Moderate Effects of Hearing Loss on Mental Health and Subjective Well-Being: Results From the Nord-Trøndelag Hearing Loss Study

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Objective: To estimate effects of hearing loss on symptoms of anxiety, depression, self-esteem, and subjective well-being. **Methods:** A normal population sample of 50,398 subjects, age 20 to 101 years, in Nord-Trøndelag completed audiometric tests and questionnaires. The association between hearing loss and mental health was assessed with multiple linear regression analyses, controlling for social background variables. **Results:** Effects of hearing loss were mostly significant, but moderate in strength. Effects were stronger among young (20–44 years) and middle-aged (45–64 years) than among older (65+ years) people. Loss of high or middle frequency hearing had almost no impact on mental health measures if low frequency hearing was not also impaired. The strongest observed effect was a change of 0.1 SD in mental health per 10 dB hearing loss. **Conclusions:** Hearing loss is associated with substantially reduced mental health ratings among some young and middle-aged persons, but usually does not affect mental health much among older persons. **Key words:** hearing loss, quality of life, self-esteem, depression.

HUNT = Nord-Trøndelag Health Study.

INTRODUCTION

Hearing loss is one of the most common health problems among the populations of the industrialized world. Prevalence estimates depend on what criteria are used for determining hearing loss. Using the criterion ≥25 dB loss averaged across the frequencies 0.5 to 4 kHz, better ear, the point prevalence among adults has been estimated at 16.6% in Australia and 16.1% in the United Kingdom (1). Sooner or later, most people will suffer from impaired hearing. Thus, the point prevalence among elderly people age 57 to 89 years (using a somewhat less strict criterion) was estimated to be 83% in Framingham, Massachusetts (2).

Besides reduced ability to enjoy music and other sounds that we appreciate, hearing loss may produce social isolation, distorted communication, and, in some cases, stigmatization, all of which can affect mental health and quality of life. Therefore, judging from the high occurrence, hearing loss may well be a major source of impaired mental health in the population. However, the evidence of associations between hearing impairment and mental health is diverse. A number of early studies (3–10) taking place from 1946 to 1980 were mostly based on clinical samples, often without a control group. Regardless of methodological limitations and heterogeneous results, however, Jakes (11), reviewing all these studies, concluded, "Most of the evidence presented appears to suggest that emotional disturbance of more than a transitory nature does occur with hearing loss, and that it is reduced when that hearing loss is cured" (p. 78).

More recent results are also divergent. At least four studies (12–15) showed associations between self-reported hearing loss and depression, but one of these (12) also recorded speech audiometry, and did not demonstrate any relationship between increased audiometric thresholds and depression. Another study showed a close to significant ($p = .06$) association between audiometric results and depression scores (16). A reduction of depressive symptoms after fitting of hearing aids has been demonstrated (17,18). One study could demonstrate clearly impaired mental health among people with postlingual deafness (age of onset of hearing impairment after 3 years) but only moderately impaired mental health among prelingually deaf people (19).

Most of the previous results on the relationship between hearing impairment and mental health are based on small or moderately sized samples. In addition to possible systematic bias effects, random fluctuations may have substantially affected the results. The aim of the present study is to estimate precisely the possible association between hearing impairment, measured by pure tone audiometry, and self-report symptoms on mental health separately for different age groups. The study is one of the first in which such associations have been examined in a large, normal population sample. Mental health variables for which effects of hearing loss are tested are symptoms of anxiety and depression, self-esteem, and subjective well-being.

MATERIALS AND METHODS

Sample

During the period August 1995 to June 1997, the adult population of the 24 municipalities of Nord-Trøndelag County, Norway, was invited to take part in a health screening survey, the Nord-Trøndelag Health Study (HUNT). The survey included as an integrated project the Nord-Trøndelag Hearing Loss Study. The population of 17 of the 24 municipalities was invited to the hearing loss study. The invitation list was based on population files stored and continuously updated by the governmental Statistics Norway.

Age ranged from 20 to 101 years (mean, 50.2; SD, 17.0). The participation rate was 68.7%, 64.7% among male subjects and 72.7% among female subjects, for all municipalities together except one, in which, for certain reasons, only 42.1% participated. Altogether, there were valid audiometry and questionnaire data from 50,398 adult subjects. Audiometry data were missing for 1252 people. The participation rate was less than 50% for the youngest subjects (<30 years old), including students and young men in military service. In Norway, students and persons who serve their 12-month compulsory military service, and who usually live temporarily in another county, keep their childhood home address unless married, so a large part of the youngest population did not have the chance to attend the screening. The participation rate increased with age to approximately 60 years and ranged from 75% to 87% for people 50 to 80 years old.

