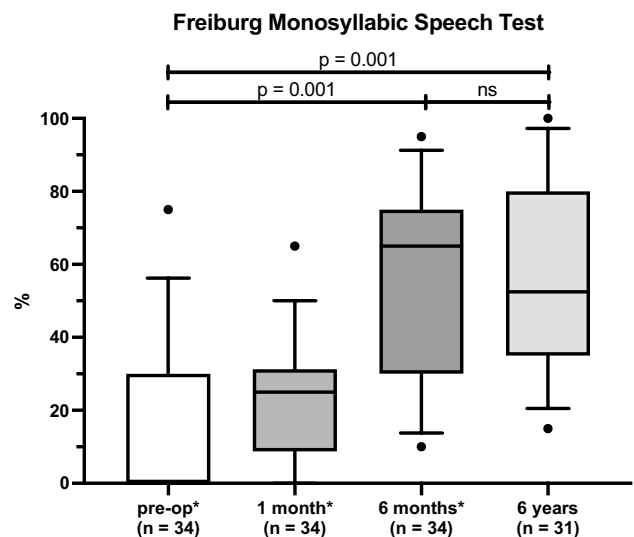
## Data analysis and statistical evaluation

Paper-based questionnaires were filled out by patients and subsequently organized using Microsoft Excel 2016 (Microsoft Corporation, Redmond, Washington). The statistic program GraphPad Prism Version 9 (GraphPad Software, Inc. San Diego) was used for statistical testing and generating graphic illustrations. Wilcoxon-matched-pairs test was used for comparison between two groups, and Kruskal–Wallis test was used to compare more than two groups. Boxplots were used for the graphical illustration. In addition to the median, the 25th and 75th percentiles are shown. All points outside the 5th and 95th percentile were presented as outliers as individual values. The significance level was assumed to be  $p \leq 0.05$ .

## Results

The study included 31 patients (12 men and 19 women) aged between 71 and 92 years at the survey 6 years after the first CI treatment. The mean age was  $79.1 \pm 4.8$  years. All participants had been treated with a CI unilaterally for the first time due to profound unilateral or bilateral hearing loss 6 years ago. Different implants of the manufacturer Cochlear™ (Cochlear: Cochlear Ltd., Macquarie, Australia) ( $10 \times$  CI 512,  $1 \times$  CI 522, and  $8 \times$  CI 532) and MED-EL™ (MED-EL Elektromedizinische Geräte, Gesellschaft m.b.H., Innsbruck, Austria) ( $15 \times$  Synchrony Mi1200) were used for the initial CI treatment. The average daily CI wearing time 6 years postoperatively was  $10.5 \pm 4.7$  h.

Six patients were also implanted with a CI on the second side during the 6 years after the first CI treatment. In all bilaterally implanted patients, the second ear was implanted no more than 2.5 years after the first. For the second CI,



**Fig. 1** Freiburg Monosyllabic Speech Test (FMS). Results of FMS preoperatively, 1 month, 6 months of our previous study (\*Issing et al. [19]) and six years postoperatively. Preoperative FMS was measured in the ear to be treated with a CI in best aided condition. After CI treatment the treated ear was assessed in CI-only condition

different implants of the company Cochlear™ ( $2 \times$  CI 512,  $1 \times$  CI 522, and  $1 \times$  CI 632) and MED-EL™ ( $2 \times$  Synchrony Mi1200) were used.

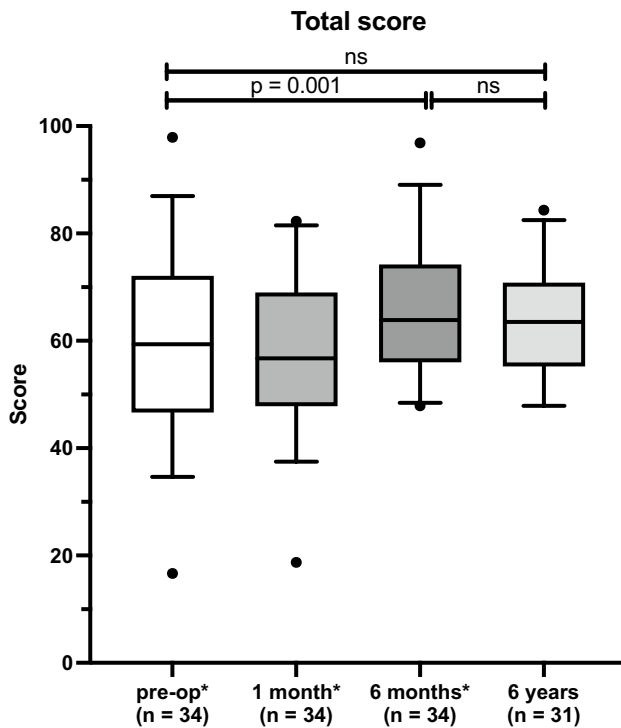
### Freiburg monosyllabic speech test (FMS)

Six years postoperatively, patients' monosyllable recognition score with the ear initially treated with a CI at 65 dB SPL averaged  $59.5 \pm 24.8\%$ . There was no significant difference in FMS between the 6 month ( $56.5 \pm 24.1\%$ ; [19]) and 6 year checkup ( $p=0.341$ ). From the preoperative measurement under best-aided conditions  $14.7 \pm 19.9\%$  [19], the monosyllable recognition score increased significantly 6 years postoperatively ( $p=0.001$ ) (Fig. 1).

### World health organization quality-of-life scale—old (WHOQL-OLD)

#### WHOQL-OLD “Total score”

The “Total score” after 6 years was  $64.2 \pm 10.6$  points on average. No significant difference was found in the 6 month follow-up with  $66.8 \pm 2.2$  points [19] ( $p=0.12$ ). There was no significant difference comparing the 6 year score with the preoperative score ( $60.0 \pm 15.7$  [19]) ( $p=0.407$ ) (Fig. 2; Table 1).



**Fig. 2** Total WHOQOL-OLD score. The total score is based on the six individual facets (see Fig. 3). In addition, the preoperative results as well as one and 6 months postoperatively of our previous study (\*Issing et al. [19]) are shown

### WHOQL-OLD “Sensory abilities”

For the facet “Sensory Abilities”, the mean score 6 years postoperatively was  $56.8 \pm 15.6$ . There was no significant difference compared to the control 6 months postoperatively ( $57.9 \pm 12.6$  [19]) ( $p = 0.816$ ). From the preoperative

assessment ( $38.1 \pm 22.6$  points [19]) to the 6 year control, there was a significant increase ( $p = 0.002$ ) (Fig. 3; Table 1).

### WHOQL-OLD “Autonomy”

The average score for “Autonomy” 6 years postoperatively was  $61.7 \pm 12.7$  points. A non-significant decrease was observed compared to the 6 month control ( $65.3 \pm 15.3$  [19]) ( $p = 0.074$ ). Overall, there was no significant change throughout the study period ( $p = 0.866$ ) (Fig. 3; Table 1).

