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Deafness and Mortality: Analyses of Linked Data from the National Health Interview Survey and National Death Index

S Y N O P S I S

Objective. To examine the association between age at onset of deafness and mortality.

Methods. The authors analyzed National Health Interview Survey data from 1990 and 1991—the years the Hearing Supplement was administered—linked with National Death Index data for 1990–1995. Adjusting for sociodemographic variables and health status, the authors compared the mortality of three groups of adults ages ≥ 19 years: those with prelingual onset of deafness (\leq age 3 years), those with postlingual onset of deafness ($>$ age 3 years), and a representative sample of the general population.

Results. Multivariate analyses adjusted for sociodemographics and stratified by age found that adults with postlingual onset of deafness were more likely to die in the given time frames than non-deaf adults. However, when analyses were also adjusted for health status, there was no difference between adults with postlingual onset of deafness and a control group of non-deaf adults. No differences in mortality were found between adults with prelingual onset of deafness and non-deaf adults.

Conclusions. Adults with postlingual onset of deafness appear to have higher mortality than non-deaf adults, which may be attributable to their lower self-reported health status.

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Approximately 4.8 million people in the US are deaf.¹ The prevalence of hearing loss is increasing, only partially due to the aging of the population.¹ People who are deaf report poorer health status and utilize health care services differently from the general population,²⁻⁵ yet little information is available about the relationship between deafness and mortality. Knowing the relationship between deafness and mortality will help guide the planning of health services for people with hearing loss.

The two most recent examinations of the association between deafness and mortality report a higher median age at death for deaf people than for non-deaf people.^{6,7} The findings of both studies have limited generalizability due to the selection methods for the deaf group and a lack of information on the nature of the hearing loss.

To accurately study health-related outcomes of deaf people, it is important to consider sociocultural factors. Although typically studied as a single homogeneous population, people with hearing loss form distinctive subpopulations.^{8,9} Within the deaf community, age at onset of deafness often predicts choice of communication mode and social group.⁸ People deafened after early adulthood and completion of their basic education are likely to communicate well in a spoken language such as English, while people deafened prelingually, before the development of language (usually considered to be before age 3 years), are likely to communicate using a signed language such as American Sign Language (ASL). These different communication modes have significant social implications for their users. Differences in age at onset of deafness are associated with differences in utilization of health care services² and differences in health-related behaviors such as smoking.¹⁰ It is not known whether these differences are associated with differences in mortality.

For the present study, we examined, using data from a national survey, the association between deafness and mortality in analyses that considered the age at onset of deafness.

METHODS

Sources of data. The National Health Interview Survey (NHIS) collects data on the civilian noninstitutionalized population of the US using in-home interviews. The sampling procedure follows a multistage probability design that includes oversampling of minority populations. Members of the armed forces, US nationals living abroad, homeless people, and institutionalized people, including

nursing home residents, are excluded. The information collected includes the sociodemographic and health characteristics of people living in the surveyed households. In addition to the core questions asked of all participants, sets of questions are administered to randomly selected subsets of participants. The NHIS's overall nonresponse rate for 1990-1991 was 4.4%, 2.7% as a result of respondent refusal, and the remainder as a result of failure to locate the respondent.¹

Mortality information for NHIS respondents is available in the NHIS Multiple Cause of Death Public Use Data File,¹¹ which links NHIS data with the National Death Index (NDI). The NDI is a computer file of deaths in the US since 1979 maintained by the National Center for Health Statistics (NCHS). The NDI has been found to be an accurate way of ascertaining deaths using personal identifiers.¹²⁻¹⁴

In 1990 and 1991, the NHIS core questionnaire included questions related to hearing ability in a Hearing Supplement. The Supplement included three screening questions used to identify hearing loss among respondents and other household members. For people with hearing loss, the Supplement also included two scales to rate hearing ability as well as questions regarding the age at onset of the hearing loss.

One hearing scale used was the self-rated scale (SRS). For each person with hearing loss in the household, participants rated the hearing ability of each ear without the use of hearing aids on a 4-point scale, ranging from "good" (a score of 1) to "deaf" (a score of 4). For people with hearing loss older than 3 years of age, a second scale, the Gallaudet Hearing Scale (GHS), was also administered. This 5-point scale rates how well a person can usually hear and understand speech without the use of hearing aids, ranging from the "ability to hear and understand whispered speech" to the "inability to hear or understand any speech."

