Psychosocial health of cochlear implant users compared to that of adults with and without hearing aids: Results of a nationwide cohort study

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Sonova AG, Switzerland financially supported the data collection of the second measurement round of the Netherlands Longitudinal Study on Hearing.

Objectives: This study aimed to examine the psychosocial health status of adult cochlear implant (CI) users, compared to that of hearing aid (HA) users, hearing-impaired adults without hearing aids and normally hearing adults.

Design: Cross-sectional observational study, using both self-reported survey data and a speech-in-noise test.

Setting: Data as collected within the Netherlands Longitudinal Study on Hearing (NL-SH) between September 2011 and June 2016 were used.

Participants: Data from 1254 Dutch adults (aged 23-74), selected in a convenience sample design, were included for analyses.

Mean outcome measures: Psychosocial health measures included emotional and social loneliness, anxiety, depression, distress and somatisation. Psychosocial health, hearing status, use of hearing technology and covariates were measured by self-report; hearing ability was assessed through an online digit triplet speech-in-noise test.

Results: After adjusting for the degree of hearing impairment, HA users (N = 418) and hearing-impaired adults (N = 247) had significantly worse scores on emotional loneliness than CI users (N = 37). HA users had significantly higher anxiety scores than CI users in some analyses. Non-significant differences were found between normally hearing (N = 552) and CI users for all psychosocial outcomes.

Conclusions: Psychosocial health of CI users is not worse than that of hearing-impaired adults with or without hearing aids. CI users’ level of emotional loneliness is even lower than that of their hearing-impaired peers using hearing aids. A possible explanation is that CI patients receive more professional and family support, and guidance along their patient journey than adults who are fitted with hearing aids.

1 | INTRODUCTION

The audiological outcomes after cochlear implantation have been studied extensively. Along with anecdotal (clinical) evidence, most studies have shown that in combination with a rehabilitation programme, cochlear implants (CI) can greatly improve an individual’s speech recognition abilities. Only a small number of studies assessed general health and quality-of-life outcomes associated with CI use. Quality-of-life outcomes included social support and physical health, participation in conversation or telephone calls, detecting environmental sounds and a combination of sound perception, speech production, self-esteem, activity limitations and social interactions.
Literature indicates that with increasing levels of hearing impairment, psychosocial health outcomes tend to decrease. On the continuum from mild to profound hearing loss, CI candidates are usually at the profound end, as a profound hearing loss is one of the criteria to become eligible for a CI. It could therefore be expected that CI users have poorer psychosocial health than hearing aid (HA) users. There is research, however, showing that CI users score similarly on depression and loneliness compared to HA users of the same age. Indications for less negative outcomes may also be different for CI users than for HA users.

Most studies on CI users’ psychosocial health have focused on changes within this group over time (before and after implantation). Cohort studies including participants with different degrees of hearing impairment and/or devices (HAs or CIs), and studies making direct comparisons between these different groups are rare. One such study found depression scores directly after implantation to be worse among CI users, compared to HA users, but better scores were observed 1 year after implantation. As increased levels of distress and somatisation (i.e., attributing unexplained somatic symptoms to physical illness and seeking medical help) have also been reported among people with hearing loss, these outcomes may also be different for CI users than for HA users.

The aim of this study was to examine psychosocial health of CI users in comparison with those of HA users, adults with hearing impairment without CIs or HAs, and normally hearing adults. To assess the impact of CI use independently of the expected poorer hearing ability in this group, we controlled for the degree of hearing impairment. Psychosocial health outcomes included are as follows: emotional and social loneliness, anxiety, depression, distress and somatisation.

2 | MATERIALS AND METHODS

2.1 | Study design

The Netherlands Longitudinal Study on Hearing (NL-SH) is an ongoing online nationwide prospective cohort study which began collecting data in 2006. The NL-SH was set up to investigate associations between hearing ability and several domains of daily life functioning in an adult population. The participants (aged 18-70 years at baseline) comprise a convenience sample. More details about the study’s design and methodology can be found elsewhere. For this study, data collected at the second measurement cycle (between September 2011 and June 2016) were used. The NL-SH was approved by the Medical Ethics Committee of VU University Medical Center in Amsterdam, the Netherlands.