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Audiometry

Two teams who traveled around in the county together with the HUNT conducted the hearing examination. Interacoustics AD25 automatic audiometers with TDH-39 earphones and MX 41/AR cushions were linked to a personal computer, and the audiometry data were automatically stored on the personal computer. An automatic procedure with fixed frequencies was followed. Manual audiometry was conducted with people unable to follow the instructions for the automatic procedure. The tests of each ear included the standard frequencies 0.25, 0.5, 1, 2, 3, 4, 6, and 8 kHz. For the present purpose, three hearing scores were computed: a) low frequency hearing level (0.25-kHz and 0.5-kHz thresholds, averaged over frequencies and both ears), b) middle frequency hearing level (1 kHz and 2 kHz), and c) high frequency hearing level (3 kHz, 4 kHz, 6 kHz, and 8 kHz).

Semiportable, dismountable sound attenuation booths (Tegnér) were used. Background noise was measured at a random sample of the rural examination rooms and all the examination rooms in the towns. The results were satisfactory and met the recommended International Organization for Standardization (ISO) standard for audiometric test administration (maximum permissible ambient sound pressure level across the frequency range, 31.5–8000 Hz, varying from 18 dB to 66 dB; 20). However, in some places, the background noise from shutting doors or walking in the room could have affected the low frequency results somewhat. To assess the quality of the audiometric scores, 100 people were tested twice, and test-retest correlations were computed. As previously reported (21), these correlations were 0.89 for low, 0.98 for middle, and 0.99 for high-frequency hearing. Descriptive statistics close to those expected from previous results (1) indicated that our audiometric data were highly valid (22). The sample and the audiometric procedure are described in more detail elsewhere (21).

Questionnaires

While waiting for the audiometric examination in the waiting room, the participants were asked to complete a one-page questionnaire (Hearing Q1). An item about acknowledged hearing loss was included: "Do you have a hearing loss of which you are aware?" ("yes," "no," or "perhaps"). There were 11 items on working on various working places and 10 items on various types of occupational noise—for instance, "sledge hammer" and "chain saw." An indicator was generated based on these items and one global item on occupational noise. The calculation of this indicator is detailed elsewhere (21). The questionnaire included 10 items from the Symptoms Checklist-25 (23,24), four tapping symptoms of anxiety, and six tapping depression. Separate scores for anxiety and depression and a global score were computed by summing the values (1–4) from each item. The 10 items were selected by a stepwise regression analysis of data on the Symptoms Checklist-25 from another data material (25), regressing each item on the total score. The correlation between the short form and original anxiety score was 0.91, and the correlation between the depression scores was 0.96. The correlation between the original anxiety and depression scores was 0.73, and the correlation between the corresponding short form scores was 0.69. The á reliability estimates were 0.68 for short form anxiety and 0.80 for short form depression (all statistics calculated from the previous data set; 25).

Another questionnaire (HUNT Q1) was distributed together with the invitation letter to HUNT and completed at home shortly before the examination. One item pertained to perceived functional disability because of hearing loss (scored 0–3: "not at all," "a little," "moderately," and "much"). One item was designed to measure subjective well-being: "When you think about the way your life is going at present, would you say that you are by and large satisfied with life or are you mostly dissatisfied?" (seven answer categories from "extremely dissatisfied" to "extremely satisfied"). Furthermore, the HUNT Q1 included a single item on subjectively assessed general health: "How is your health for the moment?" with four response categories from "poor" to "very good." A single item on educational level was scored as one of five categories from "primary school" (7–10 years of schooling, depending on birth year) to "four years or more at college/university."

Two items, "hearing loss of which you are aware " (from Hearing Q1, scored 0 or 1) and "disability due to hearing loss" (from HUNT Q1, scored 0–3), were summed to generate a new variable, self-reported awareness of hearing loss (scored 0–4).

A second HUNT questionnaire (HUNT Q2) was handed out during the examination, completed at home, and returned by mail by 84% of the hearing loss study participants. This questionnaire included four questions taken from the Rosenberg self-esteem instrument (26). The items were selected by linear regression analysis of another data material (27). A sum of the four items correlated at 0.95 with the score from the original instrument. Cronbach á was 0.80 for the four-item short version. The HUNT Q2 included an item on marital status, for the present analyses coded as "married" or "not married."