For those with hearing difficulties, respondents were asked to identify the age at which the hearing problems began or the age at which they became deaf as well as the *age range* for the onset of hearing trouble or deafness (before or after the 19th birthday and before or after the 3rd birthday).

For the present study, we defined deafness using the criteria established in earlier studies.^{1,15} Individuals were defined as deaf if they: (a) indicated on the SRS that they had at least "a lot of trouble hearing" in both ears (an SRS score of ≥ 3 for each ear) or (b) indicated on the SRS that they had at least "a little trouble hearing" in their better ear (an SRS score of ≥ 2 in both ears) and indicated on

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the GHS that they could not hear or understand any speech (a GHS score of 5). The members of the resulting deaf study population had bilateral hearing loss that interfered with understanding speech.

Study population. We limited our analyses to deaf adults ages 19 years and older included in the 1990 and 1991 NHIS samples ($N = 2728$). We divided this deaf study population into two subpopulations based on whether the onset of hearing loss was pre- or postlingual (before or after age 3) based on the responses of to the NHIS questions regarding the *age range* for the onset of hearing loss (before or after 3rd birthday and before or after 19th birthday). For our analyses, we included the 12 people who reported the onset of hearing loss before their 19th birthday but were unsure whether it was before age 3 in the postlingual group. (See Table 1.)

We compared the two deaf subpopulations with a control group comprised of the non-deaf adults with hearing problems in the 1990 and 1991 NHIS samples (those for whom the answer was yes to the question "Do you have a problem hearing?" but did not meet our definition of deafness) and a 20% random sample of adult respondents without hearing problems.

Data analysis. Because the NHIS uses a complex multi-stage stratified probability design to sample households, we used the statistical package SUDAAN¹⁶ for the analyses reported here. The SUDAAN program uses a Taylor series approximation method to compute variances, which allows adjustment for the multistage probability sampling strategy. In calculating weighted percentages,

we used the weights provided on the NHIS public use tapes to adjust for oversampling and nonresponse rates.

Demographic characteristics. We compared the prelingually deafened, postlingually deafened, and control group on each of the following demographic variables: sex, racial category (white vs non-white because of small numbers), metropolitan vs non-metropolitan residence (based on the US Office of Management and the Budget's designations of Metropolitan Statistical Areas), presence of telephone in the home, educational level, household income, and age.

Health status. We used the Healthy People 2000 Years of Healthy Life (YHL) measure¹⁷ as an indication of self-reported health status. The YHL measure is a subset of questions from the NHIS¹⁸ which assesses health on a continuum from 0.0 (death) to 1.0 (optimal health). The YHL measure incorporates two domains, self-rated health and role limitations, which are combined using multiattribute utility scaling.¹⁷ The measure takes into account age and social role¹⁷ and has been shown to have reasonable validity.^{17,19,20}

Mortality rates. To determine the mortality rates of the members of the two deaf groups and the non-deaf group, we used the methods described by NCHS.¹¹ For those in the 1990 NHIS sample, we derived death rates for 1990 through 1995, and for those in the 1991 NHIS sample, we derived death rates for 1991 through 1995.

NCHS matches records from the NDI and NHIS using name, date of birth, and social security number;

Potential matches are considered to be “true” or “false” matches based on a classification and scored weighting system that includes the above items as well as sociodemographic characteristics and birth place. We used the NCHS recommended scoring cutoff; for NHIS cohorts, this should correctly classify more than 97% of true matches and more than 97% of false matches. NHIS participants whose records were not linked with the NDI due to insufficient information were not included in our analyses.

Survival analyses. We looked at the association between survival and deafness using a Cox proportional hazard survival analysis to adjust for potential confounding variables. We analyzed prelingual and postlingual onset of deafness separately, with the control group as the reference group. We adjusted the survival analyses for age, sex, racial category, marital status, and educational level—the factors that showed a statistically significant effect on survival and affected the parameter estimates for the effects of prelingual or postlingual onset of deafness by 10% or more. Since age and mortality have a non-linear relationship, we also adjusted for age squared.

We stratified the analyses of the postlingual onset group by age because of the large difference in mean age between the control group and the postlingual onset group.

We also performed a separate set of analyses adjusted for health status to assess the impact of health status on mortality.