### WHOQL-OLD “Past, present, and future activities”

Six years postoperatively, the mean score was  $65.1 \pm 13.0$  points. 6 months postoperatively, the score was  $68.4 \pm 13.8$  [19]. The difference was not significant ( $p = 0.162$ ). Overall, there was no significant change during the entire study period ( $p = 0.731$ ) (Fig. 3; Table 1).

### WHOQL-OLD “Social participation”

For “Social participation”, the score at 6 years postoperatively was  $74.2 \pm 14.4$  points. There was no significant difference to the 6 month control  $70.6 \pm 13.6$  [19] ( $p = 0.224$ ), but there was a significant difference to the preoperative measurement ( $61.4 \pm 21.0$  points [19]) ( $p = 0.008$ ) (Fig. 3; Table 1).

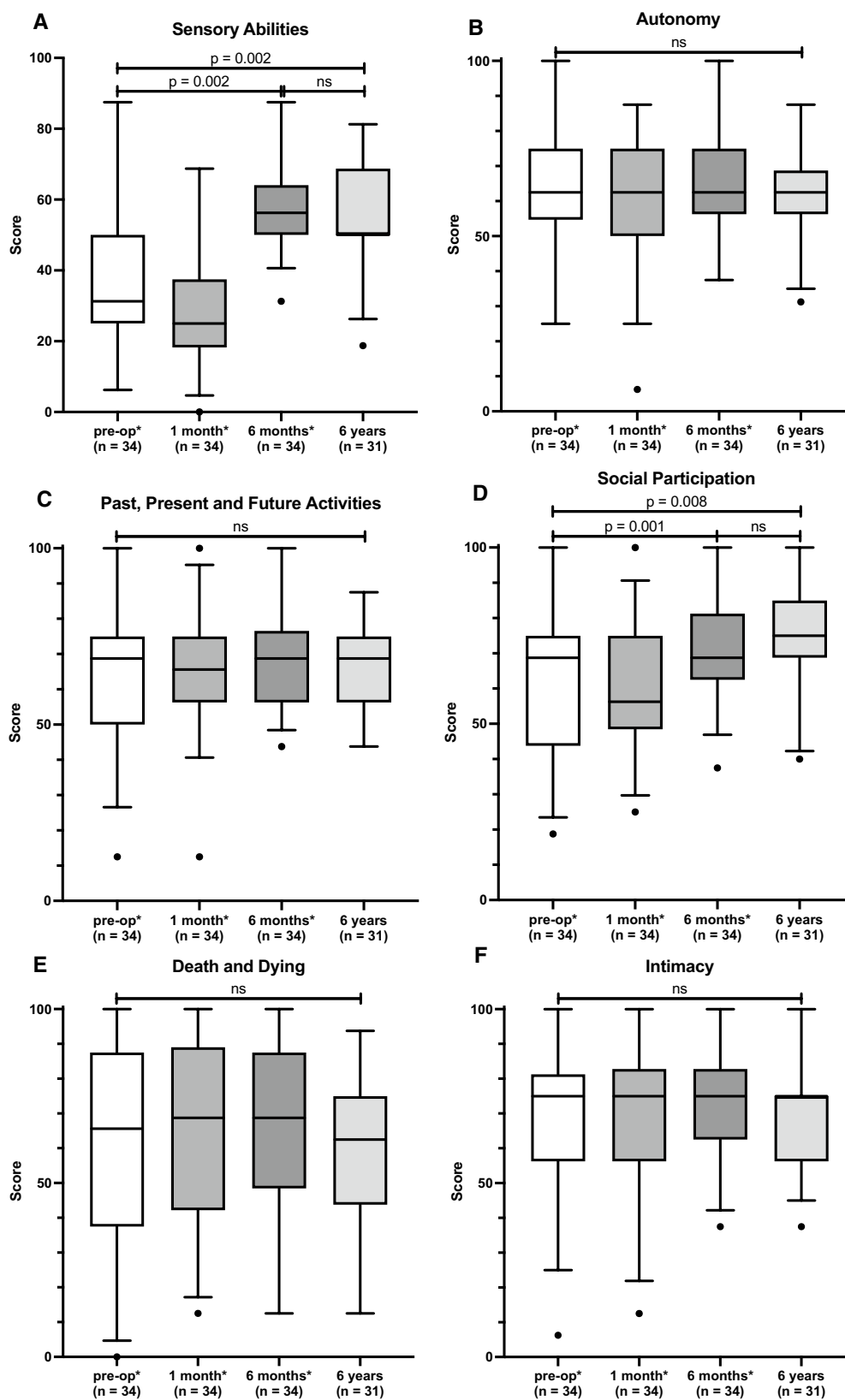
### WHOQL-OLD “Death and dying”

Six years after the initial unilateral CI treatment, the mean score was  $57.5 \pm 21.8$  points. When compared to the 6 month control ( $65.6 \pm 25.1$  points [19]), there was no significant decrease ( $p = 0.282$ ). There were no significant changes over the entire study period ( $p = 0.36$ ) (Fig. 3; Table 1).

**Table 1** Overview of total WHOQOL-OLD score and the individual facets

	Preoperative (n = 34) (Issing et al. [19])	1 month postoperative (n = 34) (Issing et al. [19])	6 months post-operative (n = 34) (Issing et al. [19])	6 years postoperative (n = 31)	Control Group $\geq 60$ yrs (Conrad et al. [26])
Total score	$60.0 \pm 15.7$	$58.5 \pm 13.6$	$66.8 \pm 12.2$	$64.2 \pm 10.6$	$68.0 \pm 14.7$
Sensory abilities	$38.1 \pm 22.6$	$29.2 \pm 16.4$	$57.9 \pm 12.6$	$56.8 \pm 15.6$	$75.85 \pm 21.1$
Autonomy	$63.2 \pm 17.6$	$61.4 \pm 17.0$	$65.3 \pm 15.3$	$61.7 \pm 12.7$	$68.9 \pm 19.1$
Past, present and future activities	$66.2 \pm 18.0$	$65.4 \pm 15.4$	$68.4 \pm 13.8$	$65.1 \pm 13.0$	$65.34 \pm 16.7$
Social participation	$61.04 \pm 21.0$	$59.9 \pm 18.0$	$70.6 \pm 13.6$	$74.2 \pm 14.4$	$69.0 \pm 20.0$
Death and dying	$61.9 \pm 30.0$	$65.4 \pm 26.5$	$65.6 \pm 25.1$	$57.5 \pm 21.8$	$62.91 \pm 24.3$
Intimacy	$69.3 \pm 20.2$	$69.9 \pm 21.0$	$73.0 \pm 16.3$	$69.8 \pm 15.5$	$65.81 \pm 20.9$

Additional are the data preoperatively, one and 6 months postoperatively of our previous study (Issing et al. [19]). Values of an age-matched control group according to Conrad et al. [26] are displayed



**Fig. 3** Facets of WHOQOL-OLD. In (A–F), the individual facets of WHOQOL-OLD are shown. In addition, the preoperative results as well as one and 6 months postoperatively of our previous study (\*Issing et al. [19]) are presented. A “Sensory abilities”; B “Autonomy”;

C “Past, present and future Activities”; D “Social participation”; E “Death and dying”; F “Intimacy”. There were no significant differences in any facet between the follow-up 6 months and 6 years post-operatively

## WHOQL-OLD “Intimacy”

For the facet “Intimacy”, the average score after 6 years was  $69.8 \pm 15.5$  points. In the 6 months postoperative control ( $73.0 \pm 16.3$  points [19]), there was no significant decrease ( $p=0.382$ ). Over the entire 6 year period, there was no significant change ( $p=0.881$ ) (Fig. 3; Table 1).

