Title:

Using the International Classification of Functioning, Disability and Health (ICF) Model to Gain Insight into the Impact of Cochlear Implants on Prelingually Deafened Recipients

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Short version of title:

ICF Model Applied to Prelingual CI Recipients

ABSTRACT

A number of factors influence the quality of life of deaf individuals following cochlear implantation. In this study, we adapted the ICF model to create a survey to specifically fit Cochlear Implant (CI) users. This enabled us to make a novel comparison and correlation among multiple factors and categories between two groups: a high and low score group in response to survey questions. The objective of this study was to determine the broader effects that cochlear implantation has on adults with prelingual deafness. Using the WHO-ICF model, in addition to previous quality of life studies as a framework, a 65-item survey (modified ICF Checklist) was created and sent out to 71 participants. From there, outcome measures were categorized as follows: 1) Activities, Participation and Personal Factors, 2) Hearing Activities, and 3) Environmental Factors. The results of this study clearly show that the quality of life of adults with prelingual deafness improved after cochlear implantation. More specifically, this study showed overall improvements in one-on-one conversations, family relationships, enjoyment in music, safety, self-esteem/confidence, overall happiness, quality of life, and level of independence. Second, this study highlighted the impact of support from family, health professionals and friends on the overall benefits received from CIs. Finally, this study showed that based on comparing two groups with high and low survey scores there is an evident trend seen between the outcome categories wherein an improvement in one outcome category showed improvements in the other two outcome categories.

INTRODUCTION

Previous research has found that adults with prelingual deafness often have limited speech recognition gains from CIs (Millette, Gobeil, Bherer & Duchesne, 2011). Furthermore, neuronal networks for speech sound processing have been evaluated in prelingually deafened individuals using positron emission tomography. The findings indicate that prelingually deafened individuals may not completely develop these networks even after implantation, since the majority of the speech acquisition period has past, as compared to postlingually deafened individuals and normal hearing individuals (Naito et al., 1997). This suggests that using speech recognition as a primary outcome measure may not be a full representation of the positive impact that a CI can have on this population including their enhanced ability to participate effectively in society (Zwolan, Kileny & Telian, 1996). Using broader outcome measures, such as sense of security and participation in hearing society to assess the effects CIs have on recipients' lives may paint a fuller picture (Millette et al., 2011). For example, one of the broader measures that can be considered is the International Classification of Functioning, Disability and Health (ICF) model (World Health Organization [WHO], 2001). The ICF is a model whereby participation, activities, environmental factors and personal factors are used to quantitatively measure and determine the barriers and facilitators that go hand in hand with the disability (Peterson, 2005).

The WHO established the ICF model in 2002 in the domain of healthcare products and services. The intention of this model was to provide a common language across health disciplines and has been endorsed as a framework that organizes outcome measures and goal setting (Hill et al., 2009). The decision to use the WHO-ICF model has at its core a goal to create a means to consistently compare data between centers and even countries. It is believed that the ICF may “likely become the generally accepted framework to describe functioning in rehabilitation” (Stucki et al., 2002, p. 281). Given its application to rehabilitation, it may be a good fit for deafened individuals, particularly CI recipients. Using the WHO-ICF model can allow practitioners and clinicians to identify the variables that are restricting participation and can provide a more all-encompassing description of functioning and health.

Initially, CIs were only given to postlingually deafened adults with profound hearing loss. It was not until the mid-90s, due to advancements in technology, that candidacy expanded to children and adults with prelingual hearing loss. Ali & O’Connell (2007) reviewed the literature and found that in general prelingually deafened children benefited from cochlear implantation at an earlier age, but that no additional benefits were found before the age of 12 months. That being said, some benefits may exist if implanted earlier. The early implantation allows for children to develop auditory skills at an earlier chronological age and improves their effectiveness of communication. Prelingually deafened adults have either been born with profound hearing loss or have acquired profound hearing loss before or during speech development (which can be considered between 1 and 4 years old). Without CIs, over 90% of children with prelingual deafness fail to develop good speech production and comprehension (Margolis, 2001|). Additionally, Margolis (2001) found that if people with profound hearing loss did not develop a concrete language base before 10 years old, they were limited in the development of more abstract language and often ended up using sign-language as adults. This differs from postlingually deafened adults in that they have acquired hearing loss after the development of speech and oral language. The potential benefits of CIs in prelingually deafened adults were still very controversial after the benefits of CIs in postlingually deafened adults were relatively well-established (Banfai et al., 1988). Specifically, Banfai et al. (1988) questioned whether or not prelingually deafened adults: a) had mature enough auditory tracts and auditory centers to accommodate CIs, b) required technology/rehabilitation adaptations, and c) would receive benefits to improve their quality of life.

An early study by Banfai, Karczag, & Luers (1984) described some of the benefits CIs have for prelingually deafened adults, including improvements in their integration into society and their understanding of language. Still, speech perception improvements in postlingually deafened recipients remains significantly higher than in prelingually deafened recipients with a high amount of individual variation among people with prelingual hearing loss (Teoh, Pisoni, & Miyamoto, 2004). However, the measured objective benefits after CIs may not fully represent the subjective benefits perceived by the prelingually deafened CI recipients. Waltzman, Cohen, & Shapiro (1992) reported that despite a lack of objective auditory gains, prelingually deafened CI recipients perceived significant improvement in their quality of life and auditory skills. Additionally, Klop, Briaire, Stiggelbout, & Frijns (2007) found a significant improvement in the quality of life of prelingually deafened adults post-cochlear implantation. Clearly, using a more holistic approach to the effects of CIs will help shed light on the discrepancy between objective and subjective benefits.

Chee et al. completed a comprehensive study in 2004 whereby a survey was used to evaluate several areas post-cochlear implantation including but not limited to: employment (changes, reactions), confidence in communication, telephone use, one-on-one conversation, dependence, safety and social life. The results, while somewhat unclear, indicated positive results regarding employment changes and telephone ability; more confidence effectively communicating with others; lowered levels of dependency; and increased feelings of personal safety. In addition to these factors, Chee et al. (2004) also included a list of subjective advantages and disadvantages of the CIs. These provided an observable pattern of responses, which were included in the current survey. The Chee et al. (2004) study provided a solid foundation from which to pull information; however, it was unclear how and why the researchers chose the factors that they did, making it somewhat difficult to replicate. Additionally, a longitudinal study by Kaplan & Puterman (2010) evaluated the long-term outcomes of prelingually deafened pediatric CI recipients. What they found was that these patients end up having a rate of employment that is comparable to the general population. However, these individuals tended to be less satisfied as a result of either a personal belief or a belief from the parents that their communication skills are still compromised due to hearing impairment.