2.2 | Variables

2.2.1 | Hearing-related variables

Self-reported general hearing status was measured by asking: “How would you typify your hearing status?” Answers were "Normally hearing," "Conductive hearing loss," "Sensorineural hearing loss," "Conductive and sensorineural hearing loss," "Meniere’s disease," "Unknown type of hearing loss," "Unilaterally deaf with normal hearing in the other ear" or "Unilaterally deaf with impaired hearing in the other ear." Participants who reported “Normally hearing” were categorised into group (i) normally hearing. All other participants received additional questions about whether or not they used hearing aids or CIs. The answers were used to create the three other groups of participants: (ii) CI users, (iii) HA users and (iv) hearing impaired: adults with hearing impairment without CIs or HAs. We further refer to these as “hearing group.” Groups were mutually exclusive, that is hearing-impaired participants who used a HA were categorised as HA users, while participants who used both a HA and CI were categorised as CI users. Of all participants using HAs, 80% reported to have used their hearing aids, on average, more than 8 hours a day.

The National Hearing Test (NHT) was used to measure the degree of hearing impairment. The NHT is an online speech-in-noise test using digit triplets as speech material. The test uses an adaptive procedure to determine the signal-to-noise ratio at which a listener understands 50% of the digit triplets correctly (i.e., the speech reception threshold, SRT). For HA users, the aided SRT scores were analysed, because those best represent their hearing ability in everyday situations. Other ear- and hearing-related variables included self-reported onset of hearing loss (congenital, gradual or sudden), duration of hearing loss (in years) and duration of CI or HA use (in years).

2.2.2 | Psychosocial health outcomes

Loneliness was measured using the De Jong Gierveld scale. This scale consists of 11 items, 6 for emotional loneliness and 5 for social loneliness. An example of an item is “I often feel rejected.” Response categories “No” and “No!” were coded as 0, and “Yes!” “Yes” and “More or less” were coded as 1. Answer categories of reversed items (e.g., “I can call on my friends whenever I need them”) were reversely coded. The emotional loneliness scale ranges from 0 to 6, and the social loneliness scale from 0 to 5. Higher scores indicate more loneliness. No validated cut-off points are available to categorise severity of emotional and social loneliness. In line with the scoring of the 11-item loneliness scale, and by merging the “Severe” and “Very severe"
groups, the following categories were computed: Emotional loneliness "None" (0-1), "Moderate" (2-4) and "Severe" (5-6), and social loneliness: "None" (0-1), "Moderate" (2-3) and "Severe" (4-5 points).

Other psychosocial health outcomes were measured by the Four-Dimensional Symptom Questionnaire (4DSQ).\textsuperscript{17} It covers four scales: anxiety (12 items, max. 24 points), depression (5 items in the NL-SH, see,\textsuperscript{14} max. 12 points), distress (16 items, max. 32 points) and somatisation (16 items, max. 32 points). Participants were asked to assess the frequency of certain thoughts, feelings and symptoms, such as: "Did you suffer from pain in the chest?" or "Did you feel that everything is meaningless?" Answers were coded as 0 ("No"), 1 ("Sometimes") and 2 ("Regularly," "Often" and "Very often"). Higher scores indicate an increasing risk for having a psychosocial disorder. According to Terluin et al\textsuperscript{17} these scores were categorised into the following risk categories: for anxiety: 0-7 = "No disorder," 8-12 = "Possible disorder" and 13-24 = "High risk of disorder." Cut-off points for depression were 0-2 = "No disorder," 3-5 = "Possible disorder" and 6-12 = "High risk of disorder." Cut-off points for distress and somatisation were 0-10 = "No disorder," 11-20 = "Possible disorder" and 21-32 = "High risk of disorder."

### 2.2.3 Covariates

The variables age (in years), sex and educational level were considered covariates as it is known that they can vary with psychosocial health.\textsuperscript{7} Educational level was categorised according to the Statistics Netherlands definition into low (not completed primary education, only primary education or completed secondary vocational education), middle (completed higher secondary education or tertiary vocational education) or high (completed higher tertiary education, university of postgraduate education). Duration of hearing loss was also included as a covariate, to take potential adaptation to the hearing difficulties into account.

### 2.3 Study size

All participants with valid data on the main self-reported hearing status variable were included, which led to a total study sample of 1254 adults. Participants with missing data on other variables were automatically excluded from analyses pertaining to those variables.