In cases with one item with missing data, the missing value was substituted with sample means for the anxiety, depression, and self-esteem scores. Scores with more than one missing value were discarded. The self-esteem and well-being scores were approximately normally distributed, whereas the anxiety and depression scores were highly skewed with tails upwards. The anxiety and depression scores were logarithm-transformed to obtain closer to normal distributions.

The HUNT 1995 to 1997 is a follow-up of a previous study of the Nord-Trøndelag population, the HUNT 1984 to 1986. The majority of the participants from the first study, 64,484 subjects, completed two questionnaires, both including the same well-being item. These data, typically reported with a time lag of 1 to 2 weeks, were used for the calculation of test-retest reliability for the well-being scores.

Statistical Methods

Regression analyses were conducted separately for men and women in the age groups 20 to 44 years, 45 to 64 years, and older than 64 years. Low, middle, and high-frequency hearing losses were entered as (continuous) independent variables, adjusting for the effect of age. The analyses were run consecutively with anxiety, depression, self-esteem, and subjective well-being as dependent variables.

A possible relationship between hearing loss and mental health could be confounded by social background variables. For instance, noisy work could be a risk factor for both hearing loss and mental health problems, producing a spurious correlation between hearing loss and mental health. Likewise, to the extent that poor self-rated general health is correlated with hearing loss and with mental health, apparent effects of hearing loss on mental health could actually reflect effects of poor health. To check for such possible confounding, we entered occupational noise, educational level, marital status, and subjectively assessed health as covariates in the multiple regression analyses. Complete data on the four possible confounders were available only for those 84% of the sample who had completed HUNT Q2. Therefore, to keep the full sample size in the main analyses, these variables were entered only in a supplementary analysis of one subsample.

Another set of regression analyses included awareness of having a hearing loss as predictor. These analyses were rerun separately because effects of self-reported hearing loss above effects of measured hearing loss may primarily reflect self-report bias. Thus, we tested to what extent previously published results on the effects of self-reported hearing loss on mental health might have been inflated by self-report bias.

Interaction effects among hearing loss, age, and sex were tested with multiple regression analyses, consecutively entering the products of hearing loss and age, of hearing loss and sex, and of hearing loss, age, and sex, together with the hearing loss variables. Possible nonlinear effects, particularly effects of strong or profound hearing loss, were tested using the computer program S-PLUS (Mathsoft, Seattle, WA), procedure GAM (28). The program tests for nonlinear trends and produces smoothed curves. Adjusting for age, the option standard setting with quadratic splines and the default 4 degrees of freedom as smoothing parameter were chosen. Scores higher than 90 dB were treated as 90 dB.

RESULTS

Reliability and Intercorrelations

Test-retest correlations among 99 randomly drawn subjects examined with audiometry twice were 0.89 for low frequencies, 0.98 for medium frequencies, and 0.99 for high frequen-

cies. The correlations between right and left ear hearing loss ranged among the various age and sex groups from 0.52 to 0.62 for low frequencies, 0.63 to 0.76 for medium frequencies, and 0.67 to 0.81 for high frequencies. The alpha reliability was 0.67 for the anxiety score, 0.80 for the depression score, and 0.71 for self-esteem. The test-retest reliability for the single well-being item, calculated with data from the HUNT 1984 to 1986 study, was 0.68.

The intercorrelations between the mental health measures were as follows: between (ln-transformed) anxiety and depression, 0.63; between anxiety and self-esteem, −0.28; between anxiety and well-being, −0.36; between depression and self-esteem, −0.39; between depression and well-being, −0.47; and between self-esteem and well-being, 0.38.

Main Effects of Hearing Loss

Entering low-frequency, medium-frequency, and high-frequency hearing level in regression analyses conducted for six age and sex groups separately (young, middle-aged, and old men and women) showed significant effects of low-frequency hearing only. Effects of age on the dependent variables were removed before the multiple regression analyses. The effects of low-frequency hearing loss on mental health were shown as nonstandardized regression coefficients in Table 1. The coefficients for the other hearing frequencies were in almost all cases much lower, and were not tabulated (but are shown for middle-aged men in Table 2, row 1). All coefficients for low-frequency hearing were significant at a 5% level except for those for depression and self-esteem among old men and women and subjective well-being among young and middle-aged women. Only two other coefficients reached significant values, those for high-frequency hearing and self-esteem among young and among middle-aged women. The regression coefficient, calculated as proportions of 1 SD of mental health per 10 dB hearing loss, varied across age, sex, and type of dependent variable from 0.00 to 0.10. The latter value, which applies for depression among young and middle-aged men, means that the expected depression symptom level on average increases with half a SD among subjects with a 50-dB low-frequency hearing reduction, which is considered a quite serious loss. The audiometric scores range from −10 dB (extremely good hearing) to 120 dB (deaf). The effects are shown as standardized regression effects in Table 3, column A.