RESULTS

The relative frequencies of ages at onset of hearing loss for 2449 deaf adults responding in 1990 and 1991 to the NHIS question regarding the *exact age* at onset showed two peaks—one before age 3 and a second after age 60 (data not shown).

Table 1 shows the distribution of responses to the question regarding age range for the onset of hearing loss.

Table 2 shows the distributions of the sociodemographic and health status variables and unadjusted mortality rates for the prelingual onset group, the postlingual onset group, and the non-deaf group.

When compared with a representative sample of the general population, adults with either prelingual or postlingual onset of deafness were less likely to be married, were more likely to be identified as white, were likely to have less education, and were likely to have lower income. Both deaf groups also reported lower overall health status than

the control group. Prelingually deafened adults were less likely than those in the control group to have a telephone. Postlingually deafened adults were more likely than those in the control group to be older and to live in a non-metropolitan area. The mortality rate was higher for adults with postlingual onset of deafness, regardless of age group, than for the control group.

The results of the adjusted multivariate analyses are shown in Table 3. In analyses that were not adjusted for health status, we found that adults with postlingual onset of deafness were more likely to die during the given time frames than non-deaf adults. After adjusting for health status, however, we found no significant relationship between deafness and mortality. For the prelingual onset group, there was no evidence of higher mortality than for non-deaf adults, with or without adjustment for health status.

We performed multivariate survival analyses excluding people from the control group reporting a hearing problem but who were not deaf and found mortality results very similar to those reported (not shown).

DISCUSSION

In analyses that were adjusted for sociodemographic variables (age, age squared, sex, racial category, marital status, and educational level), postlingual onset of deafness was associated with higher mortality than that of a representative sample of the general population. When analyses were adjusted for health status, the relationship between postlingual onset of deafness and mortality was

Table 1. Onset of hearing loss for deaf adults, National Health Interview Survey, 1990 and 1991 (N = 2728)

Age at onset category	Unweighted number	Unweighted percent
Prelingual (before 3rd birthday)	183	6.7
Postlingual		
Between 3rd and 19th birthdays	273	10.0
Before 19th birthday but not sure if before 3rd birthday	12	0.4
After 19th birthday	2260	82.8

NOTE: Percentages do not sum to 100.0 due to rounding errors.

Table 2. Individual/household sociodemographic characteristics, health status, and mortality among adults ages 19 years and older, National Health Interview Survey, 1990 and 1991

Characteristic	Control group			Prelingual onset			Postlingual onset		
	Weighted percent	Standard error	Unweighted n	Weighted percent	Standard error	Unweighted n	Weighted percent	Standard error	Unweighted n
Male	46.9	± 0.3	49,546	48.1	± 3.6	183	59.1 ^a	± 1.0	2545
White	85.1	± 0.6	49,546	91.0 ^a	± 2.4	183	93.2 ^a	± 0.7	2545
Reside outside a MSA	21.5	± 0.7	49,546	23.9	± 3.3	183	33.5 ^a	± 1.7	2545
Married not separated	66.1	± 0.4	48,775	49.8 ^a	± 4.3	182	61.3 ^a	± 1.1	2544
Have a telephone	95.0	± 0.2	49,313	86.8 ^a	± 3.2	181	96.2	± 0.4	2538
Educational level			48,373			180			2509
Less than 12 years	20.7	± 0.4		34.5 ^a	± 4.1		45.5 ^a	± 1.3	
High school graduate	37.9	± 0.4		40.1	± 4.0		30.4 ^a	± 1.0	
Beyond high school	41.4	± 0.5		25.3 ^a	± 4.0		24.1 ^a	± 1.1	
Household income			49,546			183			2545
Less than \$10,000	27.6	± 0.6		30.6	± 3.7		39.6 ^a	± 1.3	
\$10,000–\$19,999	15.9	± 0.3		18.8	± 3.4		23.2 ^a	± 0.9	
\$20,000–\$34,999	21.3	± 0.4		26.8	± 4.1		18.1 ^a	± 0.9	
≥\$35,000	35.2	± 0.5		23.8 ^a	± 3.6		19.1 ^a	± 1.1	
	Weighted mean	Standard error	Unweighted n	Weighted mean	Standard error	Unweighted n	Weighted mean	Standard error	Unweighted n
Age (years)	44.0	± 0.2	49,546	44.5	± 1.5	183	70.0 ^a	± 0.4	2545
Health status score ^b	0.85	± 0.00	49,546	0.68 ^a	± 0.02	183	0.62 ^a	± 0.01	2545
	Weighted percent	Standard error	Unweighted n	Weighted percent	Standard error	Unweighted n	Weighted percent	Standard error	Unweighted n
Mortality									
Ages 19–64 years	4.5	± 0.1	34,297	3.7	± 1.7	135	10.4 ^a	± 1.1	731
Ages ≥65 years	22.3	± 0.6	10,729	28.2	± 8.5	28	34.8 ^a	± 1.2	1537

