

Hearing ability and its relationship with psychosocial health, work-related variables, and health care use: the National Longitudinal Study on Hearing

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Introduction

Worldwide, more than 250 million people experience problems with hearing (Mathers *et al.* 2003). Depending on the definition of hearing impairment and the criteria applied, prevalence rates in adult populations vary from 10 to 20 percent (Davis, 1989; Karlsomose *et al.* 2000; Mathers *et al.* 2003; Hannaford *et al.* 2005). Although the prevalence of auditory disability is highest in older age groups (i.e. >65 years), there is still a large number of younger people with hearing problems. In 2004, Dutch Statistics estimated that about 1.5 million persons aged 12 years and older experienced problems with hearing when in a conversation with three or more persons, whereas in a conversation with one other person 290.000 individuals reported difficulties (Gommer & Poos 2010). The numbers of individuals younger than 75 years in these groups were 1.2 million and 227.000 respectively (Gommer & Poos 2010). The most prevalent type of hearing impairment is irreversible, which makes it a common chronic condition in human populations.

There is a wide range of disabilities that people may experience as a result of their hearing loss, varying from difficulties using the telephone to communicate, to feeling restricted to participate in leisure activities. Another area which might be influenced by reduced hearing ability is psychosocial health.

Psychosocial health

So far, studies addressing the relationship between hearing impairment and psychosocial health focused on a range of outcomes, varying from generic variables like overall health-related quality of life to specific domains such as depression or social isolation. In most of the studies looking at overall health related quality of life, a negative influence of hearing impairment was found, with hearing impaired individuals reporting lower levels of quality of life than people with normal hearing (Fellinger *et al.* 2007; Chia *et al.* 2007). Depression is one of the specific variables which was found to be related to auditory disability. Several studies described significantly more depressive symptoms in those with impaired hearing compared to normally hearing individuals (i.e. Knutson & Lansing 1990; Carabellese *et al.* 1993; Wallhagen 1996; Cacciatori *et al.* 1999; Strawbridge *et al.* 2000; Kramer *et al.* 2002; Tams 2004; Hallam *et al.* 2006). Others found hearing impaired people to feel lonelier or more socially isolated, anxious or distressed than their normally hearing peers (Knutson & Lansing 1990; Eriksson-Mangold & Carlsson 1991; Ringdahl & Grimby 2000; Strawbridge *et al.* 2000; Kramer *et al.* 2002; Tams 2004; Hawthorne 2008). Another variable for which an adverse relation with hearing impairment is reported is somatisation (Eriksson-Mangold & Carlsson 1991; Fellinger *et al.* 2007). Somatisation is defined as the tendency to experience somatic symptoms in response to psychological stress, which is attributed to physical illness, and for which medical help is sought (Lipowski, 1988).

Whereas the relationship between hearing ability and psychosocial health has been studied in a substantial number of studies, the vast majority of these included samples of elderly people. Relatively little is known about the impact of hearing loss on psychosocial health among younger adults. Because of differences in circumstances and lifestyles between individuals in the working age and elderly people (i.e. working life versus being retired), the psychosocial impact of hearing impairment might be different among different age groups. Hence, results from studies exclusively including elderly populations might not apply to younger age groups.

Also, most of the studies used self-report to determine the participant's hearing ability. Although self-report has shown to be a reliable method to assess hearing disability, people in different age groups are likely to rate their hearing ability differently, with older age groups being less likely to report limitations than younger age groups (Smits *et al.* 2006a). Others used pure-tone audiometry. However, previous studies have reported only moderate relationships between pure-tone thresholds and a person's ability to understand speech in adverse listening conditions (Kramer *et al.* 1996; Houtgast & Festen 2008). It is known that difficulty with understanding speech in a noisy environment is one of the primary complaints of people with hearing impairment, and is often experienced as very limiting (Plomp & Mimpen 1979; Lutman *et al.* 1987; Kramer *et al.* 1996). Therefore, hearing ability expressed as the ability to understand speech in adverse listening conditions might be a better measure

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when looking at the relationship between hearing ability and psychosocial health. So far, studies exploring impaired speech comprehension in noise in relation to psychosocial functioning have not been reported in the literature.