Interaction Effects Among Age, Sex, and Hearing Loss

Tables 1 and 3 show a clear age trend for decreasing effects of hearing loss with increasing age. This trend appeared in both sexes and, with the exception of anxiety, is even reflected by the estimates of explained variance, despite the fact that hearing problems increase dramatically with age. The interaction effect between hearing loss and age was tested by entering the product of age and low-frequency hearing loss together with age, sex, and low, medium, and high-frequency hearing loss as a predictor in multiple regression analyses of the total sample. The effects of low-frequency hearing loss decreased significantly with age ($t \geq 2.78$; $p \leq .005$ for all dependent variables). Another trend was stronger effects for men than for women. Substituting the age by hearing loss term with a sex by hearing loss term, this trend reached significance only for self-esteem and well-being ($t \geq 2.86$; $p \leq .004$). The effect of hearing loss tended to decrease more with age among men than among women, but this three-way interaction effect was not significant for any of the mental health variables. Because middle and high-frequency hearing level did not affect mental health much above what could be explained by low-frequency hearing level, only interaction terms for low-frequency hearing were tested.

Nonlinear Effects

There were significant nonlinear trends for self-esteem among young men ($p = .006$) and for all variables among women ($2 \times 10^{-6} < p < 4 \times 10^{-4}$). These trends are depicted in Figures 1 and 2. Stippled lines show 95% confidence intervals. The major trend is that hearing loss less than 20 dB, averaged over all frequency ranges and both ears, affects mental health more than further loss from 20 dB on. Similar tends appeared for the middle-aged part of the sample (not shown) and reached significance for self-esteem ($p = .005$) and well-being ($p = .03$) among middle-aged women. There were no other significant deviations from linearity.

Testing for Confounding

Possible confounding from occupational noise, educational level, marital status, and self-reported health was examined among middle-aged men, for whom the effects of hearing loss were at its strongest, and for whom a relatively strong hearing

TABLE 1. Effects of Low-Frequency (025–0.5 kHz) Hearing Loss on Mental Health-Related Variables[a]

	N[b]	Anxiety	Depression	Self-esteem	Well-being
Men 20–44 yr	9295	.07 (.04, .11)	.10 (.06, .13)	−.10 (−.14, −.06)	−.09 (−.13, −.06)
Women 20–44 yr	10,843	.06 (.02, .09)	.04 (.00, .07)	−.05 (−.09, −.01)	−.03 (−.06, .01)
Men 45–64 yr	8507	.09 (.06, .12)	.10 (.07, .13)	−.05 (−.09, −.02)	−.08 (−.11, −.05)
Women 45–64 yr	9130	.05 (.02, .09)	.05 (.02, .08)	−.04 (−.07, .00)	−.03 (−.06, .00)
Men 65 yr+	5222	.05 (.02, .08)	.02 (−.01, .05)	−.02 (−.05, .01)	−.04 (−.07, −.01)
Women 65 yr+	6165	.05 (.01, .08)	.01 (−.02, .04)	−.01 (−.04, .03)	−.03 (−.06, .00)
N total	49,162	46,188	45,824	39,426	49,162

Note. [a] The effects are given as SDs per 10 dB hearing loss with 95% confidence intervals, adjusted for medium and high-frequency hearing loss.
[b] Numbers valid for well-being.

TABLE 2. Effects (Regression Coefficients, SD per 10 dB) of Low-Frequency (0.25–0.5 kHz), Middle-Frequency (1–2 kHz), and High-Frequency (3–8 kHz) Hearing Loss, Controlling for Occupational Noise, Socioeconomic Background, and Self-Reported General Health, Men 45–64 Years

Controlling for	Anxiety			Depression			Self-esteem			Well-being		
	Low frequency	Medium frequency	High frequency	Low frequency	Medium frequency	High frequency	Low frequency	Medium frequency	High frequency	Low frequency	Medium frequency	High frequency
Age	.09	−.03	.01	.10	−.02	.01	−.06	−.01	−.01	−.08	.01	−.01
Age, occupational noise	.09	−.03	.00	.10	−.02	.00	−.05	−.01	.00	−.08	.01	.00
Age, noise, socioeconomic background	.09	−.03	.00	.10	−.02	.00	−.04	−.01	.00	−.08	.01	.00
Age, noise, background, general health	.06	−.03	.00	.06	−.02	.00	−.03	−.01	.00	−.04	.01	.01

loss induced by occupational noise has been demonstrated (21). These covariates were entered stepwise in multiple regression analyses together with hearing loss. Entering noise and social background did not affect the results, but entering self-reported health resulted in a clearly decreased effect of hearing loss. The results are shown in Table 2.