### 2.4 Statistical analyses

First, descriptive statistics such as percentages, means and standard deviations (SD), per hearing group were calculated. Next, to compare the hearing groups, we tested the associations between hearing group and psychosocial health outcomes, using multiple linear regression models. Each of the six psychosocial health outcomes (dependent variables) were modelled separately, with dummy variables included for the variable "hearing group." The CI users group was the reference category in all models. Separate models were built to compare psychosocial health of normally hearing adults with CI users, because adjustment for SRT does not make sense (aided scores of CI users were worse than scores of normally hearing participants), and duration of hearing loss was not applicable in this comparison. For ease of interpretation and comparability across outcomes, the scales of all psychosocial health outcomes were recalculated to a score ranging from 0 (best outcome) to 10 (worst outcome). Unadjusted and adjusted regression models for covariates were reported. All analyses were performed using SPSS version 22.

### 3 RESULTS

Table 1 shows the descriptive statistics of the study population, separately for each hearing group. The participants in the CI group were approximately 3 to 7 years older than the other groups. Educational level was also included as a covariate, to take potential adaptation to the hearing difficulties into account.

| TABLE 1 Descriptive statistics for the four hearing groups |
|--------------|----------------|----------------|----------------|----------------|
|               | Total sample | CI users\textsuperscript{a} | HA users\textsuperscript{b} | Hearing impaired\textsuperscript{c} | Normally hearing\textsuperscript{d} |
| Age (y)       | Mean (SD)    | 57.0 (9.1)     | 54.0 (11.7)     | 55.1 (10.7)     | 49.7 (12.9)     |
| Sex           | % Female     | 66.7           | 64.4           | 57.9           | 67.4           |
| Educational level (%) |        | Low          | 30.6          | 15.1          | 20.0          | 13.6          |
|               |              | Middle        | 38.8          | 28.8          | 30.4          | 24.3          |
|               |              | High          | 30.6          | 56.1          | 49.6          | 62.1          |
| SRT (dB SNR)  | Mean (SD)    | 1.6 (3.0)     | –2.1 (3.3)    | –4.3 (3.1)    | –6.5 (1.9)    |
| Onset of hearing loss (%) |    | Gradual      | 67.6          | 71.1          | 78.1          | –          |
|               |              | Sudden        | 8.1           | 10.3          | 17.0          | –          |
|               |              | Congenital    | 24.3          | 18.7          | 4.9           | –          |
| Years of hearing loss | Mean (SD)    | 34.3 (15.4)   | 25.3 (16.9)   | 16.1 (14.4)   | –           |
| Years of CI use | Mean (SD)    | 5.5 (6.4)     | –             | –             | –           |
| Years of HA use | Mean (SD)    | 21.5 (14.8)   | 15.2 (13.1)   | –             | –           |

SRT, speech reception threshold in noise; SNR, signal-to-noise ratio.
Self-reported hearing groups: \textsuperscript{a}cochlear implant (CI) users, \textsuperscript{b}hearing aid (HA) users, without CI, \textsuperscript{c}adults with hearing impairment, without CI or HA, \textsuperscript{d}normally hearing adults.
level varied by hearing group, with the highest proportion of low educated respondents in the CI group (30.6%). As expected, SRT scores were worst for the CI users (mean 1.6 dB SNR), and better with each following hearing group, in this order: HA users, hearing impaired and normally hearing participants. On average, CI users had 34 years of hearing loss and used their CIs for about 5.5 years. The majority of the participants with CI reported a gradual onset of hearing loss (67.6%).

Figure 1 shows the distribution of psychosocial health outcomes per hearing group. For descriptive purposes, these unadjusted continuous scores were categorised into risk categories. The proportion of adults with severe emotional loneliness was somewhat smaller in the CI users group than in the other three groups. The latter group was relatively small (N = 37). The prevalence of the high-risk category for anxiety, depression and somatisation was relatively rare in all four groups.

The results of the multiple linear regression analyses for each of the six outcomes are presented in Table 2. After adjustment for SRT scores (Model 2), or age, gender, educational level, SRT and duration of hearing loss (Model 3), "hearing group" appeared to be significantly associated with emotional loneliness and anxiety only. The emotional loneliness scores were significantly higher in the HA users (B: 1.74; 0.56-2.93, P < .01) and hearing-impaired group (B: 1.69; 0.41-2.98, P = .01) than in the CI users group. The association with anxiety was only significant adjusting for the covariates, in particular for educational level (B: HA-users: 1.30; 1.01-1.68; P = 0.046).

