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Prevalence of Hearing Loss in Older Adults in Beaver Dam, Wisconsin

The Epidemiology of Hearing Loss Study

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There are no recent population-based data on the prevalence of hearing loss in older adults using standard audiometric testing. The population-based Epidemiology of Hearing Loss Study was designed to measure the prevalence of hearing loss in adults aged 48–92 years, residing in Beaver Dam, Wisconsin. Hearing thresholds were measured with standardized protocols using pure-tone air- and bone-conduction audiometry in sound-treated booths. The examination also included an otoscopic evaluation, screening tympanogram, and a questionnaire on hearing-related medical history, noise exposure, other potential risk factors, and self-perceived hearing handicap. Of the 4,541 eligible people, 3,753 (82.6%) participated in the hearing study (1993–1995). The average age of participants was 65.8 years, and 57.7% were women. The prevalence of hearing loss was 45.9%. The odds of hearing loss increased with age (odds ratio (OR) = 1.88 for 5 years, 95% confidence interval (CI) 1.80–1.97) and were greater for men than women (OR = 4.42, 95% CI 3.73–5.24). The male excess of hearing loss remained statistically significant after adjusting for age, education, noise exposure, and occupation (OR = 3.65). These results demonstrate that hearing loss is a very common problem affecting older adults. Epidemiologic studies are needed to understand the genetic, environmental, and sex-related determinants of age-related hearing loss and to identify potential intervention strategies. *Am J Epidemiol* 1998;148:879–86.

aging; hearing loss, sensorineural; presbycusis; prevalence; sex

Among older adults, hearing loss is one of the most common self-reported conditions. In the Health Interview Survey, 27 percent of people over 65 years reported having a hearing problem (1). More recently, it has been reported that the prevalence of hearing impairments among those aged 65 years and over may be increasing (2). These studies, based on self-report, probably underestimate the prevalence of hearing loss because people may have been unaware of a hearing loss or unwilling to admit to having a problem. In spite of the frequency of self-reported hearing loss, few epidemiologic studies have been conducted to evaluate the prevalence, incidence, and risk factors associated with hearing loss in older adults. There are no recent population-based prevalence data for older adults in the United States using conventional audiometric measures of hearing. In the Health and Nutrition Examination Survey conducted in the 1970s, the prevalence of hearing loss was 30 percent for people aged 65–74 years (3). During examinations 15 (1978–1979) and 18 (1983–1985), audiologic evaluations were conducted as part of the Framingham Heart Study (4, 5). In these studies, the prevalence of hearing loss was 42–47 percent. The population-based Epidemiology of Hearing Loss Study was designed to evaluate the descriptive epidemiology of hearing loss in older adults in Beaver Dam, Wisconsin. This article reports the prevalence data from the baseline audiologic examination (1993–1995).

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Abbreviations: CI, confidence interval; db, decibels; mmhos, acoustic millimhos (the unit of measurement for acoustic admittance); OR, odds ratio; Y_{tm}, peak compensated static acoustic admittance; V_{ea}, equivalent ear canal volume.

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MATERIALS AND METHODS

During 1987–1988, a private census was conducted to identify residents of the city or township of Beaver Dam who were aged 43–84 years (6). This cohort was subsequently invited to participate in the Beaver Dam Eye Study, a study of age-related ocular disorders (7, 8). Of the 5,924 eligible people, 4,926 (83 percent) participated in the eye examination phase (1988–

1990). Participants alive as of March 1, 1993, were eligible for the hearing study (n = 4,541) that occurred at the time of the 5-year follow-up visit for the eye study. Of those eligible, 3,753 (82.6 percent) participated in the hearing study, 180 (4.0 percent) died prior to being seen, 604 (13.3 percent) refused to participate, and four (0.1 percent) were lost to follow-up. Some participants (n = 182) refused the hearing testing but completed the interview.

The hearing examination included an otoscopic evaluation (9), a screening tympanogram (9, 10) (GSI 37 Autotymp; Lucas GSI, Inc., Littleton, Massachusetts), and pure-tone air- and bone-conduction audiometry. Audiometric testing was conducted according to the guidelines of the American Speech-Language-Hearing Association (11, 12) in sound-treated booths (Industrial Acoustics Company, New York, New York) using Virtual 320 clinical audiometers (Virtual Corporation, Seattle, Washington) equipped with TDH-50 earphones. Insert earphones (E-A-Rtone 3A; Cabot Safety Corp., Indianapolis, Indiana) and masking were used as necessary. Pure-tone air-conduction thresholds were obtained for each ear at 250, 500, 1,000, 2,000, 3,000, 4,000, 6,000, and 8,000 Hz. Bone-conduction thresholds were measured at only two frequencies (500 and 4,000 Hz) because of time constraints. People unable to travel to the clinic site (nursing home residents, home-bound participants, and people living in remote areas; n = 132) were tested at their place of residence using a Beltone 112 portable audiometer (Beltone Electronic Corp., Chicago, Illinois). All audiometers were initially calibrated in accordance with American National Standards Institute standards (12) and were recalibrated every 6 months during the study period. Ambient noise levels were measured at each home or nursing home visit and were routinely monitored at the clinic site at the Beaver Dam Community Hospital to ensure that testing conditions complied with American National Standards Institute standards (13).