At this time, there are five relevant articles that can be found using the ICF model in hearing impairment populations (Stephens, Vetter, & Peter, 2003; Smiley, Threats, Mowry & Peterson, 2005; Hickson & Scarinci, 2007; Kennedy, Stephens, & Fitzmaurice, 2008; Scarinici, Worrall, & Hickson, 2009). In a paper by Smiley et al. (2005), the authors discuss two case studies and go into great detail separating each of the four components of the WHO-ICF model, as it relates to individuals who are deaf or hard of hearing including: 1) body functions, 2) body structures, 3) activities/participation, and 4) environmental factors. This study is relevant as it gives a clear description of what aspects to include in each category.

Kennedy et al. (2008) sought to identify the impact of CIs in adults from the perspective of their significant others in the context of the WHO-ICF model. Using open-ended questions, significant others indicated the benefits and shortcomings that they perceived in the CI recipient since the cochlear implantation, as well as to comment on any benefits or shortcomings that the significant other had noticed. The responses were then categorized into activities, participation, and environmental factors. In the end, it was found that the most common perceived benefit affecting the CI users were increased confidence, happiness, coping and decreased isolation. Additionally, the CIs seemed to have an effect on the quality of the relationship. More specifically, there was a reduced sense of burden, both in general and in terms of communication on the part of the significant other. Finally, there was an increased sense of independence in addition to increased participation in daily and social activities.

By using the WHO-ICF model as a framework, the current study will use widely accepted standards of different variables that effect a specific population. It may help to determine validity of findings with regards to satisfaction as it relates to personal beliefs or others' beliefs. The current study narrows in on the intervention portion of the prelingually deafened population, by-passing the body functions and structures and focusing on the activities/participation, personal factors and environmental factors. The aforementioned studies all highlight the importance of a systematic method of classifying and representing the psychosocial aspects of individuals living with hearing loss.

The aim of the present study is to identify and gain insight into the full scope of the benefits of CIs using the ICF model in prelingually deafened recipients. Specifically, we looked into the activity execution and limitations; the involvement and restrictions in life situations;

the facilitators and barriers in the environment; and any personal factors that may influence outcomes. It was predicted that the prelingually deafened CI recipients in this study would report improved activities and participation compared to what they remember of their pre-implant status. More specifically, due to the results from some of the aforementioned studies, it is believed that quality of life would have an overall improvement. In addition, we attempted to separate subjects into two groups: one with better overall scores, and the other with poorer overall scores. This provided an opportunity to see whether there are any existing trends *between* the categories as well. This paper is an important stepping stone into creating a unified framework with which to assess potential CI recipients and predict their outcome beyond speech recognition.

MATERIALS AND METHODS

Participants

The records of all adult CI recipients implanted at Glenrose Rehabilitation Hospital in Edmonton, Alberta, were reviewed. Patients that met the following criteria were contacted for the study: 1) had severe or profound hearing loss before the age of four, 2) received their CI or implants after the age of seven, and 3) were over the age of 18. Using this criterion, seventy-one potential participants were mailed packages containing: 1) Information Letter, 2) Consent Form, and 3) 60-item questionnaire. On the questionnaire, participants were given the option to indicate interest in participating in a 15-minute telephone/TTY interview, and/or a 45-minute personal interview. Eight people responded out of the 71 people that were contacted within the allotted time frame for a response rate of 11.2%. Of these, 3 (37.5%) of respondents were male and 5 (62.5%) were female. The mean age of participants was 45.5 years, with a range of

21-70 years. The average number of years post-cochlear implantation of the respondents was 8.2 with a range of 4 to 13. Seventy-five percent of the participants were married and 25% were never married. Regarding occupations, 3 participants had paid employment, two were self-employed, one had non-paid work (e.g. volunteering), one had retired, and one was a housewife. Two people were involved in the TTY/Online-Text interviews and one person was involved in a personal interview.

Ethical considerations

When initially contacted, participants were given a cover letter informing them that they were free to choose not to participate. Additionally, a more comprehensive Information Letter was provided which included details regarding confidentiality, voluntary participation, possible benefits and risks, as well as a written consent which included potential for interview participation. For the telephone and personal interviews, participants were asked for additional verbal consent and were informed that the interview could be terminated at their request at any time.

Data collection and analysis

The questionnaire consisted of 60 multiple-choice questions, 4 close-ended questions (e.g., age, years of formal education, etc.), and 1 open-ended question. The majority of the 37 items in the Activities, Participation and Personal Factors section of the questionnaire came directly from the WHO-ICF checklist (51%), others are based on research papers (27%), and the rest came from clinical expertise working with CI recipients (22%). The findings discussed in this section are based on Table 1 (1a, left columns) at the end. Outcome measures were divided into 1) Activities, Participation and Personal Factors, 2) Hearing Activities, and 3) Environmental

Factors. Data from these categories were analyzed for all participants together, as well as between two groups. The division of these two groups was determined by adding up all of the scores from the survey categories. Each response was given a numerical score from 0-5. Each category had a different number system – for the Activities and Participation section, the values were given as such: 1 = Worse, 2 = Unchanged, 3 = Slightly Better, 4 = Better and 5 = Much Better. In the Hearing Activities category, points were awarded on a scale of 1-4 where 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often. For the Environmental Factors category, this was a 3-point scale with 1 = Had No Effect, 2 = Made It Slightly Easier, 3 = Made It Significantly Easier. “No Response” was awarded a zero for every category. By tallying the scores, we were able to determine the median score and further separate the participants evenly into either the higher or lower overall score category. These two groups will be referred to as “High Scores” and “Low Scores” from here on out. Participant responses from the survey were tallied and qualitatively analyzed. Transcripts from the TTY/Online-Text and personal interview were recorded and scrutinized for patterns and common themes among the responses. Interview questions can be found in Appendix 1.

RESULTS

Activities, Participation and Personal Factors

Changes in Quality.

The purpose of this section was to determine the types of activities, personal factors, and level of participation in various groups/communities that have changed since receiving a CI. Participants were asked to describe the degree of change by responding as ‘worse’, ‘unchanged’, ‘slightly better’, ‘better’, and ‘much better’.