## Discussion

Over the last decades, the treatment of deaf and severely hearing-impaired patients of all age groups with a CI has become a routine procedure with excellent results in speech understanding for suitable candidates [8, 10, 13, 14, 22, 27, 28]. In recent years, the proportion of CI candidates over the age of 65 has been steadily increasing, with comparable results in speech understanding to younger patients [7, 8]. In recent years, the evaluation of the quality of life has become an integral part of the assessment of treatment success in Germany and is recommended in the German Cochlear Implant Guideline and the German Whitebook on Cochlear Implant Care. These recommendations also form the basis for the new German Cochlear Implant Registry and are a prerequisite for certification as a Cochlear Implant Center in Germany [15–18].

In our previous study, we also demonstrated a rapid and significant improvement in monosyllabic discrimination within 6 months postoperatively ( $p=0.001$ ). The monosyllabic discrimination was stable from the control 6 months postoperatively to the 6 year control ( $p=0.341$ ). Our data demonstrate not only a very rapid but also stable improvement in monosyllabic discrimination over the years in elderly patients.

Hearing impairment is a particular risk factor for elderly patients due to the specific psychosocial situation with often increasing physical limitations and resulting in a reduction of social participation [4, 6]. The return to “acoustic social life” due to hearing rehabilitation with CI treatment is, therefore, the basis of improving quality of life and should thus have a central focus in the clinical outcome assessment. Besides the health-related quality of life, such as the widely used Nijmegen Cochlear Implant Questionnaire, general quality-of-life questionnaires are available. As the aim of rehabilitation is, whenever possible, to reach the outcomes of a comparable healthy population, we used the World Health Organization Quality-of-Life Scale -old (WHOQL-OLD) questionnaire to allow the comparison with a healthy age-matched general population [14, 20, 21, 24, 26]. In addition, this questionnaire has been validated specifically for patients over the age of 60. For the total score, as well as

for all six facets, there were no significant changes from the control 6 months postoperatively to 6 years postoperatively. However, when comparing the total score from the preoperative measurement to the control 6 years postoperatively, there is no significant difference ( $p=0.407$ ) either. To explain these results, the individual facets have to be examined in more detail: The facets “Autonomy” ( $p=0.074$ ) and “Past, present and future activities” ( $p=0.162$ ) showed a non-significant decrease but clear negative trend in the score from the survey 6 months postoperatively to 6 years postoperatively. In particular, the overperformers decreased. Since the facets “Sensory abilities” ( $p=0.816$ ), “Social participation” ( $p=0.224$ ), as well as the monosyllabic discrimination ( $p=0.342$ ) did not change significantly during this period, other age-related factors not associated with hearing can be assumed as cause.

In monosyllabic discrimination, there was even a slight non-significant increase from the 6 month to the 6 year control. This not only confirms the suspected other factors for the decrease of the total score compared to the 6 year follow-up but also gives evidence for an continuous improvement of the monosyllabic discrimination even after more than 6 months postoperatively in elderly patients. Thus, not only do the poor performers but also the top performers improve further.

To evaluate the results of our study 6 years after hearing rehabilitation with CI, we compared the results to a healthy elderly population, according to Conrad et al. [26] (Table 1). However, the results must be considered in the context of the Conrad et al. cohort being slightly younger, with a mean of  $71.3 \pm 8.3$  years compared to our cohort with  $79.1 \pm 4.8$  years. Regarding the total score, our cohort with a score of  $64.2 \pm 10.6$  does not reach the values of the healthy general population  $68.0 \pm 14.7$  ( $p=0.057$ ) even 6 years postoperatively. However, this can also be partially explained by the older age of our cohort and presumably more age-related other infirmities. A closer look at the individual facets reveals significant differences compared to the healthy general population, particularly in the “Sensory abilities” ( $p=0.001$ ). The same is true for “Autonomy” ( $p=0.001$ ). Thus, although hearing rehabilitation with CI leads to a significant improvement in monosyllabic discrimination, the affected patients assess the performance of their sensory functions significantly worse than the general population. This may be due to a poorer speech comprehension compared to healthy persons despite the CI, but also to persisting everyday problems, especially with hearing in noise. This clearly demonstrates that there is a relevant difference from CI users to the normal hearing. This illustrates the need for further improvement of the CI technology. Possibly also new therapeutic



strategies such as optical cochlear implants may help to “close the gap” in the future [29].

Social participation ultimately represents the success of CI treatment that can be directly experienced by each patient. Through hearing rehabilitation with CI, the social deprivation that most elderly hearing impaired patients suffer can usually be successfully reversed [30]. Our data not only indicate stability of “social participation” after hearing rehabilitation for many years, but as the only facet “Social participation” increases—however not significantly—from the control 6 months postoperatively with  $70.6 \pm 13.6$  points to 6 years postoperatively with  $74.2 \pm 14.4$  points ( $p = 0.1$ ). Interestingly, our study cohort performed better than the general population both at 6 months and 6 years postoperatively ( $69.0 \pm 20.0$ ;  $p = 0.1$ ).

A critical view on our study reveals potential limitations. Although this is a prospective longitudinal study with a small loss of follow-up of only three patients (8.8%), it is not a randomized controlled study. For ethical reasons, a randomized controlled trial design was not possible. Instead of a control group, a healthy German elderly population, according to Conrad et al. [26], was used. Although this control group is suitable in principle, the data must be considered in the context that the cohort of Conrad et al. [26] is on average almost 8 years younger. As a result, comparisons with the general population according to Conrad et al. are slightly too stringent, as usual age-related changes tending to decrease the quality of life of an older cohort are not considered. Consequently, in addition to the cohort treated with a CI, an age-matched healthy control group would be preferable, that would have to be examined at the same time points. Due to the lack of a sufficient number of healthy age-matched patients, this approach was not feasible.