Working life

Another major life area which might be influenced by impaired hearing is working life. Several studies showed that workers with hearing loss comprise a vulnerable group on the labour market. They seem to have lower levels of education and greater likelihood of low income compared to groups with normal hearing (Järvelin *et al.* 1997; Hogan *et al.* 2009; Rydberg *et al.* 2010). Also, higher levels of un(der)employment are reported and people with hearing loss seem to be overrepresented in the group taking early retirement (Parving *et al.* 2001; Danermark & Gellerstedt 2004). Mohr *et al.* (2000) demonstrated that adverse work-related consequences of hearing impairment are associated with high societal costs. Though, the exact implications of hearing impairment in the workplace are not well understood yet (Jennings & Shaw 2006).

Only a few studies addressed the implications of hearing impairment in the workplace. A condition often mentioned by employees with hearing impairment is a lack of energy or fatigue (Ringdahl and Grimby 2000; Backenroth *et al.* 2003; Danermark and Gellerstedt 2004). The degree to which employees are able to recover from fatigue and distress after work is an important factor influencing their physical and mental health status. In occupational health care, this so-called need for recovery after work is seen as an acute, short-term reaction to work related fatigue. Repeated insufficient recovery after work has been found to be an intermediate stage between stressful working conditions (high job demands and low job control), and the development of psychosomatic health problems (Sluiter *et al.* 2003). Also, need for recovery has been found to be related to the duration of future sick leave (Sluiter *et al.* 2003).

Several studies have shown associations between chronic conditions and increased levels of need for recovery (Jansen *et al.* 2002; Weijman *et al.* 2004). The association between hearing impairment and need for recovery has not been studied so far. Though, some studies have examined psychosocial job characteristics, expressed by job demand and job control, among employees with hearing impairment. The findings show that those with hearing problems experience significantly more often an imbalance between the psychological demands of their job and the degree of control over their working conditions (Danermark & Gellerstedt 2004; Kramer *et al.* 2006). Although it is often suggested that the prevalence of long-term sick leave is higher among employees with reduced hearing, there is not much evidence yet. Recent work found a higher level of sick leave among those with impaired hearing compared to those with normal hearing (Kramer *et al.* 2006). This study suggested that the difference in sick leave between the groups was caused by a higher incidence of psychological distress in those with auditory problems (Kramer *et al.* 2006).

Health care use

Nowadays, the use of health care resources and the costs related to it are important issues for health economists and politicians. As the consumption of care in the population is likely to increase because of the aging society, insight into the health care use and the related costs of people with reduced hearing is also important. It is likely that health care use, and costs related to it, are influenced by the inability to hear. Not only because of the use of resources directly related to hearing impairment, such as contacts with an audiology clinic or ENT physician, but also because of a higher number of contacts with health care providers for care indirectly related to hearing impairment. For example, psychosocial health problems, such as depression, often coincide with hearing impairment, as discussed earlier. Depression itself has been found to be associated with an increase in health care use

(Johnson *et al.* 1992; Grabe *et al.* 2009). When psychosocial health complaints are also more often reported in people with hearing impairment, it is reasonable to assume that they have a higher amount of health care contacts and costs compared to those with normal hearing. Some previous research demonstrated differences in health care use between normally hearing and hearing impaired individuals, with the latter group having more contacts. However, almost none of the studies conducted so far accounted for confounding variables like educational level or income. Only one study distinguished between hearing related contacts and health care contacts which were not directly related to hearing impairment (Green & Pope 2001).

National Longitudinal Study on Hearing

The preceding sections illustrate that there is still a lack of knowledge about hearing loss and its possible influence on different domains of daily life, in particular among adults in the working age. Therefore, the National Longitudinal Study on Hearing (NL-SH) was set up in 2006. Aim of this study is to gain more insight into the relationship between hearing ability and areas of psychosocial health, work situation, and health care use among adults aged 18 to 70 years. This paper highlights the main findings of the NL-SH on:

1. The association between hearing ability and different psychosocial health variables.
2. The association between hearing ability and both psychosocial work characteristics and need for recovery after work.
3. A comparison of health care use and the related costs between hearing impaired and normally hearing participants.

Methods

The National Longitudinal Study on Hearing is an ongoing prospective cohort study, which is conducted over the Internet. A website is used to enroll and inform the participants and to collect data (www.hooronderzoek.nl). People are invited to participate in the NL-SH through advertisements and flyers distributed at audiology clinics and hearing aid dispensers throughout The Netherlands. Eligible participants are adults between 18 and 70 years of age. Both persons with and without hearing impairment are encouraged to participate in the NL-SH. Each person who is interested to participate in the NL-SH is instructed to first perform the National Hearing Test on the Internet. At the end of the test, people are redirected to the website of the study where they can subscribe. After subscription, contact details and the results of the National Hearing test are stored in a database. The present paper reports on data collected during the first wave of the NL-SH.