The first thing to note that is of importance is that 29 out of the 37 items listed in the Activities and Participation section had a combined total ≥ 50% of the responses in the 'better' and 'much better' categories. This equates to an improvement in 78% (29/37) of the activities and participation selected for this survey upon receiving a CI. The eight items that did not fit this criteria were as follows: B5) Producing non-verbal messages (e.g. gestures), B7) Conversations in a noisy environment, B8) Conversations with multiple speakers, B9) Telephone use, B22) Intimate relationships, B25) Religion and spirituality, B26) Political life and citizenship, and B30) Participation in deaf community. Out of the eight items that did not get ≥ 50% of the responses in the 'better' and 'much better' categories, there were some very interesting trends. Particularly, three of those categories received the majority (≥ 50%) of the responses in the 'unchanged' category. These categories were B22) Intimate relationships, B26) Political life and citizenship, and B30) Participation in the deaf community. Responses received during the personal interview and the TTY interviews elaborated on B30:

> *"Before implant, I hardly fit into the hearing world, so I leaned towards deaf community for support and communication, but I don't need to do that now."*
>
> *"I've been through all the classes with Deaf people, you know? And I don't know how they react to the hearing because sometimes they can't talk. They have to use sign-language or they have to read lips and write something down to talk, to communicate. That really wasn't my thing."*

When we delve deeper into the analysis, there were eight items in this section that had ≥ 50% in the "much better" category. Those categories are as follows: B11) One-on-one conversations, B21) Family relationships, B27) Enjoyment in music, B32) Safety, B33) Self-esteem/confidence, B35) Overall happiness, B36) Quality of life, and B37) Level of independence. Again, the personal interview and telephone interviews provided some further insight on a few of these items:

> *(B11) "The main thing is I became a much more social person, A LOT less scared to just approach a stranger, or anyone I know, especially at work, i.e. I am not avoiding people anymore. This was the biggest barrier for me as communication is so much easier now, I don't have to worry about missing too much when I don't understand a person. I can just ask them to repeat what they said once, not 4 times, or not have to ask to write it down for me."*

> *(B21) "I'm having more people in my life right now. I made a lot of friends when I got my CI. When I got my CI put inside me and two years later I'm starting to make friends because I am able to hear them. I am able to communicate back and forth. You know they were talking to me with my hearing aid, they always talk when I'm looking away, and I don't even like don't even catch it, you know? But now, it's a big difference with my friends and family."*

> *(B33) "I definitely don't feel isolated any more. I used to fear going to a doctor by myself without sign language interpreter and fear talking to people or asking for help at the store to find something, etc. Now I don't need any help from interpreters at all. Haven't used one since implanted in [year]. I used to just keep to myself if I walked into a pet shop, or something, but now I go and if I see someone I know, I won't avoid them, even if it is a stranger I start yakking like no big deal. No way I would have been able to do that without implant."*

Table 1b demonstrates the distribution of scores for every category found in the Activities and Participation section. In this table, it is clear to see that although these participants scored well overall, they still were not happy with one question in particular, which was the only question in this category that had a “worse” score. That question is B30) Participation in the deaf community. One interesting thing to note is that these four participants who scored higher overall turned out to have 100% of the scores in the “much better” category for two questions: B27) Enjoyment in music, and B33) Self-Esteem/Confidence. In contrast to Table 1b, Table 1c has four questions with responses in the “worse” category: B7) Conversations in a noisy environment, B8) Conversations with multiple speakers, B9) Telephone use, and B25) Religion and spirituality. Furthermore, not a single question had more than 50% of the responses in the “much better” category.

By conducting a further mathematical analysis of the number of total responses to the activities and participation items, a new light is cast upon the data (Table 4). The number of total responses to the “Much Better” category in Table 1b was tallied and found to be 71. Comparatively, 77 was the total value of the responses of the combination of “No Response, Worse, Unchanged, Slightly Better, and Better” in Table 1b. In contrast, the total for Table 1c was found to be 14 and 134, respectively. The ratio of 71/77 for Table 1b is 0.92; while for Table 1c the ratio is 0.1 (14/134). It is clear that the ratio in Table 1b regarding the High Scores group (0.92) is greater than ratio in Table 1c from the Low Scores group (0.1). The trend is evident although, due to small sample size, no statistical analysis can be identified that is able to perform quantitative analysis.

Frequency of Activities.

Table 2a displays how often participants partook in some specific activities post-cochlear implantation. The activities with the highest frequency were one-on-one conversations, group conversations, conversations in a noisy environment, and music related activities. Although the quantity of participation in these activities is high, the quality may leave something to be desired as one participant described that they still wish they could improve their “understanding of a voice on a CD/song”. The activities with the lowest frequency were telephone conversations and computer training to increase oral language skills. Though most participants reported using the telephone infrequently, one participant reported that they “talk on the phone all the time.” Another participant also reported having conversations more frequently on the phone post-CI:

> *“For the phone, definitely big change there, although I can't understand voice without lip reading, maybe 30% and depends on who I am talking with, I can talk to my family in [my native language] no problem over the phone, no lip reading. So after implant, the very first time I called my mom and dad, I spoke to them no problem I understood 100%. Mom and dad cried when they heard my voice over the phone as it was a surprise for them, they never heard my talking on the phone with them as I was never able to do that with my hearing aids. In English it is a bit harder as it is my second language, but depending on the person, I can perhaps understand maybe 30 to 50% depending how the person's voice is like, and women tend to be a lot easier to understand than men. However, strange is that I can hear the automated voice mail response when person cannot come to the phone, I can understand 100%.”*

Table 2b and Table 2c contrast the similarities and differences between the High Scores group and the Low Scores group of the frequency of hearing activities with participants that had an overall high score on total responses with participants that had an overall low score. Both groups reported participating in music-related activities, one on one conversations, group conversations, and conversations in noisy environments more frequently than the other activities. One of the subtle differences between the groups is that the group with the overall high score reported to participate in telephone conversations more and computer-training to increase oral language skills less than the group with the overall low scores. A deeper analysis can be conducted analyzing the number of total responses to the hearing activities items further (Table 4). The number of total responses to the "Often" category in Table 2b was tallied and found to be 19. Comparatively, 5 was the total value of the responses of the combination of "Never, Rarely, and Sometimes" in Table 2b. In contrast, the total for Table 2c was found to be 16 and 8, respectively. The ratio of 19/5 for Table 2b is 3.8; while for Table 2c the ratio is 2 (16/8). It is clear that the ratio in Table 2b regarding the High Scores group (3.8) is greater than ratio in Table 1c from the Low Scores group (2.0). The differences between two groups are 1.8 in ratio (3.8-2) and 6 in difference (14-8).The trend is evident although, due to small sample size, no statistical analysis can be identified that is able to perform quantitative analysis.