Ultimately, it is not only the audiological measurable success but rather the return to social life and thus the improvement in quality of life that defines the CI-treatment success experienced by the patient. In summary, our study data indicate a significant increase in “Social participation” in addition to a rapid and stable improvement in monosyllabic discrimination over 6 years. As the only facet, the “Social participation” score continues to increase slightly on average over the years, even better than the average population. As a consequence, in particular elderly CI candidates, should not only be counseled for improvement in speech understanding, but also on the multidimensional positive impact especially on social participation. In addition, a continuous monitoring of the quality of life should be performed routinely during the CI follow-up in order to be able to assess this dimension of the CI-treatment success.

## Conclusion

Our study data demonstrate a rapid and stable improvement in quality of life over the 6 years in elderly patients over the age of 65. Moreover, the importance of the systematic assessment of the quality of life, as included in the German Cochlear Implant Guideline and the German Whitebook on Cochlear Implant Care as a central treatment success parameter, is underlined [15–18]. In particular, “Social participation” as a treatment success directly experienced by the patient reaches the level of the general population within only 6 months postoperatively and even exceeds this level 6 years after CI treatment. Hearing rehabilitation with a CI can be explicitly recommended in case of audiological indication without an age limit. The multidimensional positive effects of CI treatment in elderly patients should also be discussed in detail during preoperative consultation.

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## Declarations

**Conflict of interest** The authors declare that there is no conflict of interest.

**Ethical approval** The study was conducted in accordance with the Declaration of Helsinki 1964, and with approval of the local ethical review committee (105/15). All patients gave their written informed consent for inclusion before they participated in this study.

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# Long-term effects on the quality of life following cochlear implant treatment in older patients

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## Abstract

**Purpose** Even in older patients, hearing rehabilitation with a cochlear implant has become an established method for deafened or severely hearing-impaired patients. In addition to the hearing improvement, numerous other effects of CI treatment can be observed in clinical routine. In the literature, there is multiple evidence for a rapid and significant improvement in quality of life with CI treatment. The aim of this study was to evaluate the long-term effects of hearing rehabilitation using CI on the quality of life in older patients ( $\geq 65$  years).

**Methods** This prospective cross-sectional study examined 84 patients between the age of 65 and 101 years who received unilateral CI treatment for the first time between one and 10 years ago. The World Health Organization Quality-of-Life Scale-Old (WHOQOL-OLD) was used to determine the quality of life. The study cohort was divided into three groups to compare the quality of life over time: group I (1–3 years after CI treatment), group II (4–6 years after CI treatment), and group III (7–10 years after CI treatment). In addition, the data from this study were compared with the results of our previous study (Issing et al. 2020) in which we focused on the first 6 months after CI treatment.

**Results** In all three groups, there was a significant improvement in monosyllabic discrimination within 1 year after CI fitting ( $p > 0.001$ ). No significant differences were found between the three groups. There were no significant differences between the three groups in the WHOQOL-OLD total score ( $p = 0.487$ ) or any of the other six facets. Moreover, no significant differences were found compared to the study group of our previous study 6 months after CI treatment.

**Conclusion** This study demonstrates the long-term stability of the improved quality of life following unilateral CI treatment in patients aged 65 years or older.

**Keywords** Cochlear implant · Quality of life · Elderly · Older patients · Long-term results

## Introduction

Due to the demographic development in the western industrialized nations, the proportion of elderly patients is continuously rising. In the elderly population, severe hearing loss or deafness is one of the most common chronic conditions [1–4]. Consequently, the proportion of cochlear implant

candidates over 65 years represents a considerable percentage of the patients treated in cochlear implant (CI) centers.

For more than three decades, CI have been used successfully for functional hearing rehabilitation of severely hearing-impaired and deaf patients [5–7]. Previous studies have confirmed a significant gain in speech understanding also in the elderly [5, 7–11]. Consequently, CI treatment is performed in patients in many countries without an age limitation.

The success of hearing rehabilitation is measured primarily by audiological criteria—especially with speech understanding. In recent years, clinical research has increasingly focused on the effects of CI treatment in elderly patients beyond the improvement of speech understanding, as several studies have demonstrated a positive effect of hearing rehabilitation on the cognitive functions of elderly patients [12–16].

For the patient, the most important measure besides the success of hearing rehabilitation is the improvement in

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quality of life. Hearing deprivation often leads to social isolation and, as a result, to a massive reduction in the quality of life of elderly patients [17–19].

In the literature, there is several evidence for a timely and substantial improvement in quality of life with CI treatment in elderly patients [4, 18, 20–23]. Previous studies have focused on suitable measurement instruments for evaluating the quality of life in elderly patients, the speed of effects, and possible correlations. The focus of our previous study was primarily on the short- and medium-term development of quality of life after CI treatment. Therefore, this prospective study aimed to evaluate the long-term effects on the quality of life after hearing rehabilitation with CI in elderly patients.

## Patients and methods

### Study design

This prospective cross-sectional study was conducted at the Department of Oto-Rhino-Laryngology, Medical University Frankfurt/Main, Germany. Data were collected from the first quarter of 2017 until the fourth quarter of 2017. The ethics commission of Goethe University Frankfurt gave its approval to this study.

Inclusion criteria were unilateral CI treatment at least 1 year and a maximum of 10 years ago, more than 65 years of age (at the time of the survey), German language skills at native speaker level. Exclusion criteria were known dementia or other mental illness (depression, psychosis).

Initially, all patients treated at the Department of Oto-Rhino-Laryngology, University Hospital Frankfurt, who fit the inclusion criteria were informed about the study by telephone. Among these patients, seven could not be contacted and one patient declined to participate in the study. The questionnaire was sent to all remaining patients by mail. The patients completed a questionnaire on quality of life (WHOQL-OLD) in addition to demographic data.

To better assess the development of the collected parameters over time, the study cohort was divided into three groups:

- Group I: patients who were treated with a CI between one and 3 years ago
- Group II: patients who were treated with a CI four to 6 years ago
- Group III: patients who were treated with a CI seven to 10 years ago

In addition, the data from this study were compared with the results of our previous study (Issing et al. [22]) and the normative baseline scores of an average age population according to Conrad et al. [24].

### Patients

In total, questionnaires were sent to 93 patients. Of these, however, nine patients had to be excluded because either the questionnaire was not returned ( $n = 6$ ) or the questionnaire was answered incompletely ( $n = 3$ ). The study thus included 84 patients (36 men and 48 women) between the ages of 65 and 101 years. The average age at the time of the survey was  $75.3 \pm 7.3$  years. At the time of implantation, the average age was  $70.4 \pm 7.3$  years. The total cohort was divided into three groups as described above. All candidates had profound unilateral or bilateral hearing loss and had been treated with a CI unilaterally for at least 1 year and a maximum of 10 years at the time of the survey.

### Freiburg monosyllabic speech test

In addition, audiological data collected during clinical routine preoperatively and 1 year postoperatively were analyzed. The Freiburg monosyllabic speech test (FMS) was used for all patients preoperatively and 1 year after implantation to determine the monosyllable recognition in free field. The non-CI ear was masked by broadband noise or mechanical blocking. The measurement was conducted in best-aided condition preoperatively and postoperatively with a CI at 65 dB SPL.