A questionnaire about ear and hearing-related medical history, noise exposure (during leisure, military service, and work), and self-perceived hearing function (14) was administered as an interview. Questionnaire data on socioeconomic status, medical history, lifestyle factors, and medication use were obtained as part of the Beaver Dam Eye Study examination.

The Hearing Handicap Inventory for the Elderly (screening version) assesses the emotional and social effects of any perceived hearing loss (14), with higher scores corresponding to a higher degree of perceived hearing handicap and scores >8 indicating the presence of a handicap.

Performance-based assessments of communication difficulties included two word recognition tasks, one in quiet conditions and one with a competing signal (15, 16). Each task consisted of a phonetically balanced list of 50 words from the Northwestern University auditory test no. 6 (female talker version) on compact disk (15, 16). For the quiet condition, the list was presented at 36 decibels (dB) above the better ear threshold at 2,000 Hz. In cases where both right and left ear thresholds were identical, the right ear was used. The second test included the addition of a competing message of a man's voice 8 dB below that of the woman's voice. The score for each test was the percentage of words correct out of 50.

For the purposes of this article, the presence of a hearing loss was defined as a pure-tone average of thresholds at 500, 1,000, 2,000, and 4,000 Hz greater than 25 dB of hearing loss in the worse ear. The worse ear was chosen in order to include people with at least one affected ear. Severity of hearing loss was classified as mild (>25 and ≤40 dB of hearing loss), moderate (>40 and ≤60 dB of hearing loss), or marked (>60 dB of hearing loss) based on this pure-tone average. A conductive loss was considered to be present if an air-bone gap of 15 dB or greater was present at 500 or 4,000 Hz in the ear with the worse hearing. Abnormal middle ear function was considered to be present if 1) an air-bone gap was detected; 2) the tympanogram showed a flat or severely reduced peak compensated static acoustic admittance (peak Y_{tm}) (≤0.1 millimhos (mmhos)), high peak Y_{tm} (≥3.0 mmhos), or an equivalent ear-canal volume (V_{ea}) (≥3.0 cm^3); *or* 3) the examiner reported evidence on otoscopic evaluation of drainage, a bulging or retracted eardrum, a visible air-liquid line, or a perforated eardrum.

The average age of participants was 65.8 years, and 57.7 percent were women. Comparing participants with 1990 Census data for US non-Hispanic whites (17) revealed that the participant group was similar to all US non-Hispanic whites in age and sex distributions but less likely to report high household incomes (table 1).

Comparisons of participants with nonparticipants indicated that nonparticipants were older (68.7 vs. 64.8 years, $p < 0.001$), slightly more likely to be male (46.1 vs. 42.3 percent, $p = 0.055$), and more likely to have died since the examination phase began (22.8 vs. 2.3 percent, $p < 0.001$). Based on data from the baseline eye study (table 2), participants were slightly younger and more likely to be female; had higher household incomes and years of education; were more likely to have reported a hearing loss; were less likely to be current smokers; and had lower cholesterol, higher high density lipoprotein cholesterol levels, and

TABLE 1. Participants in the Epidemiology of Hearing Loss Study (1993–1995) in Beaver Dam, Wisconsin, versus 1990 US Census data for non-Hispanic whites, shown as percentages by sex, age group, and household income

	EHLS* participants† (%)	US NHW*,† (%)
Male sex	42.3	45.4
Age group (years)		
43–49	19.1	23.9
50–59	29.6	25.3
60–69	29.1	24.9
70–79	17.9	17.3
≥80	4.3	8.5
Household income ($)		
≤9,000	16.5	16.5
10,000–19,000	26.1	18.3
20,000–29,000	18.8	15.6
30,000–44,000	21.7	17.8
45,000–59,000	9.6	11.3
≥60,000	7.3	20.5

* EHLS, Epidemiology of Hearing Loss Study; NHW, non-Hispanic whites.
† EHLS participants (n = 3,753); US NHW (n = 73,014,505).

lower systolic blood pressure than surviving nonparticipants. However, the magnitude of these differences was small.

Analyses were conducted using the 1990 SAS version 6.09 software (SAS Institute, Inc., Cary, North Carolina). Univariate analyses used the chi-square test of association for categorical variables, Mantel-Haenszel test of trend for ordinal data (18), and t tests of mean differences for continuous data. Logistic regression was used to evaluate the odds of having a hearing loss associated with age, sex, and socioeconomic factors.

RESULTS

Hearing sensitivity

Mean air-conduction thresholds for frequencies between 250 and 8,000 Hz are presented in table 3, by ear, sex, and age group. Hearing thresholds were slightly worse (higher) for left ears than right ears at frequencies above 250 Hz ($p < 0.05$). This pattern held for men and women and within each age group ($p < 0.05$). Thresholds were higher for men than women ($p < 0.05$) and increased with age at each frequency ($p < 0.05$). For both men and women, hearing sensitivity declined with increasing frequency. This sloping pattern of loss at frequencies above 1,000 Hz is typical of presbycusis and was more pronounced for men than women.