Job Satisfaction.

For this subsection, 25% of participants stated that questions about job satisfaction were not applicable since one participant was a stay-at-home mom and the other was retired. Of the 75% of participants that did respond, 83% stated that their job had improved since receiving their CI as one participant described: "The same workplace before implant, same people, I am a lot more comfortable talking to them too and working with them." Another participant also described the positive impact the CI had on his employment: "I am full time farmer that is my full time employment. In spring to fall it is easier now but now in winter time I take CI out before going outside because too cold for implant." Additionally, 50% of participants stated that their current job was different from the job they had before they had a CI. Of these participants, 63.3% indicated that this change was related to their CI.

CI Expectations.

For this subsection, seven of the eight participants responded. Participants were asked to describe their level of expectation with their CI as high, medium or low. Seventy-one percent of participants stated they had high expectations for their CI, and 29% of participants stated they had medium expectations. One-hundred percent of participants said that their CI matched their expectations. When asked to provide an explanation of how their CI met their expectations, participants fell into three categories: those whose expectations were surpassed; those whose expectations were fully met; and those whose expectations were only partially met. One participant who expectations were surpassed described that she "expected [her CI] to be only a little better than [her] hearing aid, but [that] it is a lot better". Another participant whose expectations were fully met described that, "It is a big difference in my life. I can hear very well with my CI and they pick up the specific sounds for me. I don't have to read lips anymore. I can hear very well." However, not needing to rely on lip-reading was not consistent among participants as another participant whose expectations were only partially met described, "It only matched my expectation to a certain degree, I was hoping not to have to rely as much on lip-reading."

Environmental Factors.

The purpose of this section was to determine how certain support and attitudes affected participants' experience with cochlear implantation indicating whether they made it harder, easier or if there was no effect. Table 3a shows the ratings of the impact of these environmental factors. For all categories in this section, all participants rated that different attitudes and supports either had no effect, made their experience slightly easier or made their experience much easier. Additionally, support was rated overall higher than attitudes. Support from family was rated the highest, followed by health professional support, friend support and acquaintance support, whereby a friend can be defined as a person who you like and enjoy being with or who helps or supports someone or something (Merriam-Webster's online dictionary, n.d.), whereas an acquaintance is someone who is known but who is not a close friend (Merriam-Webster's online dictionary, n.d.). One participant described the support from their family as:

> *"Family yes, they were very supportive, although they expected miracle right off the bat, they were there for my surgery and for my first activation, and still support me when I talk over the phone with them by saying things like you are doing better, or worse, then I know I need to go for tune up."*

Friends were also found supportive as described here: "People at work were great too, they didn't have the demands that I thought they might have, i.e. like they might have thought I would become hearing right away, this was the best I could get, not too much expectations." Another participant described the support from acquaintances: "Yes, I feel like whenever I need support, there's always support…people help me to get through. It's when they know that I don't understand them, they'll make me repeat it."

Table 3b and Table 3c contrast the similarities and differences of environmental factors with participants in the High Scores group and Low Score group. Overall, the High Scores group with overall higher scores reported that support from all avenues (family, friends, acquaintances, and health professionals) and attitudes made their experience easier compared to the group with lower scores. Further analysis of the data can be conducted by analyzing the number of total responses to the environmental factor items further (Table 4) The number of total responses to the "Made it much easier" category in Table 3b was tallied and found to be 29. Comparatively, 7 was the total value of the responses of the combination of "No effect, Made it slightly easier" in Table 3b. In contrast, the total for Table 3c was found to be 12 and 24, respectively. The ratio of 29/7 for Table 3 (3b is 4.1; while for Table 3c the ratio is 0.5 (12/24). It is clear that the ratio in Table 3b regarding the High Scores group (4.1) is greater than ratio in Table 3c from the Low Scores group (0.5). The trend is evident although, due to small sample size, no statistical analysis can be identified that is able to perform quantitative analysis.

DISCUSSION

World Health Organization ICF

Based on previous studies involving adults with prelingual deafness and not using the ICF model, we predicted that, from what participants remember from their pre-implant state, there would be an increase in participation and activities including improved communication, social skills, relationships and work performance after receiving their CIs (Klop et al., 2007; Most, Shrem & Duvdevani, 2010; Teoh et al., 2004; Waltzman et al., 1992). In this study we found that these predictions were mostly met. This is an important study as it contributes to the current knowledge-base of the broader effects that cochlear implantation can have on recipients. As well, to the best of our knowledge, our report appears to be first study to apply the WHO ICF model to prelingually deafened adults.

Family Relationships and Self-Esteem/Confidence

In this study, family relationships and self-esteem/confidence were areas in which 50% or more of the participants described as ‘much better’ following cochlear implantation. These results are somewhat contradictory to the results found in a study by Most et al. (2010) who surveyed thirty-eight adult participants with prelingual deafness before and after implantation as adults to determine whether there was a change in the following variables: communication, family relations, social skills, academic and work performance, general satisfaction, loneliness and self-esteem. Results of that study indicated a significant increase in function and satisfaction in all areas except family climate and self-esteem. One potential explanation for the discrepancy found between the results of self-esteem between the studies could be the number of years post-implantation. The current study had an average of 8.2 years post cochlear-implantation whereas the participants in the study by Most et al. (2010) may have had their CIs for a shorter amount of time, although it is unclear how much time that was. The only reported information about the CI duration by Most et al. (2010) was that most participants had a minimum of six months of usage experience with the CI. The shorter prolapsed time of CI usage could be a contributing factor since it may take time to adjust to the CI and to fully appreciate the gains that may be experienced from the device.

Loneliness

Additionally, although loneliness turned out to be a factor that was relatively improved with 50% of the participants responding in the ‘better’ and ‘much better’ categories, the positive change in this study was not as marked as the study by Most et al. (2010). This could have resulted from the way this question was worded in the present survey, which may have led to comprehension breakdown. The way it read in the survey was “Loneliness = ‘worse’, ‘unchanged’, ‘slightly better’, ‘better’, ‘much better’” which may have been interpreted as their loneliness increasing as opposed to decreasing in the better categories as better has accretion-like implications. This possible confusion is further supported by lack of response on this item by one of the participants.