National Hearing test

Hearing ability was determined by The National Hearing Test, an adaptive speech-in-noise test using digit triplets presented against a background noise. The development and procedure of the test have been described in several studies by Smits *et al.* (Smits *et al.* 2004; Smits & Houtgast 2005; Smits *et al.* 2006a; Smits *et al.* 2006b). The test was initially developed for delivery by telephone, but an identical version for Internet use was launched as well. A series of studies demonstrated the validity and reliability of the National Hearing test (Smits *et al.* 2004; Smits & Houtgast 2005; Smits *et al.* 2006a; Smits *et al.* 2006b). The telephone and Internet versions appeared to be equally feasible, except that elderly persons preferred the telephone version (Smits *et al.* 2006b). As the participants of the NL-SH were all younger than 70 years, the requirement of Internet was no limitation.

Participants were instructed to perform the test in a quiet environment, and they had to indicate whether they did the test using head-

phones or speakers. The advice was to use speakers only when in a quiet environment. With the test, the speech reception threshold corresponding to 50% intelligibility was determined (Smits *et al.* 2006b). This speech reception threshold at 50% intelligibility will be further referred to as SRT_n. According to Smits *et al.* (2006b), the score on the test can be divided into three categories: good (SRT_n < -5.5 dB), insufficient (-5.5 dB ≤ SRT_n ≤ -2.8 dB), and poor (SRT_n > -2.8 dB) hearing ability. These cut-off scores correspond to SRT_n -3.0 and 0.0 dB on the sentences SRT_n test by headphones of Plomp and Mimpen (1979) (Smits & Houtgast 2005).

Data collection

All data for the NL-SH were collected over the Internet, including psychosocial health status, work situation, and health care use. After enrolment, participants received a link to a set of online questionnaires. When participants did not complete all questionnaires within one week, an email reminder was sent to them. After one month, a postal letter (providing the link to the questionnaire) was sent to their home address, followed by an email reminder the same week.

Psychosocial health status was measured using three questionnaires covering six variables (distress, depression, anxiety, somatisation, loneliness, and self-efficacy) (Terluin *et al.* 2006; Van Tilburg & De Jong Gierveld 1999; Bosscher & Smit 1998). The Job Content Questionnaire was used to determine the psychosocial work characteristics job demands, job control and social support (Karasek *et al.* 1998). Short term effects of fatigue by work activities were expressed by the Need for recovery scale (Van Veldhoven & Meijman, 1994). Self-reported work productivity, limitations at work, and sick leave were measured using the WHO Health Performance Questionnaire (Kessler *et al.* 2003). Finally, an individuals' health care use was expressed by the number of contacts with health care providers during a period of seven months. In addition to the number of contacts, respondents were asked whether the contact was related to their hearing or not.

Results and Discussion

The results of the NL-SH showed that hearing ability may have an adverse effect on an individual's functioning in several domains of daily life among adults aged between 18 and 70 years. The main results of the NL-SH will be discussed in the following subsections. Figure 1 presents a graphic illustration of the significant associations found within the NL-SH. More detailed results are described in several publications (Nachtegaal *et al.* 2009a, 2009b, 2010).

Study population

The set of questionnaires were sent to 1796 people of whom 88% returned the questionnaires. About half of the participants had insufficient or poor hearing ability according to the test. On average, women were significantly younger than men, and had significantly poorer scores on the National Hearing Test.

Psychosocial health

Regression models revealed that reduced hearing ability is associated with higher levels of distress, somatisation, depression, and loneliness (Nachtegaal *et al.* 2009a). Significant effect-modification for age, indicated that the associations are different for different age groups. The study is among the first ones describing differences in consequences of reduced hearing ability in different age groups. A study by Tambs (2004) revealed highly similar findings with the relationship between hearing impairment and psychosocial problems being stronger in young and middle-aged groups than in those older than 65 years. It is likely that the psy-

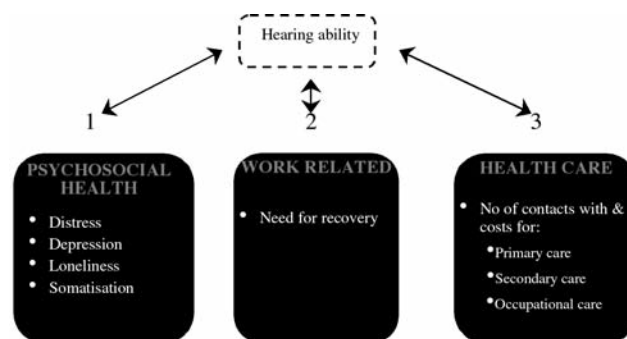


Figure 1. Significant associations found between hearing ability and the different domains of daily life.

chosocial problems of middle-aged hearing impaired adults are related to work. This issue was addressed in the second study.