In addition, all psychosocial health outcomes were modelled again, comparing normally hearing adults to CI users (Table 3). None of the associations in either model 1 (unadjusted) or model 2 (adjusting for age, sex and education) was statistically significant.

4 | DISCUSSION

4.1 | Synopsis of key findings

The current findings indicate that CI users are significantly less emotionally lonely than other adults with hearing impairment who use hearing aids or not. CI users scored significantly better on anxiety than HA users in some of the analyses. For the other psychosocial outcomes (social loneliness, depression, distress and somatisation), CI users do not differ from their hearing-impaired peers with or without hearing aids. On average, scores on emotional loneliness of CI users were not statistically different from their normally hearing peers.

A main strength of this study is the varied population studied. The sampling strategy, through use of an online survey and diverse sampling channels, covered the whole of the Netherlands. The study population showed a broad distribution across age groups and educational level. Moreover, it is a non-clinical sample and it not only examined depression and loneliness as outcomes of psychosocial health, but also anxiety, distress and somatisation.

4.2 | Comparison with other studies

Previous studies also reported that CI users had comparable psychosocial health,9 and even better outcomes on loneliness than HA users.12 This can partly be explained by the unique nature of the
TABLE 2  Linear regression associations between groups of adults with hearing impairment and psychosocial health

|                     | Model 1 |                     | Model 2 |                     | Model 3 |                     |
|---------------------|---------|---------------------|---------|---------------------|---------|---------------------|
|                     | B       | 95% Confidence Interval | P-value | B       | 95% Confidence Interval | P-value | B       | 95% Confidence Interval | P-value |
| Emotional loneliness<sup>d</sup> |         |                      |         |         |                      |         |         |                      |         |
| CI users<sup>a</sup> | Reference |                     |         | Reference |                      |         | Reference |                      |         |
| HA users<sup>b</sup> | 1.26   | 0.14 – 2.39          | .028    | 1.51   | 0.33 – 2.68          | .012    | 1.74   | 0.56 – 2.93          | .004    |
| Hearing-impaired<sup>c</sup> | 0.86 | –0.29 – 2.02        | .143    | 1.33   | 0.07 – 2.59          | .038    | 1.69   | 0.41 – 2.98          | .010    |
| Social loneliness<sup>d</sup> |         |                      |         |         |                      |         |         |                      |         |
| CI users<sup>a</sup> | Reference |                     |         | Reference |                      |         | Reference |                      |         |
| HA users | 0.49  | –0.75 – 1.72          | .439    | 0.61   | –0.69 – 1.90         | .357    | 0.99   | –0.31 – 2.29         | .134    |
| Hearing-impaired | 0.44  | –0.82 – 1.71          | .492    | 0.68   | –0.71 – 2.07         | .339    | 1.15   | –0.25 – 2.56         | .107    |
| Anxiety<sup>de</sup> |         |                      |         |         |                      |         |         |                      |         |
| CI users<sup>a</sup> | Reference |                     |         | Reference |                      |         | Reference |                      |         |
| HA users | 1.18  | 0.92 – 1.50          | .193    | 1.23   | 0.95 – 1.59          | .121    | 1.30   | 1.01 – 1.68          | .046    |
| Hearing-impaired | 1.08  | 0.84 – 1.39          | .549    | 1.15   | 0.87 – 1.51          | .326    | 1.23   | 0.93 – 1.62          | .153    |
| Depression<sup>de</sup> |         |                      |         |         |                      |         |         |                      |         |
| CI users<sup>a</sup> | Reference |                     |         | Reference |                      |         | Reference |                      |         |
| HA users | 1.13  | 0.84 – 1.53          | .405    | 1.18   | 0.87 – 1.61          | .288    | 1.22   | 0.89 – 1.67          | .213    |
| Hearing-impaired | 1.05  | 0.77 – 1.42          | .770    | 1.16   | 0.83 – 1.62          | .376    | 1.21   | 0.86 – 1.70          | .269    |
| Distress<sup>d</sup> |         |                      |         |         |                      |         |         |                      |         |
| CI users<sup>a</sup> | Reference |                     |         | Reference |                      |         | Reference |                      |         |
| HA users | 0.48  | –0.27 – 1.24         | .212    | 0.62   | –0.17 – 1.41         | .124    | 0.65   | –0.14 – 1.44         | .108    |
| Hearing-impaired | 0.21  | –0.57 – 0.99         | .592    | 0.54   | –0.31 – 1.39         | .216    | 0.58   | –0.27 – 1.43         | .183    |
| Somatisation<sup>d</sup> |         |                      |         |         |                      |         |         |                      |         |
| CI users<sup>a</sup> | Reference |                     |         | Reference |                      |         | Reference |                      |         |
| HA users | 0.15  | –0.46 – 0.76         | .627    | 0.14   | –0.50 – 0.78         | .661    | 0.27   | –0.37 – 0.92         | .404    |
| Hearing-impaired | 0.38  | –0.25 – 1.01         | .235    | 0.50   | –0.18 – 1.19         | .151    | 0.65   | –0.04 – 1.34         | .067    |