In the present study, intimate relationships and political life and citizenship were found to be predominantly ‘unchanged’. In terms of intimate relationships, this result appears to be somewhat unexpected. In a study by Kennedy et al. (2008), it appeared that the CI not only improved quality of life for the CI user, but for the significant other as well. They mentioned that the significant other felt that the CI enabled improved communication between the parties and decreased the social burden. Although the question of whether or not the intimate relationship itself was any better, it could be inferred that with improved communication, quality of life and decreased burden, the relationship itself would be also be improved. It is important to note that since ‘not applicable’ was not an available response option, the two individuals who were not currently married or cohabiting would have likely responded to this item as ‘unchanged’. This in turn may have skewed the data. Equally, political life and citizenship is something more innate that does not require hearing input; people develop a sense of citizenship and national pride by merely living in a particular country and developing a sense of belonging. As well, political opinions are formed based on a person's living experience and family/friend influence, which a CI would have little impact on.

Hearing Activities

In regards to activities most directly related to hearing, participants reported the highest amount of participation in conversations and music-related activities. This finding supports the improvement in communication post-cochlear implantation. Since their hearing has improved, the participants are likely more confident and at ease communicating with others on a more regular basis. This is further supported by the participant who explained that they no longer avoid talking to people when out in public. Another finding was that participants infrequently used the phone. This was both reported in the questionnaire and inferred from the interviews who required use of TTY or Online-Text interview (e.g., Skype, Facebook, text messaging, gmail chat, Facetime, etc.). Again, this finding was not consistent among participants. This range of responses may be attributed to participants' reliance on lip-reading, familiarity with TTY use, and availability and knowledge of widespread alternative means of communication such as texting, email, and social media chats. Currently, there are many different ways to communicate from a distance without speaking on a phone. Participants may not use the telephone because other means are easier and more fluid. Additionally, participants' over-reliance on other means of communication may leave those individuals out of touch/practice with telephone usage.

Job Satisfaction

In this study, job satisfaction showed an improvement by 83% of the participants. This is consistent with Chee et al. (2004) who found that 82.6% of their adult participants with prelingual deafness reported a positive impact of their CI on their employment. Additionally, in both studies around 50% of participants had a change in employment post-cochlear implantation and over 50% of these participants attributed the change to their CI. Most et al. (2010) also found a significant difference between pre- and post-CI work performance. The improvement found by Most et al. (2010) and others may be attributed to participants' higher level of confidence, independence, and overall improvement in their ability to understand others and express themselves post-cochlear implantation. This increased ability to communicate may have also increased the amount of collaboration and facilitation of teamwork between colleagues. This is supported by one participant's account of reduced isolation at work and development of more friendships with co-workers post cochlear-implantation. A higher level of confidence and better communication skills may also have allowed some participants to work at jobs that they were previously unsuitable for and take on more complex tasks at their current job.

Expectations Regarding Implant

Expectations regarding participants' CI were unanimously met in this study. This finding indicates that most participants had realistic expectations about their CIs and may have received accurate information from health care professionals about the potential benefits. A study by Shpak, Koren, Tzach, Most & Luntz (2009) suggested that expectations for CI outcomes on speech perception can be tailored to each patient's pre-implantation assessment. Therefore, a thorough pre-implantation assessment should be completed for potential candidates and realistic expectations should be drawn. One point to consider in this pre-implantation assessment is the amount of residual hearing before implantation. In a study Yang et al. (2011), residual auditory capacity predicted outcomes in delayed cochlear implantation in adults with prelingual severe-profound hearing loss. This is an important factor to consider as more accurate education can be provided to potential candidates in terms of what they can expect based on their residual auditory capacity. Furthermore, in a study by Galvin, Hughes & Mok (2010), benefits from a second, sequential CI were evaluated in adolescents and young adults. It was found that additional benefits may be experienced from a second implant with greater than sixteen years between implants. This may be another factor to consider for clients who have already achieved gains from a single CI. Another trend regarding expectations in the present study included participants' decreased reliance on lip-reading. Some participants indicated they no longer needed to lip read, whereas others were disappointed they still needed to rely on lip reading. This finding is consistent with results from Chee et al. (2004) who found that reliance on lip-reading varied across participants. Additionally, one participant's personal account that her CI surpassed her expectations when compared to her hearing aid is supported by Meyer, Svirsky, Kirk & Miyamoto (1998). Meyer et al. (1998) studied the benefits of CIs versus hearing aids with prelingually deafened children with profound hearing loss. The research found that they receive greater speech perception results from a CI versus a hearing aid.

Environmental Factors

Overall, family support was the highest rated environmental factor that had a positive impact on the cochlear implantation experience. This finding is consistent with Chee et al. (2004) who found that family and peer support were more frequently cited as factors that helped CI recipients be more successful. Family support is most likely seen as the most helpful factor because families often tend to spend the most amount of time with CI recipients. Families also tend to have a higher investment in the well-being of its members and may go beyond what is expected or needed. It was noted that along with familial support, families may also have higher expectations for CIs as one participant described. However, unlike Chee et al. (2004), health professional support was seen as more helpful than peer support in this study. Many participants commented on the ongoing help and support from their audiologists and speech-language pathologists to get the most benefits from their CIs.

Relation Among Multiple Categories in Scores Between High and Low Score Groups

Evidently, there is a trend that is exists between the High Scores and Low Scores group; however due to a small sample size, statistical analysis was not an option for this study. This trend indicates that “Activities and Participation”, “Hearing Activities”, and “Environmental Factors” are related. That is, the high ratio from one category was also observed in the other two categories as well. These between-category effects of each of the three categories may have two-directional mutual effect as opposed to a one-directional cause and effect relationship. For example, better scores in “Activities and Participation” may enhance “Hearing Activities”, and the same is true for “Hearing Activities” and “Environmental Factors”. That being said, similar reports in the literature have not been identified. Regardless, the trends and mutual effects may lead to a very useful suggestion to the clinic and to the prelingually deafened CI users: areas of improvement in any of the three categories may spill over to the other categories, creating a synergistic effect and a positive loop. For example, increased support from family may improve the practice of using the CI. This may result in hearing skills becoming improved, followed by improvement in social skills. On the other hand, improvement in social skills may increase social activities, and may improve hearing ability with increase in practice of using CI for social activities. The opposite can be true as well, and a negative loop may occur. These bidirectional interactions between these categories are clearly displayed by the ICF model and can be seen in Figure 1.