Effects of Self-Reported Hearing Loss

A new set of regression analyses included self-reported hearing loss together with measured hearing loss as predictor. The effects of awareness of having a hearing loss are shown as standardized regression coefficients in Table 3, columns SR. Even under control for measured hearing loss, self-reported hearing loss explains self reported mental health much better than does measured hearing loss, and the difference increases with age.

DISCUSSION

Our results show a moderate but clear effect of measured hearing loss on anxiety, depression, self-esteem, and well-being. With the possible exception of confounding with general health, to which we will return, we cannot think of any good reason why our estimates should be inflated. It is perhaps more likely that the estimates are somewhat attenuated because of the imperfect reliability of the mental health measures, and because the audiometry data are not perfectly valid as measures of functional hearing loss. Nevertheless, the results imply that the effects of hearing loss on mental health are moderate among young and middle-aged people and almost absent among elderly people. The strongest effects were estimated for depression and self-esteem among young men. In this group, a 50-dB hearing loss for low frequencies, which is a very serious impairment, on average produces a 0.5-SD increase in depression and 0.5-SD loss of self-esteem in addition to slight effects produced by medium and high-frequency hearing loss. Assuming approximately linear effects, 100-dB loss, which is almost equivalent with total deafness, produces deviations of approximately 1 SD for these two variables. It makes sense that effects on self-esteem disappear almost completely with old age, when impaired hearing is normal rather than an unusual disability. Similar but less strong trends apply for anxiety, depression, and well-being. The decreasing effect with age may suggest that the functional loss per se is not the most important cause of impaired mental health and well-being. Old people appear to accept their hearing loss because it is normal. Young people with a less severe hearing loss than what is normal for old people may suffer from being different in terms of not being fully able to function as expected for people at their age. The effects are stronger among men than among women, perhaps because career expectations for men result in stronger feelings of being disabled at work among hearing-impaired men. The data permit only speculations regarding this sex difference, however.

The analyses of nonlinear trends show that among young people, the effects on mental health when hearing is reduced from normal to somewhat impaired (20 dB) are generally

TABLE 3. Effects of Low-Frequency (0.25–0.5 kHz) Hearing Loss and Self-Reported Hearing Loss on Mental Health-Related Variables by Age and Sex, Standardized Regression Coefficients

	Anxiety		Depression		Self-esteem		Well-being	
	A[a]	SR[b]	A[a]	SR[b]	A[a]	SR[b]	A[a]	SR[b]
Men 20–44 yr	.05	.08	.07	.07	−.07	.00	−.07	−.07
Women 20–44 yr	.04	.06	.03	.06	−.04	.00	−.02	−.05
Men 45–64 yr	.08	.12	.08	.16	−.05	−.05	−.07	−.12
Women 45–64 yr	.05	.10	.04	.10	−.03	−.02	−.03	−.08
Men 65 yr+	.07	.15	.03	.16	−.03	−.10	−.04	−.12
Women 65 yr+	.06	.13	.02	.17	−.01	−.07	−.04	−.08

Note. [a] For low-frequency hearing loss, under control for age and medium and high-frequency hearing loss.
[b] For self reported hearing loss, under control for age and low, medium, and high-frequency hearing loss.