Model 1, unadjusted; Model 2, adjusted for SRT score; Model 3, adjusted for age, sex, education, SRT score and duration of hearing loss. Significant associations are highlighted in bold (P < .05).

Self-reported hearing groups: <sup>a</sup> cochlear implant (CI) users, <sup>b</sup> hearing aid (HA) users, without CI, and <sup>c</sup> adults with hearing impairment, without CI or HA. <sup>d</sup>Please note that all psychosocial health outcomes were recalculated to a score ranging from 0 (best outcome) to 10 (worst outcome).<sup>e</sup> Anxiety and depression have been transformed (LN) for regression; the numbers presented are back-transformed coefficients and confidence intervals.

select group of adults with a CI. For example, to receive a CI, one must meet a number of strict candidacy criteria, and one must be sufficiently motivated and supported to undergo surgery and to enter the rehabilitation programme. People who experience severe emotional loneliness might lack the level of social support that is needed to be eligible for implantation. It may be that the process of rehabilitation after implementation itself influenced adults’ feelings of emotional loneliness, as this is a very intense and time-consuming trajectory in which an intimate partner or friend is mostly highly involved.

In addition, people who underwent cochlear implantation have in general received more hearing care than hearing-impaired people fitted with hearing aids. Receiving care and support can in itself have a strong positive influence on emotional loneliness. Moreover, optimising the use of a CI usually requires intensive training and interaction with healthcare professionals to fine-tune the settings of the device. This training and supervision might make CI users more attuned to their device than HA users, and therefore probably result in more positive outcomes. It should be noted, however, that improvements in psychosocial health post-implantation are not always correlated to improved audiological performance.

It is important to note that until adult CI users get their device implanted, they already have had a long patient journey in audiology, as they have usually worn hearing aids first or used other hearing technologies until implantation. The CI users in our sample were on average 57 years old and their mean duration of CI use was 5 years, which means that they received their CI at an already advanced age. It is possible that after years of hearing impairment (on average 34 years), they may have accepted their situation and adapted to it. It is important to note that until adult CI users get their device implanted, they already have had a long patient journey in audiology, as they have usually worn hearing aids first or used other hearing technologies until implantation. The CI users in our sample were on average 57 years old and their mean duration of CI use was 5 years, which means that they received their CI at an already advanced age.
about the success of implantation may be partly related to psychosocial health. If their hearing ability after cochlear implantation was even better than expected, then their new situation with CIs and a relatively good hearing ability might be regarded as very satisfactory. For some adults, CI serves as a way to “coming back to life.” Yet another explanation for the CI users being less emotional lonely than their hearing-impaired peers (with or without hearing aids) may be their stable hearing status post-implantation. This is in stark contrast to the hearing status of people with hearing loss with or without HAs. It is most likely that their hearing status further declines with age. Whereas it would be expected that this particular aspect of a CI (ie no further decline in hearing status) would have had positive effects on the other psychosocial outcomes such as anxiety, depression, somatisation, distress and social loneliness as well, this was not found in the current study. The absence of significant findings for these outcomes may be due to the small number of CI users in the current study.