### Quality of life assessment

The aim of the study was to assess quality of life in older patients undergoing hearing rehabilitation with respect to the time interval since CI-fitting was initiated. For the standardized assessment of quality of life, the German version of the World Health Organization Quality-of-Life Scale–old (WHOQL-OLD) was used according to Conrad et al. [24].

This questionnaire, specially developed for patients over the age of 60, takes particular account of the multidimensionality of the quality of life. Six dimensions of the quality of life, so-called facets, are covered:

#### "Sensory abilities"

This facet generally represents the sensory functions (such as hearing, seeing, or tasting) [24].

#### "Autonomy"

"Autonomy" captures the ability to live a self-determined, independent life [24].

### "Past, present and future activities"

This facet represents achievements already accomplished in life, ongoing activities, and those planned for the future [24].

### "Social participation"

Participation in social life and social interactions are queried here [24].

### "Death and Dying"

In addition to concerns about one's own death, this facet also considered the loss of nearby relatives [24].

### "Intimacy"

The facet "intimacy" describes the importance of human relationships [24].

## Data analysis and statistical evaluation

Data extraction and transfer of the paper-based questionnaires were performed using Microsoft Excel 2016 (Microsoft Corporation, Redmond, Washington). The statistic programs BiAS 11.06 (epsilon-Verlag Hochheim Darmstadt) and GraphPad Prism Version 9 (GraphPad Software, Inc. San Diego) were used for statistical evaluation of the data and application of the statistical test procedures.

First, the Shapiro–Wilk test was used to test for normal distribution. In the absence of a normal distribution, non-parametric tests were used. The Kruskal–Wallis test was used for group comparisons. For the comparisons of our study cohort with the data of the average elderly population, according to Conrad et al. [24], the Wilcoxon-matched pairs test was used. The significance level was set at  $p \leq 0.05$ .

## Results

This prospective cross-sectional study included 84 patients aged 65 years and older treated unilaterally with a CI between 1 and 10 years ago. Implants from manufacturers Advanced-Bionics (Advanced-Bionics: Sonova Holding AG, Stäfa, Switzerland) (2.4%;  $n=2$ ), Cochlear (Cochlear: Cochlear Ltd., Macquarie, Australia) (47.6%;  $n=40$ ) and Med-EL (MED-EL Elektromedizinische Geräte, Gesellschaft m.b.H., Innsbruck, Austria) ( $n=50.0\%$ ;  $n=42$ ) were used.

To enable a statement on the development of the different parameters after several years post CI treatment, the patients were divided into three groups:

Group I (1–3 years after CI treatment)

We included 31 patients (15 men and 16 women) with a mean age of  $75.0 \pm 8.3$  years at the time of the survey. The average time the speech processor was worn was reported by 83.9% as more than 12 h per day, and 6.5% in group I wore the speech processor between 6 and 12 h.

Group II (4–6 years after CI treatment)

Group II included 40 patients (19 men and 21 women) with a mean age of  $75.2 \pm 7.2$  years. The wearing time of the speech processor was 70% over 12 h and 20% 6–12 h.

Group III (7–10 years after CI treatment)

In this group, there were 13 patients (2 men and 11 women) with a mean age of  $76.7 \pm 4.4$  years. Regarding this group, 66.7% of patients wore the speech processor for more than 12 h, and 33.3% wore it for 6–12 h.

### Freiburg monosyllabic speech test (FMS)

In best-aided condition, preoperative monosyllabic discrimination in the ear to be treated with a CI was on average at 65 dB SPL in group I  $15.3 \pm 19.3\%$ , in group II  $16.9 \pm 24.7\%$  and  $9.6 \pm 12.3\%$  in group III. The monosyllabic discrimination increased 1 year after implantation at 65 dB SPL to  $68.0 \pm 19.7\%$  in group I, to  $68.0 \pm 28.2\%$  in group II, and to  $55.4 \pm 21.9\%$  in group III. In all three groups, the increase in monosyllabic discrimination from preoperative measurement to follow-up at 1 year was significant ( $p < 0.001$ ). There was no significant difference between the three groups either preoperatively ( $p = 0.956$ ) or 1 year postoperatively ( $p = 0.112$ ).

### World Health Organization Quality-of-Life Scale-Old (WHOQOL-OLD)

The WHOQOL-OLD questionnaire measures a total score and six facets of quality of life. In Table 1, in addition to the data of this study, the data of our previous study (preoperative and 6 months postoperative) [22] as well as data of an age-matched average population from Conrad et al. [24] are shown.

For the WHOQOL-OLD total score, the average of group I was  $67.9 \pm 11.1$ , group II  $69.4 \pm 10.5$ , and group III  $65.7 \pm 11.4$  points. There was no significant difference between the three groups ( $p = 0.487$ ).

### WHOQOL-OLD "Sensory abilities"

On this facet, in average group I scored  $54.8 \pm 18.5$ , group II  $53.5 \pm 15.6$ , and group III  $54.5 \pm 20.8$  points. No significant difference could be found between the three groups ( $p = 0.942$ ).

**Table 1** Overview of total WHOQOL-OLD score and the individual facets

	Preoperative (Issing et al. [22])	6 months postop- erative (Issing et al. [22])	Group I (1–3 years post- operative)	Group II (4–6 years post- operative)	Group III (7–10 years post- operative)	Control Group $\geq 60$ years (Con- rad et al. [24])
Total Score	60.0 $\pm$ 15.7	66.8 $\pm$ 12.2	67.9 $\pm$ 11.1	69.4 $\pm$ 10.5	65.7 $\pm$ 11.4	68.0 $\pm$ 14.7
Sensory Abilities	38.1 $\pm$ 22.6	57.9 $\pm$ 12.6	54.8 $\pm$ 18.5	53.5 $\pm$ 15.6	54.5 $\pm$ 20.8	75.85 $\pm$ 21.1
Autonomy	63.2 $\pm$ 17.6	65.3 $\pm$ 15.3	74.1 $\pm$ 15.8	71.7 $\pm$ 16.8	68.1 $\pm$ 19.1	68.9 $\pm$ 19.1
Past, Present and Future Activities	66.2 $\pm$ 18.0	68.4 $\pm$ 13.8	69.2 $\pm$ 15.8	73.1 $\pm$ 15.5	75.8 $\pm$ 14.5	65.34 $\pm$ 16.7
Social Participation	61.04 $\pm$ 21.0	70.6 $\pm$ 13.6	67.1 $\pm$ 17.5	72.0 $\pm$ 11.3	65.9 $\pm$ 17.6	69.0 $\pm$ 20.0
Death and Dying	61.9 $\pm$ 30.0	65.6 $\pm$ 25.1	69.0 $\pm$ 24.1	71.2 $\pm$ 19.4	56.3 $\pm$ 21.7	62.91 $\pm$ 24.3
Intimacy	69.3 $\pm$ 20.2	73.0 $\pm$ 16.3	72.3 $\pm$ 17.0	73.6 $\pm$ 16.4	76.0 $\pm$ 17.5	65.81 $\pm$ 20.9

Complementary are the data preoperatively and 6 months postoperatively of our previous study (Issing et al. [22]). In addition, the normal values of an age-adjusted control group according to Conrad et al. [24] are shown

### WHOQL-OLD "Autonomy"

For autonomy, group I scored 74.1  $\pm$  15.8, group II 71.7  $\pm$  16.8, and group III 68.1  $\pm$  19.1 points. There was no significant difference between the three groups ( $p=0.522$ ).