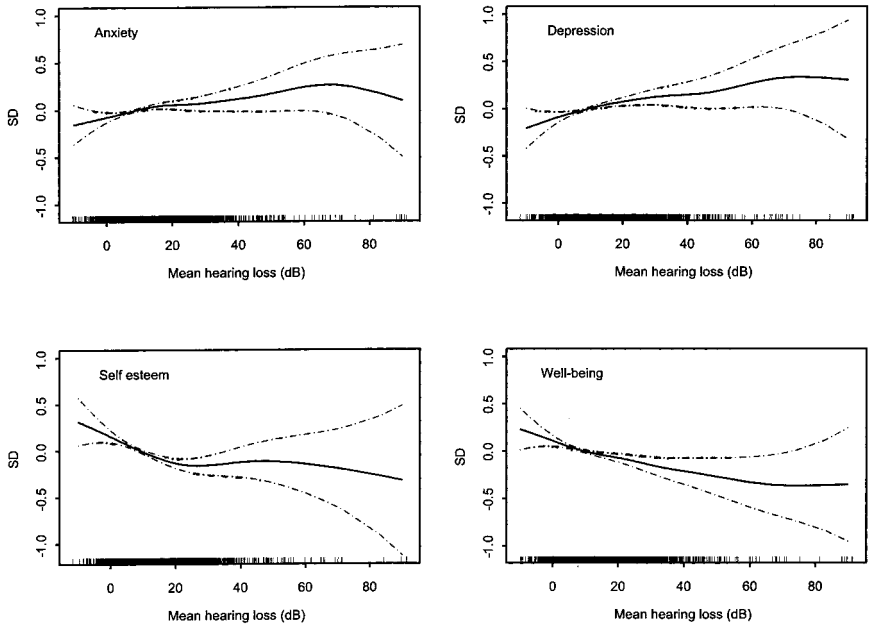

Figure 1. Mental health as a function of hearing loss, men 20 to 44 years old. Stippled lines show 95% confidence intervals.

somewhat more severe than when reduced further from 20 dB to a profound loss (>80 dB). A similar but weaker nonlinear effects was observed among middle-aged people. It appears counterintuitive that a rather mild functional hearing loss, which to a large extent may be restored by hearing aids, is more important to mental health and well-being than losing hearing altogether, even if somewhat impaired in the first place. Our data are not helpful in explaining these surprising results, but some of the explanation could be that severe hearing loss among young and middle-aged people tends to be steady, often innate, whereas a mild loss may more often reflect a gradual loss with time. The experience of a gradual hearing loss may well feel more painful than a more severe but steady hearing loss to which one has adapted.

It may be argued that some of the effects could be confounded with effects from variables like social background and occupation. However, as shown in the supplementary analyses among middle-aged men, controlling for the latter does not make any difference for the estimated effects of hearing loss on mental health. Entering self-reported health substantially reduces the estimated effects for hearing loss. That may partly reflect a confounding effect, but only to the extent that general health and hearing loss are negatively correlated because of third variables such as individual rate of aging. It is equally likely, however, that this negative correlation primarily arises because hearing is regarded as a component of general health, implying that people with poor hearing judge their health as worse than other people, regardless of other health problems. In such a case, in which the effect of hearing loss on mental health is actually partly mediated through worsened perceived health, controlling for self-reported health is tantamount to an overcorrection.

The statistical model and the interpretation of the results are based on the assumption that hearing loss causes poor mental health, and not the other way around, that poor mental health affects the audiometric results. It is possible, however, that poor mental health in some cases has affected the results because of loss of attention during the audiometric examination. Our data do not permit a resolution of this ambiguity.

The fact that almost all the observed effects are from

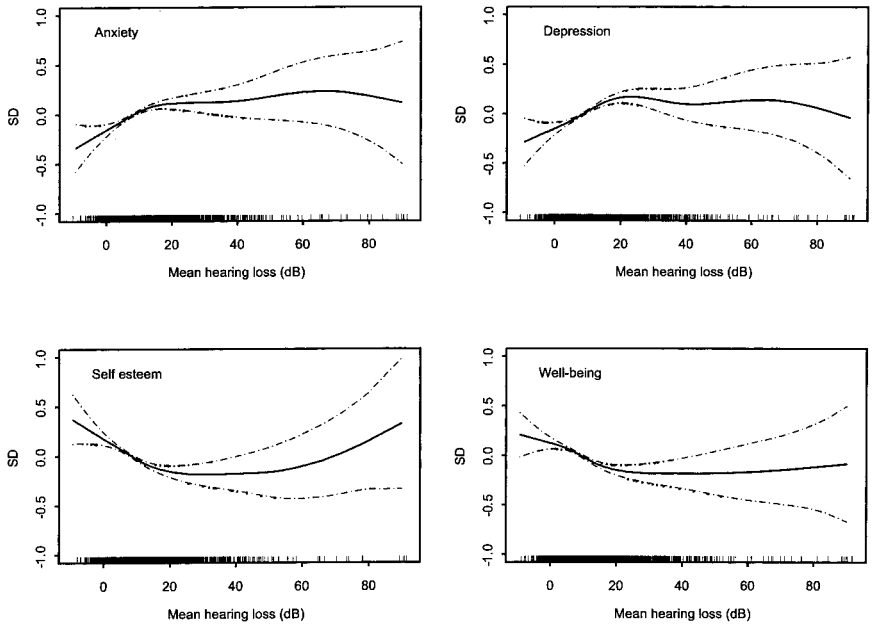

Figure 2. Mental health as a function of hearing loss, Women 20 to 44 years old. Stippled lines show 95% confidence intervals.