Work related variables

An often observed problem of employees with hearing impairment is a lack of energy or fatigue. Hence, it was hypothesized that people with hearing reduced hearing ability experience higher levels of need for recovery after work. The results of the NL-SH confirm this hypothesis (Nachtegaal *et al.* 2009b). For every dB SNR poorer hearing ability, the need for recovery increases significantly. Furthermore, the odds for risky levels of need for recovery after work increased significantly as well with a decreasing hearing ability. According to Broersen *et al.* (2004), a risky level of need for recovery is associated with a higher risk to develop psychosocial problems and even drop out from work because of these complaints. A study of the relationship between hearing ability and sick leave supported this idea, as the higher level of need for recovery among people with poorer hearing ability appeared to be a factor partly explaining a higher odds for sick leave (Nachtegaal *et al.*, *under review*).

Health care use

Despite the adverse relationships between hearing ability and psychosocial health (Nachtegaal *et al.* 2009a) and work related problems (Nachtegaal *et al.* 2009b & Nachtegaal *et al.* *under review*), differences between participants with and without auditory difficulties in health care use and costs, after excluding hearing-related care, were not found (Nachtegaal *et al.* 2010). It was expected that people with insufficient and poor hearing ability would have higher levels of health care use (and related costs) over and above the care directly related to their hearing problem, as many people do not directly link their auditory difficulties with problems like fatigue. However, only when hearing related contacts were included, a significantly higher use and costs for overall primary, secondary, and occupational health care was observed in participants with insufficient and poor hearing, compared to their normally hearing peers. The results therefore suggest that adults with hearing loss (compared to normally hearing peers) do not make more use of health care resources over and above their hearing related health care contacts.

Apart from a potential overcorrection for chronic conditions (depressive symptoms were among the chronic conditions evaluated), other possibilities to explain this finding are that psychosocial care is not offered to the patients and therefore not used. Another option is that individuals just do not wish to make use of this type of care. Also, the results on psychosocial health show a wide distribution of the psychosocial health scores, with people in the normal range and with clinically deviant scores whereas group mean scores for all hearing test categories fell in the normal range. As such, it is possible that the psy-

chosocial health problems experienced by people with reduced hearing were mild enough to not require direct psychosocial care. It is an issue that deserves attention in future studies.

Methodological considerations

The NL-SH is conducted over the Internet and used on-line questionnaires to collect the data. One of the frequently reported concerns on using Internet for (population based) research purposes is the degree of access in the population. Although the proportion of people using the Internet has increased tremendously since its introduction, the penetration is not yet 100%. This implies that using the Internet for a study such as the NL-SH excludes participants without access, who would have been eligible otherwise. In The Netherlands, the proportion of the population having connection to the Internet is one of the highest in the world: in 2006, 80% of the households were connected at home, and in 2007 this proportion had increased to 83% (Dutch Statistics 2010). In these years, an additional 2% of the households used the Internet at other places than home, for example at work (Dutch Statistics 2010). Furthermore, comparison of accessibility in the group aged 50-65 years and in the general population revealed that availability of the Internet was nearly the same in both groups (SCP 2010). Based on these findings, it was concluded that penetration was sufficiently certain at the start of the NL-SH.

Whereas it is concluded that the penetration of the Internet in the target population was sufficiently certain to minimize selection bias, the way participants were recruited for this study is another factor potentially causing selection bias. Although we explored several approaches to recruit potential subjects (both normally hearing and hearing impaired), all had to actively subscribe themselves. This procedure could have led to a biased selection, more than one would expect when using random lists of addresses to invite potential participants. As such, it might be useful to extend the NL-SH in the future with inviting a randomly selected sample drawn from the general population to participate. This will increase the generalizability of the results even more. A huge advantage of the NL-SH, however, is that it is not limited to a group of clinical patients or clients. Whereas previous studies, especially those focusing on work related topics and health care use, mostly consisted of a samples selected at audiology clinics, the sample of the NL-SH comprised a mixture of a clinical and non-clinical population.