### WHOQL-OLD "Past, present and future activities"

Regarding this facet, group I scored 69.2  $\pm$  15.8, group II scored 73.1  $\pm$  15.5, and group III scored 75.8  $\pm$  14.5 points. Between the three individual groups, there was no significant difference ( $p=0.384$ ).

### WHOQL-OLD "Social participation"

Group I could measure 67.1  $\pm$  17.5, group II 72.0  $\pm$  11.3, and group III 65.9  $\pm$  17.6 points. There was no significant difference ( $p=0.645$ ) between the three groups.

### WHOQL-OLD "Death and dying"

In "Death and Dying," group I had 69.0  $\pm$  24.1 points, group II had 71.2  $\pm$  19.4 points and group III had 56.3  $\pm$  21.7 points. There was no significant difference between the three groups ( $p=0.127$ ).

### WHOQL-OLD "Intimacy"

On this facet, group I achieved a score of 72.3  $\pm$  17.0, group II of 73.6  $\pm$  16.4, and group III of 76.0  $\pm$  17.5. Again, there was no significant difference between the three groups ( $p=0.646$ ).

## Discussion

In recent years, the percentage of CI candidates over 65 years of age has steadily risen in many CI centers. Because the expectations for speech understanding from CI treatment are similar to those for younger patients, CI treatment is provided in many countries with no age limit for suitable patients [5, 8, 9, 11]. In addition to a pure audiological assessment, further aspects of hearing rehabilitation, such as the quality of life, are gaining importance as a measure of treatment success. There is strong evidence in the literature for a rapid and significant improvement in quality of life with hearing rehabilitation. However, it is largely unknown whether this is a consistent long-term improvement. This study is a follow-up to our previously published study (Issing et al. [22]) in which we focused on the first 6 months after CI treatment.

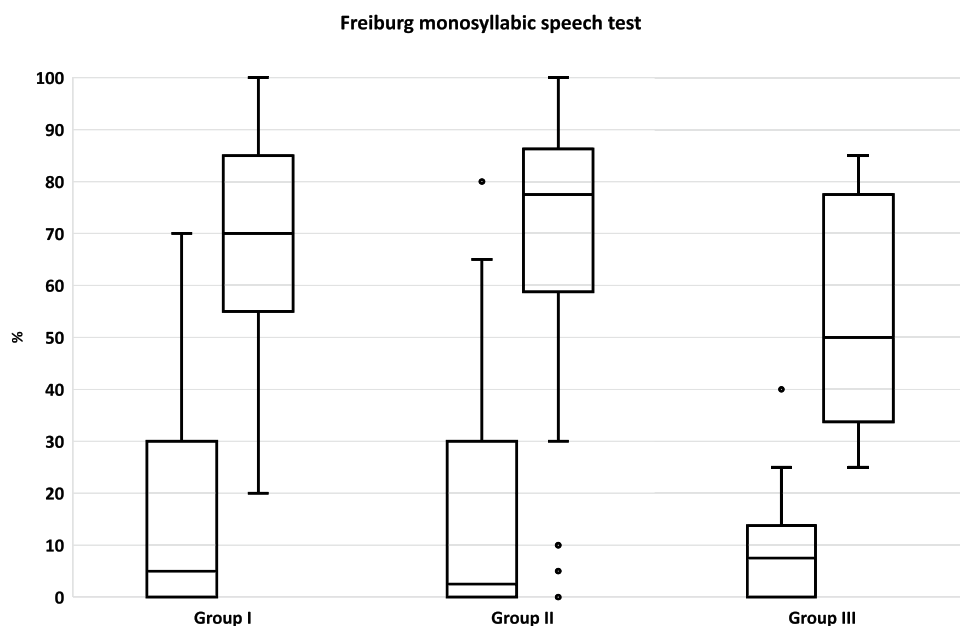
To assess the quality of life, we chose the WHOQOL-OLD (World Health Organization Quality of Life-OLD) questionnaire [24]. This questionnaire, which was developed specifically for patients aged 60 and older, is characterized by its multidimensional approach to represent the quality of life accurately. Therefore, in addition to a total score, six different so-called facets of quality of life ("Sensory Abilities," "Autonomy," "Past, Present and Future Activities," "Social Participation," "Death and Dying" and "Intimacy") were used to best represent the different aspects of quality of life. Other commonly used questionnaires are generally not validated for this older age group. On the other hand, this questionnaire measures the quality of life multidimensionally but not disease-specifically like

other often used questionnaires as the Nijmegen cochlear implant questionnaire, which can be used meaningfully only in patients with hearing impairment [25]. As a result, data from these disease-specific questionnaires cannot be compared with data from the general population. However, the goal of rehabilitation, and thus also of hearing rehabilitation, should aim at the average population of the same age as good as possible. Consequently, comparisons with an average population appear essential.

To reliably measure the potential change of the quality of life over time, the study cohort was divided into three comparable groups (group I 1–3 years after CI treatment, group II 4–6 years after CI treatment, and group III 7–10 years after CI treatment). In addition to the mean age at implantation (group I  $72.2 \pm 8.3$ , group II  $69.9 \pm 7.1$  and group III  $67.7 \pm 4.0$  years), the audiological findings preoperatively and 1 year postoperatively were comparable (see Fig. 1). As result, there were no significant differences between the three groups in the Freiburg monosyllabic speech test (FMS) (preoperatively  $p = 0.956$ ; 1 year postoperatively  $p = 0.112$ ). Thus, all three groups showed similar audiological benefits from hearing rehabilitation with CI. This allows standardized comparisons of quality of life between the three groups, excluding possible confounding variables, such as different audiological outcomes or different ages.

Our primary goal for this study was to evaluate the long-term effects of hearing rehabilitation in elderly patients aged 65 and older. Considering the WHOQL-OLD total score, our results showed no significant difference between the three groups. Also, when looking at the individual facets there were no significant differences. Comparing the results of this study with the data 6 months postoperatively from our previous study [22], in which we examined only the first 6 months after CI treatment, there were no significant differences neither in the total score ( $p = 0.529$ ) nor in the individual facets (“Sensory abilities”  $p = 0.556$ ; “Autonomy”  $p = 0.078$ ; “Past, Present and Future Activities”  $p = 0.21$ ; “Social Participation”  $p = 0.812$ ; “Death and Dying”  $p = 0.256$ ; “Intimacy”  $p = 0.802$ ) for any of the three groups (see Figs. 2 and 3A–F). Consequently, our data of this study compared with the data of our previous study [22] indicate a long-term stable improvement in quality of life over the years not only in the total score but also when looking at all individual facets. Elderly patients thus seem to show a significant improvement in quality of life already about 6 months after hearing rehabilitation by CI and then keep this level stable for years. In the literature, mainly only the short- and medium-term positive effects of CI treatment on quality of life have been described so far [19–23, 26–29].