low-frequency hearing loss may appear surprising. That does not necessarily mean that low frequency hearing is more important than medium frequencies, however. When hearing is gradually lost, low-frequency hearing is usually kept longer and more intact than higher-frequency hearing. The results probably reflect that as long as the hearing is kept for at least some frequencies (usually low frequencies), it does not make such a crucial difference for mental health whether the hearing is good for other frequency areas. Even if medium-frequency hearing is more important for understanding speech, keeping low-frequency (and a certain part of medium-frequency) hearing may be sufficient to prevent most of the harmful effects regarding communication. Also, when predictors in multiple regression analysis are highly intercorrelated, as here, the predictor most highly correlated with the dependent variable tends to predict the bulk of the variation. If low-frequency hearing were removed from the analyses, medium-frequency hearing would have been taking over some of the predictive power.

The much higher predictive power of self-rated hearing loss than of measured hearing loss probably primarily reflects a reporting bias. People who are generally depressed and discontented tend to report most things, including their hearing, as more negative than do happy people. However, the larger effect of self-rated hearing loss may also stem from a real functional disability that is not fully tapped by audiometry. For instance, people with the same audiometric results can have a quite different ability to communicate verbally, partly because not all characteristics about hearing are measured by audiometry, and partly because ability to communicate depends on a large number of factors, those associated with both the person and the person's environment. Nonetheless, because we do not know to what extent the relatively high effect of self-reported hearing loss is real or just an artifact, self-report exposure data do not appear to be well suited for examining the relation between hearing loss and mental health.

As mentioned, pervious evidence, especially from older studies, is diverse. More recent results are somewhat less heterogeneous, showing no (29) or mostly quite moderate (16,30–32) effects of hearing impairment on mental health and subjective well-being. One study revealed a quite strong relationship between hearing loss and what was termed "quality of life," but the quality-of-life score was based on descriptions of activities requiring a certain hearing acuity ("I enjoy sounds in nature"; 33). Another set of results showed a quite strong relationship between hearing disability and life satisfaction ($r = -0.22$), but the hearing disability scores were based on self-report (34). One study showed slight increases in symptoms of mental distress among deaf men and prelingually deaf women, but a clear increase among postlingually deaf women (43.2% scoring above a threshold value compared with 26.6% among hearing women; 19). Although difficult to compare because of different methods, measures, and statistical power, none of these recent results are in striking contrast with our own results.

Although the present data do not show a strong association between hearing loss and mental health, the effects are more than trivial among young and middle-aged people with severe hearing impairment. The low effects among the elderly does not at all mean that age-related hearing loss should be ignored as a major public health problem. It is beyond the scope of the present article to address possible modifying factors, but, for instance, the psychosocial effects of hearing loss may be worse among people not using hearing aids than among users, and worse among people who also have an impaired vision. Poor social network, certain personality traits, or some types of work may also amplify the consequences. Therefore, some

people may experience hearing loss as very painful. Still, the results certainly do not indicate that a severe loss of well-being and mental health is a regular consequence of hearing loss during high age.