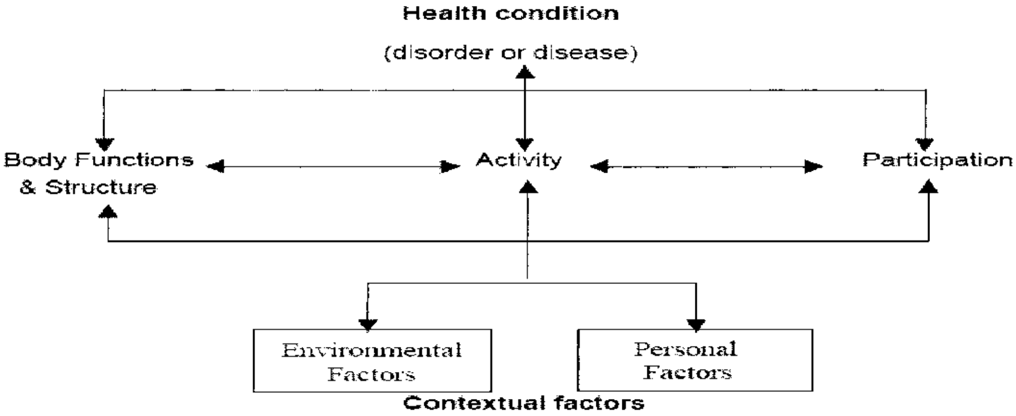

Figure 1. Interaction between components of the ICF. From *International Classification of Functioning, Disability, and Health* (p.18) by the World Health Organization, 2001, Genova, Switzerland: Author.

Limitations

Although this study provided great insight into the broader gains of cochlear implantation, there were definite limitations which should be cautiously considered when interpreting the results. First, one of the biggest factors was the small sample size. Although 71 surveys were sent out, there was a low response rate (11. 2%), which required a revision of the proposed statistical analysis: a quantitative analysis was initially desired but due to the response rate, a qualitative method was undertaken. This being said, the descriptive analysis brought insight and further contributed to the broader gains experienced with CIs, which was the ultimate goal of the study. An additional factor to take into consideration is which participants responded to the study in the first place. Given the overall positive results observed, it is necessary to consider whether only the participants that responded were the ones that had positive changes post cochlear-implantation, and the ones that had more of a negative experience simply did not respond at all, skewing the results.

Another factor that limits this study is the fact that some participants did not respond at all to certain questions in the survey. The participants may not have responded due to several reasons: 1) Missing the question altogether due to small font or difficulty tracking the question on the left of the page to the response options on the right of the page, particularly with some of the older participants, 2) Not understanding the question due to level of the wording, and 3) Not responding due to not applicable.

Finally this survey, as a tool to apply this WHO-ICF in this field, is not mature yet. This was our first attempt to apply WHO-ICF tool in the area of CI users and prelingual subjects. The survey was created through a blending of the WHO-ICF checklist, relevant research papers, and clinical expertise to demonstrate a fuller picture. Development of a more mature and validated tool remains to continue.

CONCLUSION

Adults with prelingual deafness may have limited speech recognition gains. The results of this study suggest that quality was improved in many aspects of their lives post-cochlear implantation. More specifically, this study showed overall improvements in one-on-one conversations, family relationships, enjoyment in music, safety, self-esteem/confidence, overall happiness, quality of life, and level of independence. This study also highlights the impact of support from family, health professionals and friends on the overall benefits received from the CIs. Finally, there is an evident trend seen between the categories wherein an improvement in one category showed improvements in the other two categories equally.

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TABLES

Table 1. Participants' responses to changes in activities and participation post-cochlear implantation.

Group:	**1a** --- All 8 subjects						**1b** --- 4 high-score subjects						**1c** --- 4 low-score subjects					
Score*	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
B#**	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)
B1	0(0)	0(0)	0(0)	2(25)	3(37.5)	3(37.5)	0(0)	0(0)	0(0)	0(0)	2(50)	2(50)	0(0)	0(0)	0(0)	2(50)	1(25)	1(25)
B2	0(0)	0(0)	0(0)	1(12.5)	5(62.5)	2(25)	0(0)	0(0)	0(0)	0(0)	3(75)	1(25)	0(0)	0(0)	0(0)	1(25)	2(50)	1(25)
B3	0(0)	0(0)	3(37.5)	2(12.5)	3(37.5)	1(12.5)	0(0)	0(0)	1(25)	0(0)	2(50)	1(25)	0(0)	0(0)	2(50)	1(25)	1(25)	0(0)
B4	0(0)	0(0)	1(12.5)	2(25)	3(37.5)	2(25)	0(0)	0(0)	1(25)	0(0)	1(25)	2(50)	0(0)	0(0)	0(0)	2(50)	2(50)	0(0)
B5	1(12.5)	0(0)	2(25)	2(25)	1(12.5)	2(25)	0(0)	0(0)	1(25)	1(25)	0(0)	2(50)	1(25)	0(0)	1(25)	1(25)	1(25)	0(0)
B6	0(0)	0(0)	0(0)	1(12.5)	2(25)	5(62.5)	0(0)	0(0)	0(0)	0(0)	1(25)	3(75)	0(0)	0(0)	0(0)	1(25)	1(25)	2(50)
B7	0(0)	1(12.5)	1(12.5)	4(50)	1(12.5)	1(12.5)	0(0)	0(0)	0(0)	2(50)	1(25)	1(25)	0(0)	1(25)	1(25)	2(50)	0(0)	0(0)
B8	2(25)	1(12.5)	1(12.5)	3(37.5)	1(12.5)	0(0)	1(25)	0(0)	0(0)	2(50)	1(25)	0(0)	1(25)	1(25)	1(25)	1(25)	0(0)	0(0)
B9	0(0)	1(12.5)	2(25)	2(25)	0(0)	3(37.5)	0(0)	0(0)	1(25)	0(0)	0(0)	3(75)	0(0)	1(25)	1(25)	2(50)	0(0)	0(0)
B10	2(25)	0(0)	1(12.5)	0(0)	3(37.5)	2(25)	0(0)	0(0)	1(25)	0(0)	1(25)	2(50)	2(50)	0(0)	0(0)	0(0)	2(50)	0(0)
B11	0(0)	0(0)	0(0)	0(0)	5(62.5)	3(37.5)	0(0)	0(0)	0(0)	0(0)	1(25)	3(75)	0(0)	0(0)	0(0)	0(0)	4(100)	0(0)
B12	1(12.5)	0(0)	1(12.5)	0(0)	4(50)	2(25)	0(0)	0(0)	0(0)	0(0)	2(50)	2(50)	1(25)	0(0)	1(25)	0(0)	2(50)	0(0)
B13	0(0)	0(0)	1(12.5)	3(37.5)	3(37.5)	1(12.5)	0(0)	0(0)	0(0)	1(25)	2(50)	1(25)	0(0)	0(0)	1(25)	2(50)	1(25)	0(0)
B14	0(0)	0(0)	1(12.5)	1(12.5)	3(37.5)	3(37.5)	0(0)	0(0)	0(0)	0(0)	2(50)	2(50)	0(0)	0(0)	1(25)	1(25)	1(25)	1(25)
B15	0(0)	0(0)	2(25)	2(25)	3(37.5)	1(12.5)	0(0)	0(0)	2(50)	0(0)	1(25)	1(25)	0(0)	0(0)	0(0)	2(50)	2(50)	0(0)
B16	0(0)	0(0)	2(25)	2(25)	2(25)	2(25)	0(0)	0(0)	2(50)	0(0)	1(25)	1(25)	0(0)	0(0)	0(0)	2(50)	1(25)	1(25)
B17	0(0)	0(0)	0(0)	2(25)	3(37.5)	3(37.5)	0(0)	0(0)	0(0)	1(25)	0(0)	3(75)	0(0)	0(0)	0(0)	2(50)	2(50)	0(0)
B18	0(0)	0(0)	0(0)	2(25)	3(37.5)	3(37.5)	0(0)	0(0)	0(0)	0(0)	1(25)	3(75)	0(0)	0(0)	0(0)	2(50)	2(50)	0(0)
B19	0(0)	0(0)	0(0)	3(37.5)	3(37.5)	2(25)	0(0)	0(0)	0(0)	1(25)	2(50)	1(25)	0(0)	0(0)	0(0)	2(50)	2(50)	0(0)
B20	0(0)	0(0)	0(0)	3(37.5)	2(25)	3(37.5)	0(0)	0(0)	0(0)	1(25)	0(0)	3(75)	0(0)	0(0)	0(0)	2(50)	2(50)	0(0)
B21	0(0)	0(0)	1(12.5)	0(0)	3(37.5)	4(50)	0(0)	0(0)	0(0)	0(0)	1(25)	3(75)	0(0)	0(0)	1(25)	0(0)	2(50)	1(25)