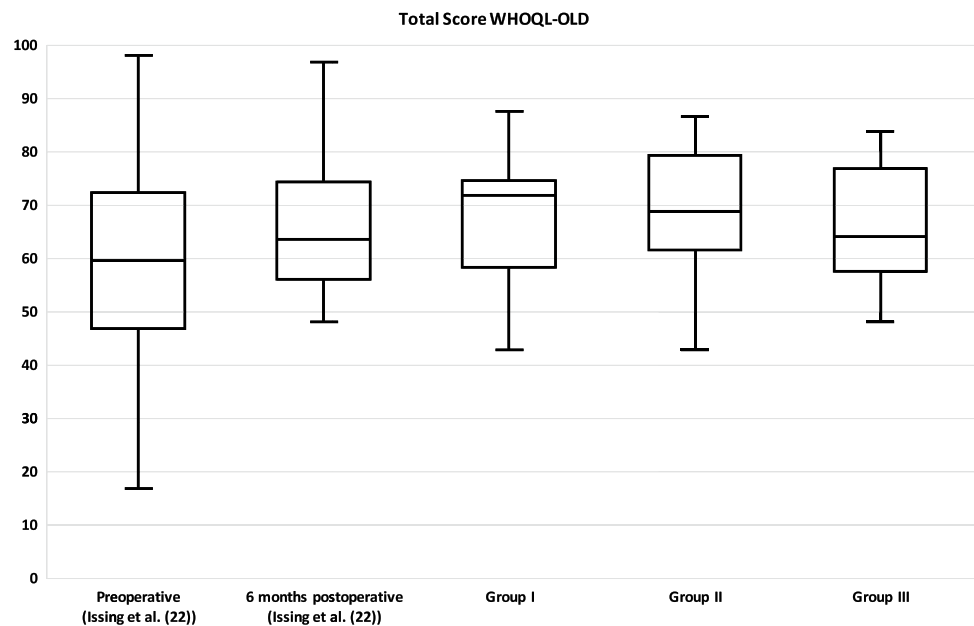
These undoubtedly positive effects of CI treatment should also be considered in the context of an age-adjusted average



**Fig. 1** Freiburg monosyllabic speech test (FMS). Results of FMS of the three groups (Group I 1–3 years after CI treatment, Group II 4–6 years after CI treatment, and Group III 7–10 years after CI treatment) preoperatively and one year postoperatively. Preoperative FMS was measured in the ear to be treated with a CI in best-aided condition (contralateral ear blocked or masked). The treated ear was

assessed in CI-only condition after 12 months. In all three groups, the increase from preoperative measurement to follow-up at 1 year was significant ( $p < 0.001$ ). At both time points, there was no significant difference between the three groups (preoperatively  $p = 0.956$ ; postoperatively  $p = 0.112$ ).

**Fig. 2** Total WHOQOL-OLD score. The total score is formed from the six individual facets shown in Fig. 3. There were no significant differences between the three groups in the WHOQOL-OLD total score ( $p=0.487$ ). Complementary results preoperatively and 6 months postoperatively from our previous study (Issing et al. [22]) are presented



population. Comparing the "sensory abilities" of our three groups (Group I  $54.8 \pm 18.5$ ; Group II  $53.5 \pm 5.6$  and Group III  $54.5 \pm 20.8$  points) with the score of the age-adjusted average population of  $75.85 \pm 21.1$  (24), all three groups showed a significant difference (Group I  $p=0.001$ ; Group II  $p=0.001$ ; Group III  $p=0.005$ ). So even after years, the patients treated with a CI do not reach the level of the average population in terms of "sensory abilities". When comparing the total score of the three groups with the score of the average population [24], there is no significant difference (Group I  $p=0.97$ ; Group II  $p=0.336$ ; Group III  $p=0.47$ ).

A critical review of the study reveals potential limitations: The study design did not have a control group. Instead, normative values of an age-adjusted average population from the literature had to be used [24]. Second, this was no proper longitudinal study design, in which the same patient is followed multiple times over the period of treatment. Instead, we interviewed patients who had been implanted for different lengths of time at one timepoint. This was partly because many older patients, in particular, do not usually attend the annual CI check-up appointments, e.g., due to other health problems, and therefore often present themselves irregular to CI consultation. Although it is unlikely to influence the results, it should

be noted that in group III the gender distribution (2 men and 11 women) is not balanced.

Further randomized long-term studies are therefore needed to evaluate the long-term effects more extensively.

In summary, our data of this study compared with the results of our previous study [22] demonstrate a stable improvement in quality of life over many years after CI treatment and therefore emphasize the benefit of CI treatment in the elderly population. This is a valuable result to be presented to patients before CI surgery to help the decision-making process.

## Conclusion

The results our study demonstrate the positive long-term effect on the improvement in quality of life resulting from hearing rehabilitation using CI in patients aged 65 years and older. There was no significant deterioration in the WHOQOL-OLD total score or in any of the six facets. Nevertheless, despite CI treatment, the patients did not reach the level of the average population in "sensory abilities" even after years.



**Fig. 3** Facets of WHOQOL-OLD. In (a–f), the individual facets of WHOQOL-OLD and their scores in points (0–100) of the three groups are shown. **a** "Sensory Abilities"; **b** "Autonomy"; **c** "Past, Present and Future Activities"; **d** "Social Participation"; **e** "Death and Dying"; **f** "Intimacy." There was no significant difference between the three groups in any facet ( $p > 0.05$ ). Complementary results preoperatively and 6 months postoperatively from our previous study (Issing et al. [22]) are presented