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REFERENCES

1. Wilson DH, Walsh PG, Sanchez L, Davis AC, Taylor AW, Tucker G, Meagher I. The epidemiology of hearing impairment in an Australian adult population. Int J Epidemiol 1999;28:247–52.
2. Moscicki EK, Elkins EF, Baum HM, McNamara PM. Hearing loss in the elderly: an epidemiologic study of the Framingham Heart Study Cohort. Ear Hear 1985;6:184–90.
3. Ingalls GS. Some psychiatric observations on patients with hearing defect. Occup Ther Rehabil 1946;25:62–6.
4. Knapp PH. Emotional aspects of hearing loss. Psychosom Med 1948;10: 203–22.
5. Gildston H., Gildston P. Personality changes associated with surgically corrected hypoacusis. Audiology 1972;11:354–67.
6. Mahapatra SB. Deafness and mental health: Psychiatric and psychosomatic illness in the deaf. Acta Psychiatr Scand 1974;50:596–611.
7. Thomas A, Gilhome-Herbst K. Social and psychological implications of acquired deafness for adults of employment age. Br J Audiol 1980;14: 76–85.
8. Gilhome-Herbst K, Humphrey C. Hearing impairment and mental state in the elderly living at home. BMJ 1980;281:903–5.
9. Singerman B, Fiedner E, Folstein M. Emotional disturbance in hearing clinic patients. Br J Psychiatry 1980;137:58–62.
10. Stephens SDG. Evaluating the problems of the hearing impaired. Audiology 1980;19:205–20.
11. Jakes S. Otological symptoms and emotion. Adv Behav Res Ther 1988; 10:53–103.
12. Jones DA, Victor CA, Vetter NJ. Hearing difficulty and its psychological implications for the elderly. J Epidemiol Commun Health 1984;38:75–8.
13. Maggi S, Minicuci N, Martini A, Langlois J, Siviero P, Pavan M, Enzi G. Prevalence rates of hearing impairment and comorbid conditions in older people. J Am Geriatr Soc 1998;46:1069–74.
14. Cacciatore F, Napoli C, Abete P, Marciano E, Triassi M, Rengo F. Quality of life determinants and hearing function in an elderly population. Gerontology 1999;45:323–8.
15. Strawbridge WJ, Wallhagen MI, Shema SJ, Kaplan GA. Negative consequences of hearing impairment in old age: a longitudinal analysis. Gerontologist 2000;40:320–6.
16. Mulrow CD, Aguilar C, Endicott JE, Velez R, Tuley MR, Charlip WS, Hill JA. Association between hearing impairment and the quality of life of elderly individuals. J Am Geriatr Soc 1990;38:45–50.
17. Mulrow CD, Aguilar C, Endicott JE, Tuley MR, Velez R, Charlip WS, Rhodes MC, Hill JA, DeNino LA. Quality-of-life changes and hearing impairment. Ann Int Med 1990;113:188–93.
18. Mulrow CD, Tuley MR, Aguilar C. Sustained benefits of hearing-aids. J Speech Hear Res 1992;35:1402–5.
19. De Graaf R, Bijl RV. Determinants of mental distress in adults with a severe auditory impairment: difference between prelingual and postlingual deafness. Psychosom Med 2002;64:61–70.
20. ISO 8253–1 acoustics—audiometric test methods—part 1: basic pure tone and bone conduction threshold audiometry. Geneva, Switzerland: International Organisation for Standardisation; 1989.
21. Borchgrevink HM, Tambs K, Hoffman HJ. The Nord-Trøndelag Norway Audiometric Survey 1996–98: unscreened thresholds for adults ≥ 20 years. Submitted.
22. Tambs K, Hoffman HJ, Borchgrevink HM, Holmen J, Samuelsen SO. Hearing loss induced by noise, ear infections, and head injuries: results from the Nord-Trøndelag Hearing Loss Study. Int J Audiol 2003;42: 89–105.
23. Winokur A, Winokur D, Rickels K, Cox DS. Symptoms of emotional distress in a family planning service: stability over a four-week period. Br J Psychiatry 1984;144:395–9.
24. Hesbacher PT, Rickels R, Morris RJ, Newman H, Rosenfeld MD. Psychiatric illness in family practice. J Clin Psychiatry 1980;41:6–10.
25. Tambs K, Moum T. How well can a few questionnaire items indicate anxiety and depression? Acta Psychiatr Scand 1993;87:364–7.
26. Rosenberg, M. Society and the adolescent self-image. New Jersey: Princeton University Press; 1965.
27. Ystgaard M. Sårbar ungdom og sosial støtte. En tilnærming til forebygging av psykisk stress og selvmord. Rapport nr. 1/93. Oslo, Norway: Senter for sosialt nettverk og helse; 1993.
28. S-PLUS 4. Seattle: Mathsoft; 1997.
29. Stewart MG. Outcomes and patient-based hearing status in conductive hearing loss. Laryngoscope 2001;111:1–21.
30. Bazargan M, Baker RS, Bazargan SH. Sensory impairment and subjective well-being among aged African American persons. J Gerontol Psychol Sci 2001;56b:268–78.
31. Wallhagen MI, Strawbridge WJ, Shema MS, Kurata J, Kaplan GA. Comparative impact of hearing and vision impairment on subsequent functioning. J Am Geriatr Soc 2001;49:1086–92.
32. Werngren-Elgström M, Dehlin O, Iwarsson S. Aspects of quality of life in persons with prelingual deafness using sign language: subjective wellbeing, ill-health symptoms, depression and insomnia. Arch Gerontol Geriatr 2003;37:13–24.
33. Espmark AAK, Rosenhall U, Erlandsson S, Steen B. The two faces of presbyacusis: hearing impairment and psychosocial consequences. Int J Audiol 2002;41:125–35.
34. Miyakita T, Ueda A, Zusho H, Kudoh Y. Self-evaluation scores of hearing difficulties and quality of life components among retired workers with noise-related hearing loss. J Sound Vib 2002;250:119–28.