B22	0(0)	0(0)	4(50)	0(0)	2(25)	2(25)	0(0)	0(0)	1(25)	0(0)	1(25)	2(50)	0(0)	0(0)	3(75)	0(0)	1(25)	0(0)
B23	0(0)	0(0)	2(25)	2(25)	2(25)	2(25)	0(0)	0(0)	1(25)	1(25)	0(0)	2(50)	0(0)	0(0)	1(25)	1(25)	2(50)	0(0)
B24	1(12.5)	0(0)	2(25)	1(12.5)	4(50)	1(12.5)	0(0)	0(0)	0(0)	1(25)	3(75)	0(0)	0(0)	0(0)	2(50)	0(0)	1(25)	1(25)
B25	1(12.5)	1(12.5)	3(37.5)	1(12.5)	2(25)	0(0)	0(0)	0(0)	2(50)	1(25)	1(25)	0(0)	1(25)	1(25)	1(25)	0(0)	1(25)	0(0)
B26	1(12.5)	0(0)	4(50)	1(12.5)	2(25)	0(0)	0(0)	0(0)	1(25)	1(25)	2(50)	0(0)	1(25)	0(0)	3(75)	0(0)	0(0)	0(0)
B27	0(0)	0(0)	0(0)	2(25)	2(25)	4(50)	0(0)	0(0)	0(0)	0(0)	0(0)	4(100)	0(0)	0(0)	0(0)	2(50)	2(50)	0(0)
B28	0(0)	0(0)	0(0)	2(25)	3(37.5)	3(37.5)	0(0)	0(0)	0(0)	1(25)	0(0)	3(75)	0(0)	0(0)	0(0)	1(25)	3(75)	0(0)
B29	1(12.5)	0(0)	3(37.5)	0(0)	3(37.5)	1(12.5)	1(25)	0(0)	1(25)	0(0)	1(25)	1(25)	0(0)	0(0)	2(50)	0(0)	2(50)	0(0)
B30	0(0)	2(25)	5(62.5)	0(0)	0(0)	0(0)	0(0)	2(50)	2(50)	0(0)	0(0)	0(0)	1(25)	0(0)	3(75)	0(0)	0(0)	0(0)
B31	0(0)	0(0)	2(25)	4(50)	1(12.5)	1(12.5)	0(0)	0(0)	0(0)	2(50)	1(25)	1(25)	0(0)	0(0)	2(50)	2(50)	0(0)	0(0)
B32	0(0)	0(0)	0(0)	2(25)	2(25)	4(50)	0(0)	0(0)	0(0)	1(25)	1(25)	2(50)	0(0)	0(0)	0(0)	1(25)	1(25)	2(50)
B33	0(0)	0(0)	1(12.5)	0(0)	2(25)	5(62.5)	0(0)	0(0)	0(0)	0(0)	0(0)	4(100)	0(0)	0(0)	1(25)	0(0)	2(50)	1(25)
B34	1(12.5)	0(0)	3(37.5)	0(0)	1(12.5)	3(37.5)	0(0)	0(0)	1(25)	0(0)	0(0)	3(75)	1(25)	0(0)	2(50)	0(0)	1(25)	0(0)
B35	0(0)	0(0)	0(0)	2(25)	2(25)	4(50)	0(0)	0(0)	0(0)	0(0)	1(25)	3(75)	0(0)	0(0)	0(0)	2(50)	1(25)	1(25)
B36	0(0)	0(0)	0(0)	1(12.5)	3(37.5)	4(50)	0(0)	0(0)	0(0)	0(0)	1(25)	3(75)	0(0)	0(0)	0(0)	1(25)	2(50)	1(25)
B37	0(0)	0(0)	1(12.5)	0(0)	3(37.5)	4(50)	0(0)	0(0)	0(0)	0(0)	1(25)	3(75)	0(0)	0(0)	1(25)	0(0)	2(50)	1(25)

* **Score (Activities and Participation).** 0: No Response, 1: Worse, 2: Unchanged, 3: Slightly Better, 4: Better, 5: Much Better.