4.3 | Limitations of the study

The relatively small number of CI users in this sample may have prevented us from demonstrating more significant differences. It may be that inconsistent CI use influences psychosocial health. However, information about the average CI use was not assessed in our study and thus not available. Another limitation is that adults with a CI are a heterogeneous group, making it hard to generalise the current findings to the entire population of adults with a CI. Moreover, this study presents cross-sectional analyses, which might make it unsuitable to pick up on effects that are dependent on the time after implantation. Some positive psychosocial effects of CI use are known to be mainly in the short term while effects on assertiveness and marital satisfaction become apparent only after long-term implant use. Further prospective studies comparing different rehabilitation trajectories in adults with comparable hearing difficulties at baseline are, therefore, recommended.

5 | CONCLUSION

Even though CI users’ (aided) hearing status was significantly worse than that of their hearing-impaired peers, with or without hearing aids, their psychosocial health status was similar or even better. This indicates that the known association between degree of hearing impairment and psychosocial health cannot be considered linear at least not in adult CI users. Even after adjustment for degree of hearing impairment, the level of emotional loneliness was significantly lower in CI users than in HA users. The most likely explanation for

| TABLE 3 | Linear regression associations between hearing groups (normally hearing vs CI users) and psychosocial health |
| --- | --- |
| | Model 1 | Model 2 |
| | B | 95% Confidence Interval | P-value | B | 95% Confidence Interval | P-value |
| Emotional loneliness<sup>c</sup> | CI users<sup>d</sup> | Reference | Reference |
| Normally hearing<sup>b</sup> | 0.89 | −0.16 – 1.95 | .097 | 0.97 | −0.10 – 2.05 | .076 |
| Social loneliness<sup>e</sup> | CI users | Reference | Reference |
| Normally hearing | 0.38 | −0.84 – 1.60 | .540 | 0.73 | −0.50 – 1.97 | .244 |
| Anxiety<sup>d</sup> | CI users | Reference | Reference |
| Normally hearing | 1.00 | 0.79 – 1.25 | .981 | 1.06 | 0.84 – 1.33 | .648 |
| Depression<sup>d</sup> | CI users | Reference | Reference |
| Normally hearing | 1.03 | 0.79 – 1.34 | .852 | 1.03 | 0.79 – 1.36 | .819 |
| Distress<sup>c</sup> | CI users | Reference | Reference |
| Normally hearing | 0.10 | −0.63 – 0.82 | .788 | 0.17 | −0.56 – 0.89 | .651 |
| Somatisation<sup>f</sup> | CI users | Reference | Reference |
| Normally hearing | −0.18 | −0.71 – 0.35 | .514 | 0.03 | −0.49 – 0.55 | .901 |

Model 1, unadjusted; Model 2, adjusted for age, sex and education.
Self-reported hearing groups: <sup>c</sup>cochlear implant (CI) users, <sup>b</sup>normally hearing adults.
<sup>d</sup>Please note that all psychosocial health outcomes were recalculated to a score ranging from 0 (best outcome) to 10 (worst outcome).
<sup>e</sup>Anxiety and depression have been transformed (LN) for regression; the numbers presented are back-transformed coefficients and confidence intervals. Significant associations are highlighted in bold (P < .05).
this result is that CI patients receive more professional and family support, and guidance along their patient journey than adults who are fitted with hearing aids. Our findings suggest that to prevent emotional loneliness in people fitted with hearing aids, it may be relevant to consider a more comprehensive rehabilitation pathway like in CI rehabilitation, including speech communication or auditory training, training of hearing tactics or even taking a more family-centred approach in hearing aid rehabilitation.\textsuperscript{24,25}

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**CONFLICT OF INTERESTS**

None declared.