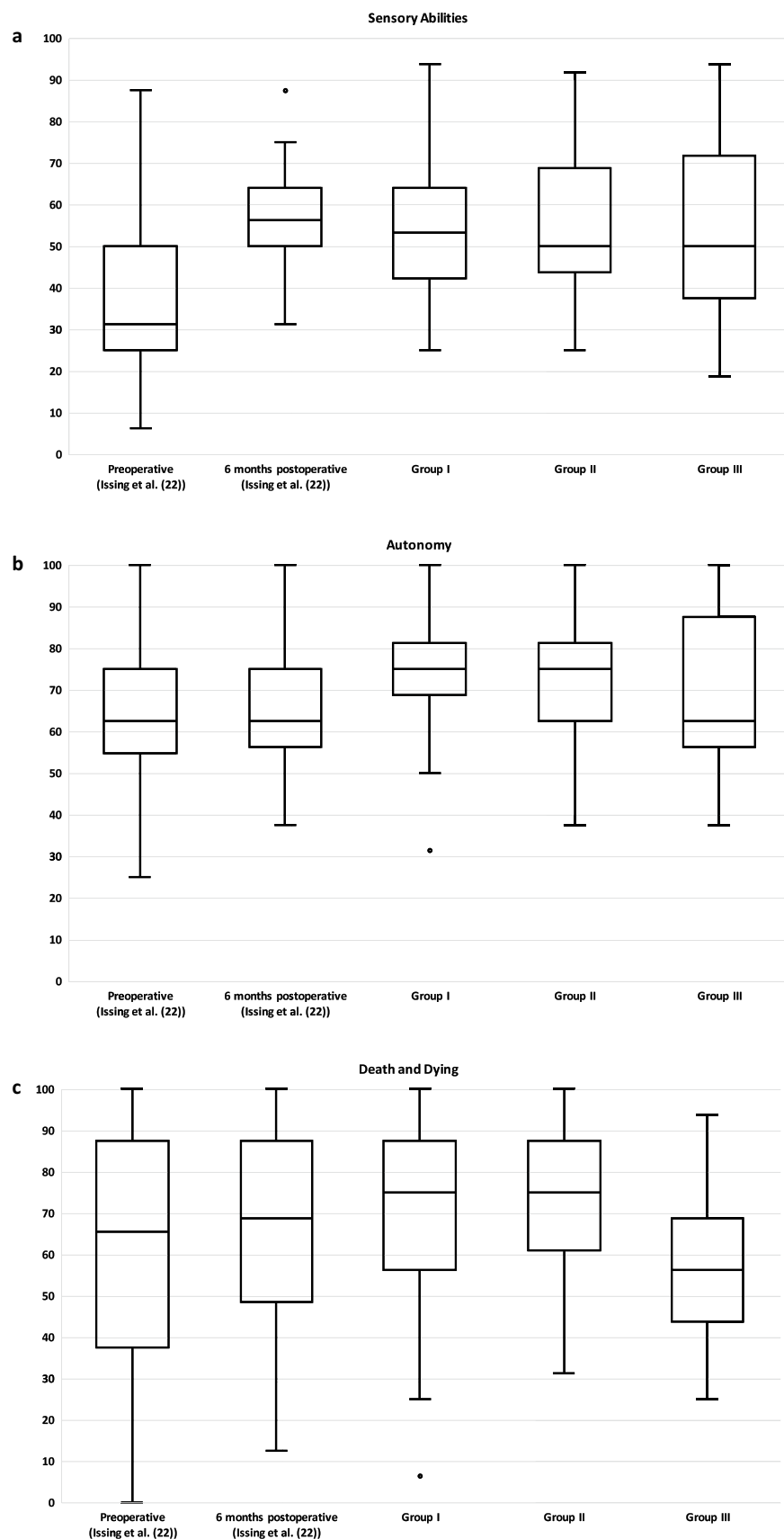
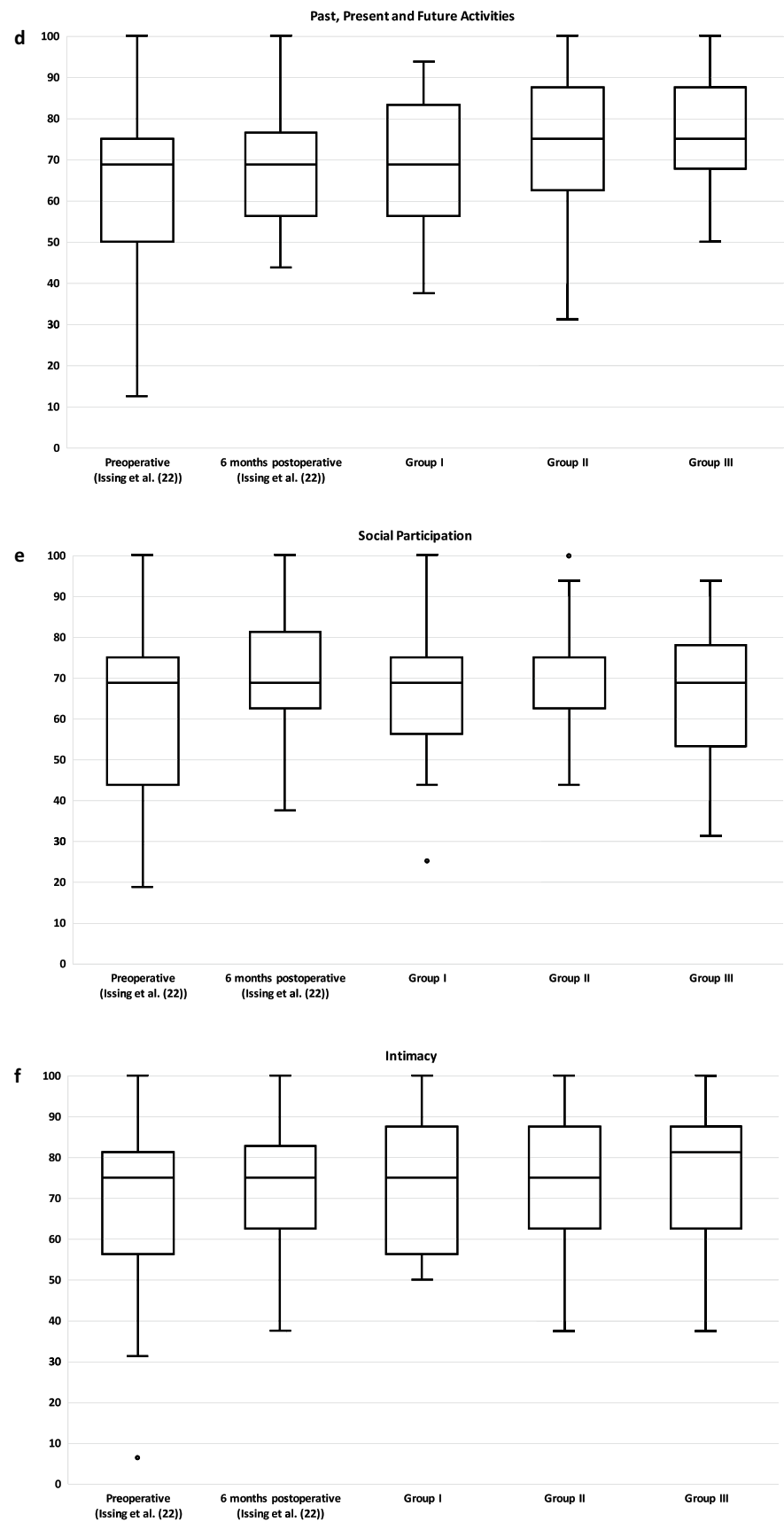


Fig. 3 (continued)





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## Declarations

**Conflict of interest** The authors declare that there is no conflict of interest.

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