** **B#**: B1: Understanding females' speech, B2: Understanding males' speech, B3: Understanding non-verbal messages, B4: Speaking/talking, B5: Producing non-verbal messages e.g. gestures:, B6: One-on-one conversations, B7: Conversations in a noisy environment, B8: Conversations with multiple speakers, B9: Telephone Use, B10: Awareness of surroundings, B11: Walking outside of you home, B12: Use of transportation car, bus, train, plane, etc.:, B13: Driving riding bicycle and motorbike, driving car, etc.:, B14: Running errands grocery shopping, going to the bank, etc.:, B15: Preparation of meals cooking, etc.:, B16: Doing housework cleaning house, washing dishes, doing laundry etc.:, B17: Having a casual conversation, B18: Participation in a more complex discussion talking with a doctor, etc.:, B19: Formal relationships boss, service providers, etc.:, B20: Informal social relationships friends, acquaintances, etc.:, B21: Family relationships, B22: Intimate relationships, B23: Community life, B24: Recreation and leisure, B25: Religion and spirituality, B26: Political life and citizenship, B27: Enjoyment in music, B28: Enjoyment in television and/or movies, B29: Participation in hearing community, B30: Participation in deaf community, B31: Energy level, B32: Safety, B33: Self-esteem/confidence, B34: Loneliness, B35: Overall happiness, B36: Quality of life, B37: Level of independence.

Table 2. Participants' responses to frequency of hearing activities with cochlear implants.

Group	**2a** --- All 8 subjects				**2b** --- 4 high-score subjects				**2c** --- 4 low-score subjects			
Score:	Never	Rarely	Sometimes	Often	Never	Rarely	Sometimes	Often	Never	Rarely	Sometimes	Often
HA#*	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)
HA1	0 (0)	1 (12.5)	6 (75)	1 (12.5)	0(0)	0(0)	3(75)	1(25)	0(0)	1(25)	3 (75)	0(0)
HA2	2 (25)	3 (37.5)	1 (12.5)	2 (25)	2(50)	1(25)	1(25)	0(0)	0(0)	2(50)	0(0)	2(50)
HA3	1 (12.5)	4 (50)	1 (12.5)	1 (12.5)	0(0)	2(50)	1(25)	1(25)	1(25)	2(50)	1(25)	0(0)
HA4	0 (0)	0 (0)	0 (0)	8 (100)	0(0)	0(0)	0(0)	4(100)	0(0)	0(0)	0(0)	4(100)
HA5	0 (0)	1 (12.5)	1 (12.5)	6 (75)	0(0)	0(0)	1(25)	3(75)	1(25)	0(0)	0(0)	3(75)
HA6	0 (0)	1 (12.5)	1 (12.5)	6 (75)	0(0)	0(0)	0(0)	4(100)	1(25)	0(0)	1(25)	2(50)

* **HA# (Hearing Activity)**. HA1: Music-related activity, HA2: Computer training to increase oral language skills, HA3: Telephone conversations, HA4: One-on-one conversation, HA5: Group conversation, HA6: Conversations in noisy environments.

Table 3. Participants' responses of impact of environmental factors on cochlear implantation experience.

Group	**3a** --- All 8 subjects			**3b** --- 4 high-score subjects			**3c** --- 4 low-score subjects		
Score:	No effect	Slightly easier	Much easier	No effect	Slightly easier	Much easier	No effect	Slightly easier	Much easier
EF#*	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)
EF1	0 (0)	2 (25)	6 (75)	0(0)	0(0)	4(100)	0(0)	2(50)	2(50)
EF2	0 (0)	4 (50)	4 (50)	0(0)	1(25)	3(75)	0(0)	3(75)	1(25)
EF3	3 (37.5)	1 (12.5)	4 (50)	1(25)	0(0)	3(75)	2(50)	1(25)	1(25)
EF4	0 (0)	3 (37.5)	5 (62.5)	0(0)	0(0)	4(100)	0(0)	3(75)	1(25)
EF5	3 (37.5)	0 (0)	5 (62.5)	1(25)	0(0)	3(75)	2(50)	0(0)	2(50)
EF6	2 (25)	2 (25)	4 (50)	1(25)	0(0)	3(75)	1(25)	2(50)	1(25)
EF7	3 (37.5)	1 (12.5)	4 (50)	1(25)	0(0)	3(75)	2(50)	1(25)	1(25)
EF8	2 (25)	2 (25)	4 (50)	1(25)	0(0)	3(75)	1(25)	2(50)	1(25)
EF9	2 (25)	1 (12.5)	5 (62.5)	1(25)	0(0)	3(75)	1(25)	1(25)	2(50)

*** EF# (Environment Factor).** EF1: Family support, EF2: Friend support, EF3: Acquaintance support, EF4: Health professional support, EF5: Family attitudes, EF6: Friend attitudes, EF7: Health professional attitudes, EF8: Societal attitudes, EF9: Social norms, practices, and ideologies.

Table 4. Summary of comparison between high and low score groups.

Participants' responses to changes in activities and participation post-cochlear implantation.			Participants' responses to frequency of hearing activities with cochlear implants.			Participant responses of impact of environmental factors on cochlear implantation experience.		
From Tables:	Table 1b High-Score	Table 1c Low-Score	From Tables:	Table 2b High-Score	Table 2c Low-Score	From Tables:	Table 3b High-Score	Table 3c Low-Score
Much better	71	14	Often	19	16	Made it much easier	29	12
No response, Worse, Unchanged, Slightly better, Better	77	134	Never, Rarely, Sometimes	5	8	No effect, Made it slightly easier	7	24
Ratio	0.92 (71/77)	0.1 (14/134)	Ratio	3.8 (19/5)	2.0 (16/8)	Ratio	4.1 (29/7)	0.5 (12/24)

Appendix 1. INTERVIEW QUESTIONS

Many people find that they have an easier time communicating with people after they receive they cochlear implant, can you give some examples of your communication before your cochlear implantation and after your cochlear implantation? Overall, how have your personal relationships changed since you've had a cochlear implantation? Tell me about the changes. Many people feel an increased sense of independence once they have their cochlear implantation, do you? Tell me about how your independence has changed since your cochlear implantation? Since you've received your cochlear implant, is there a specific activity that is easier to do? If so, how has that impacted your life? (E.g. running errands, driving, talking on the phone) Have you felt supported throughout the process? By whom? Tell me about it. Is there anything that you would like to do that you feel you are currently unable to do or wish you could improve on? Tell me about that.

Please note: additional open-ended questions were asked, but they were based off the questionnaire.