A limitation of using a speech-in-noise test to determine hearing ability, is that it does not detect middle ear problems, beginning high frequency hearing losses, or unilateral hearing impairment (Smits, *et al.* 2004; Smits and Houtgast 2005). Thus, people with a conductive or unilateral type of loss might have a good score on the test, while they do experience problems in daily life. However, these types of hearing problems are reported by only a small number of participants (about 7%), and as such it is assumed that the possible influence on the results is limited. Another potential drawback of testing hearing ability over the Internet is that there is no control over the testing conditions. Participants were allowed to use either headphones or loudspeakers. Though, they were advised to use loudspeakers only when in a quiet environment, as using speakers in a noisy environment might influence the test result. The majority of people used speakers instead of headphones. The absence of significant confounding or effect-modification in all analyses, however, indicated little influence from test conditions on the results. This is supported by a previous study of Culling *et al.* 2005, who showed that variations in equipment had negligible effects on speech-in-noise audiometry. Given these findings and the previously established reliability and validity of the test, the National Hearing Test is seen as a valuable way to objectively determine hearing ability in large samples.

Implications for clinical practice

Given the aging societies of today, and the focus of politicians on raising retirement age, it is likely that the proportion of workers with hearing impairment will rise in the coming years. Also, the focus is more and more on keeping people with an impairment active in the workforce. As such, the findings presented in this dissertation underline the need to further address and explore possible adverse effects of hearing loss in these age groups in clinical practice.

The findings on psychosocial health show different associations between hearing ability and psychosocial health for different age groups. These dissimilarities possibly reflect the overall way in which hearing impairment is regarded in the different age groups. In older populations, hearing loss is quite common and seen as part of the aging process. However, in younger age and middle-aged adults groups, hearing loss is not as prevalent and consequently, may have a higher personal impact. The results of this study suggest that awareness of the differential effects in different age groups could be useful for clinicians when assisting people with auditory difficulties. Specific rehabilitation programs for different age groups are scarce and deserve more attention. Another clinical implication relates to work. Work is a challenging activity, especially for people with hearing problems. This study shows that among workers, reduced hearing ability is associated work related problems like higher levels of need for recovery. With the governmental focus of keeping people at work, these results stress the need for specific work-related support of people with hearing problems. Examples of such programs have been reported previously in the literature (Héту and Getty 1991; Kramer 2008). Implementing the management of need for recovery (e.g. by learning efficient coping strategies or relaxation techniques) might be useful to avoid high levels of need for recovery or maybe even drop out from work.

Future research

The results of the present paper support the need for specific rehabilitation programs for workers with hearing impairment, which is also stressed by several previous studies (i.e. Jennings and Shaw 2008). Future research could help to further develop, adapt or evaluate such vocational programs, and thereby improve the care for workers with hearing problems.

The study sample included, consists of a mixture of people receiving help for their auditory problem and people not receiving help (yet). It would be interesting to examine if there are any differences between these groups, and to determine which factors influence help seeking. Such information may be useful for the organization of the care delivered to hearing impaired adults, and may help to reach those people with auditory problems not receiving help yet.

The National Longitudinal Study on Hearing started early 2006. In the present paper, the results of the cross-sectional analyses of data collected during the period from November 2006 to January 2008 were summarized. Cross-sectional analyses do not provide information about the causality of the relationships. Hence, questions addressing the consequences of changes in hearing ability for psychosocial health, work situation, and health care use cannot be answered with these cross-sectional data. This requires longitudinal data. So far however, longitudinal data with a special focus on hearing ability and its possible consequences are scarce, especially for working aged adults. Hence, in 2011 the NL-SH will start a second measurement cycle to collect longitudinal data on both hearing ability and the different life domains. By monitoring participants during a longer period, more insight can be gained into the effects of changes in hearing ability on, for example, psychosocial health or work situation. Also, the longitudinal design creates the opportunity to follow people who are normally hearing at baseline and who will develop hearing problems in the period of investiga-

tion. In this way, more insight into the health care pathway, the (psycho-social) health effects, and the needs and help seeking behavior of these people can be gained.

Conclusions

Whereas previous studies mainly focused on elderly populations, the NL-SH exclusively focuses on possible effects of hearing impairment in young and middle-aged adults and young-elderly. Also, it is the first study on the association between hearing ability and various domains of daily life which used a speech-in-noise test over the Internet to determine hearing ability. The results indicate that limitations in hearing have an impact on psychosocial health and work in young and middle-aged adults and young-elderly. As such, these findings underline the need to further address and explore the adverse effects of hearing loss in these age groups, both in research and clinical practice. Continuation of NL-SH by collecting longitudinal data could help to obtain insight into the effects of *changes* in hearing ability on psychosocial health, work and health care use.

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