NOTES: Mortality is defined as the weighted percent of respondents who died during the years 1990–1995 for those included in 1990 survey and during the years 1991–1995 for those included in 1991 survey.

^aSignificantly different from the control group

^bBased on responses to a set of questions assessing health status on a continuum from 0 (death) to 1.0 (optimal health)

MSA = Metropolitan Statistical Area, as defined by the US Office of Management and Budget

attenuated and no longer statistically significant. These findings are consistent with those of other studies that looked at the relationship between disability and mortality. For example, one study found that the association between mortality and vision or hearing deficits in older people was due to differences in physical health status and social functioning.²¹

The association between mortality and health status for adults with postlingual onset suggests that the higher

mortality in this group may be due to the presence of other chronic health conditions. However, the YHL measure includes items, such as restrictions in activities of daily living, that may be affected by deafness. Consequently, we may have masked the effect of deafness on mortality by adjusting for health status.

Limitations. There are a number of other limitations to this study. First, it is difficult to draw conclusions

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about differences in mortality between adults with prelingual and postlingual onset of deafness because of the small sample size of adults with prelingual onset. In an earlier study we found that adults with prelingual onset had poorer health status and fewer physician visits than hearing people.² It would be interesting to know if these factors are associated with differences in mortality between deaf and non-deaf populations. Future studies should oversample deaf people to permit these analyses.

It is unlikely that nonresponse to the survey or the use of self-report produced significant bias. The NHIS's overall nonresponse rate was low. Self-reported health status²² and self-reported hearing status on the NHIS Hearing Supplement²³ have been shown to be valid measures.

Because the NHIS excludes institutionalized people, our findings do not reflect mortality among elderly nursing home residents, 22% of whom were found to be hearing impaired in 1995.²⁴ We do not know what percentages of nursing home residents were hearing impaired in 1990 and 1991 or what percentages of hearing impaired nursing home residents would have met our definition of deafness.

Further, the hearing loss categories used in this study are likely to have resulted in some misclassification bias. For example, not all people deafened prelingually (before age 3 years) use ASL, so their sociocultural ties to the deaf community may be weaker than those of ASL users.²⁵ It is also possible that additional categories based on the age at onset of hearing loss might show sig-

Table 3. Adjusted relationship between the onset of deafness and mortality among adults ages 19 years and older, National Health Interview Survey, 1990 and 1991

Deaf group	Adjusted for sociodemographic variables		Adjusted for sociodemographic variables and health status	
	Hazard ratio	95% CI	Hazard ratio	95% CI
Prelingual onset	0.97	0.58, 1.64	0.82	0.48, 1.41
Postlingual onset				
Ages 19–64 years	1.32	1.05, 1.64	1.05	0.84, 1.32
Age 65 years and older . . .	1.15	1.03, 1.27	0.99	0.88, 1.10

NOTE: The sociodemographic variables were age, age squared, sex, racial category (white vs non-white), educational level, and marital status.

nificant differences among adults with postlingual onset. However, using at least two categories of people with hearing loss, as in the present study, is a more appropriate way to study the deaf population than considering people with serious bilateral hearing loss as one homogeneous population. We used age at onset of hearing loss as a surrogate for the preferred communication mode of deaf people, assuming that adults with prelingual onset of deafness use ASL and those with postlingual onset use written or spoken English and that they therefore belong to two socioculturally distinct subpopulations.

That these sociocultural distinctions may be associated with differences in mortality was a premise of this study. Preferred mode of communication may have been a more valid way to categorize deaf people for the purpose of these analyses, but those data are not available. The findings of this study suggest that more direct questions about modes of communication used by deaf people should be included in future surveys.

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