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**REFERENCES**

1. Clark JH, Yeagle J, Arbaje AI, Lin FR, Niparko JK, Francis HW. Cochlear implant rehabilitation in older adults: literature review and proposal of a conceptual framework. *J Am Geriatr Soc*. 2012;60:1936-1945.
2. Berrettini S, Baggiani A, Bruschini L, et al. Systematic review of the literature on the clinical effectiveness of the cochlear implant procedure in adult patients. *Acta Otorhinolaryngol Ital*. 2011;31:299-310.
3. Bond M, Mealings S, Anderson R, et al. The effectiveness and cost-effectiveness of cochlear implants for severe to profound deafness in children and adults: a systematic review and economic model. *Health Technol Assess*. 2009;13:1-330.
4. Aimoni C, Ciorda A, Hatzopoulos S, et al. Cochlear implants in subjects over age 65: quality of life and audiological outcomes. *Med Sci Monitor*. 2016;22:3035-3042.
5. Cohen SM, Labadie RF, Dietrich MS, Haynes DS. Quality of life in hearing-impaired adults: the role of cochlear implants and hearing aids. *Otologyngol Head Neck Surg*. 2004;131:413-422.
6. Kunimoto MY, Yamana N, Kimura T, et al. The benefit of cochlear implantation in the Japanese elderly. *Auris Nasus Larynx*. 1999;26:131-137.
7. Nachtgeaal J, Smit JH, Smits C, et al. The association between hearing status and psychosocial health before the age of 70 years: results from an internet-based national survey on hearing. *Ear Hear*. 2009;30:302-312.
8. Pronk M, Deeg DJ, Smits C, van Tilburg TG, Festen JM, Kramer SE. Hearing loss in older persons: does the rate of decline affect psychosocial health? *J Aging Health*. 2014;26:703-723.
9. Poissant SF, Beaudoin F, Huang J, Brodsky J, Lee DJ. Impact of cochlear implantation on speech understanding, depression, and loneliness in the elderly. *J Otolaryngol Head Neck Surg*. 2008;37:488-494.
10. Manrique-Huarte R, Calavia D, Irujo AH, Giron L, Manrique-Rodriguez M. Treatment for hearing loss among the elderly: auditory outcomes and impact on quality of life. *Audiol Neurootol*. 2016;21:29-35.
11. Mo B, Lindbaek M, Harris S. Cochlear implants and quality of life: a prospective study. *Ear Hear*. 2005;26:186-194.
12. Choi JS, Betz J, Li L, et al. Association of using hearing aids or cochlear implants with changes in depressive symptoms in older adults. *JAMA Otolaryngol Head Neck Surg*. 2016;142:652-657.
13. Contrera KJ, Sung YK, Bets J, Li L, Lin FR. Change in loneliness after intervention with cochlear implants or hearing aids. *Laryngoscope*. 2017;127:1885-1889.
14. Stam M, Smit JH, Twisk JR, Lempke U, Smits C, Festen JM, Kramer SE. Change in psychosocial health status over five years in relation to adults’ hearing. *Ear Hear*. 2016;37(6):680-689.
15. Smits C, Kapteyn TS, Houtgast T. Development and validation of an automatic speech-in-noise screening test by telephone. *Int J Audiol*. 2004;43:15-28.
16. De Jong Gierveld J, Kamphuis F. The development of a rasch-type loneliness scale. *Appl Psychol Meas*. 1985;9:289-299.
17. Terluin B, Van Rhenen W, Schaafel WB, De Haan M. The four-dimensional symptom questionnaire (4DSQ): measuring distress and other mental health problems in a working population. *Work Stress*. 2004;18:187-207.
18. Lakey B, Orehek E. Relational regulation theory: a new approach to explain the link between perceived social support and mental health. *Psychol Rev*. 2011;118:482-495.
19. Knutson JF, Murray KT, Husarek S, et al. Psychological change over 54 months of cochlear implant use. *Ear Hear*. 1998;19:191-201.
20. Maki-Torkko EM, Vestergren S, Harder H, Lyxell B. From isolation and dependence to autonomy - expectations before and experiences after cochlear implantation in adult cochlear implant users and their significant others. *Disabil Rehabil*. 2015;37:541-547.
21. Chen SK, Karamy B, Shipp D, Nedzelski J, Chen J, Lin V. Assessment of the psychosocial impacts of cochlear implants on adult recipients and their partners. *Cochlear Implants Int*. 2016;17:90-97.
22. Hallberg LRM, Ringdahl A. Living with cochlear implants: experiences of 17 adult patients in Sweden. *Int J Audiol*. 2004;43:115-121.
23. Hilly O, Hwang E, Smith L, et al. Cochlear implantation in elderly patients: stability of outcome over time. *J Laryngol Otol*. 2016;130:706-711.
24. Grenness C, Meyer C, Scarinci N, Ekberg K, Hickson L. The international classification of functioning, disability and health as a framework for providing patient- and family-centered audiological care for older adults and their significant others. *Semin Hear*. 2016;37:187-199.
25. Meijerink JF, Pronk M, Paulissen B, et al. Effectiveness of an online Support Programme (SUPR) for older hearing aid users: study protocol for a cluster randomised controlled trial. *BMJ Open*. 2017;7:e015012.

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