Figure 1 illustrates hearing sensitivity by sex for Beaver Dam participants aged 60–64 years and by published age- and sex-specific data from Framingham (5). There is no evidence of threshold differences between the Framingham data collected in 1983–1985 and the data from Wisconsin collected in 1993–1995.

Prevalence of hearing loss

Overall, the prevalence of hearing loss was 45.9 percent. Of those with a hearing loss, 58.1 percent had a mild hearing loss, 30.6 percent had a moderate loss, and 11.3 percent had a marked loss. People with a hearing loss were more likely to report a hearing handicap (Hearing Handicap Inventory for the Elderly (screening version)) (14) and had worse performance on the word recognition tasks (15, 16) in both the quiet and competing message conditions than did those without a hearing loss (table 4). The percentage of people reporting a hearing handicap increased with severity of loss (5.5, 19.7, 47.5, and 71.4 percent for none, mild, moderate, and severe losses, respectively; p for trend < 0.001).

Hearing loss was usually symmetrical (94.8 percent experienced bilateral hearing loss). Few people had evidence of conductive losses (8.1 percent), a positive history of otosclerosis (0.2 percent), hearing loss with an onset before age 20 years (1.9 percent), or a history of ear surgery (1.7 percent). The prevalence of abnormal middle-ear function was low (12.9 percent). Thirty-six percent of all participants had never had a hearing test.

The prevalence of hearing loss increased greatly with age, and men were more likely to be affected than were women (table 5). A logistic regression model indicated that, for every 5 years of age, the risk of hearing loss increased by almost 90 percent, and men were more than four times as likely to have a hearing loss than were women (odds ratio (OR) = 1.88, 95 percent confidence interval (CI) 1.80–1.97, and OR = 4.42, 95 percent CI 3.73–5.24, respectively).

Education and income level were inversely associated with the prevalence of hearing loss (table 6). After adjustment for age and sex, people who had not completed high school were 2.42 times as likely to have a hearing loss as were those with a college education. People who earned less than $30,000 were about twice as likely to have a hearing loss as were those with incomes of $60,000 or more per year. Occupational exposure to noise was associated with an increased likelihood of having a hearing loss (OR = 1.31). People in service, production, and operations occupations were more likely to have a hearing loss than were those in management positions.

In a multivariate logistic regression model with age, sex, occupation, noise exposure, and education, men remained at excess risk for hearing loss compared with women (OR = 3.65, 95 percent CI 2.97–4.49), sug-

TABLE 2. Characteristics at the Beaver Dam Eye Study baseline examination (1988–1990) by participation in the Epidemiology of Hearing Loss Study, 1993–1995

	Participants (n = 3,753)		Nonparticipants					
			Alive (n = 608)			Dead (n = 180)		
	%	No.	%	No.	p value*	%	No.	p value†
Age group (years)								
43–54	34.4	1,292	31.7	193	<0.01	9.4	17	<0.001
55–64	28.9	1,086	24.0	146		12.8	23	
65–74	25.7	965	23.9	145		27.2	49	
≥75	10.9	410	20.4	124		50.6	91	
Male sex	42.3	1,589	45.6	277	0.029	47.8	86	0.001
Self-reported hearing loss	33.7	1,260	31.2	189	0.034	50.6	90	0.040
Income ($)								
≤9,000	13.5	487	21.4	120	<0.001	32.7	50	0.020
10,000–19,000	26.0	938	28.6	160		38.6	59	
20,000–29,000	21.2	765	19.6	110		15.0	23	
30,000–44,000	22.3	806	18.4	103		10.5	16	
≥45,000	17.1	618	12.0	67		3.3	5	
Education (years)								
<12	24.4	914	41.9	254	<0.001	49.4	88	0.038
12	45.7	1,714	38.1	231		33.2	59	
13–15	15.4	577	11.4	69		10.1	18	
≥16	14.6	546	8.7	53		7.3	13	
Smoking								
Never	45.7	1,714	40.2	244	<0.001	50.0	90	0.028
Past	35.0	1,314	35.6	216		31.7	57	
Current	19.3	724	24.2	147		18.3	33	
Diabetes	7.6	285	8.2	50	0.70	16.7	30	<0.001
Cardiovascular disease	12.1	447	15.4	92	0.19	30.9	54	<0.001
	Mean	No.	Mean	No.	p value*	Mean	No.	p value†
Cholesterol (mg/dl)	233 (44)‡	3,744	238 (45)	605	0.011	232 (47)	174	0.35
High density lipoprotein cholesterol (mg/dl)	53 (18)	3,739	51 (18)	605	0.040	50 (17)	175	0.018
Systolic blood pressure (mmHg)	131 (20)	3,752	135 (21)	608	<0.001	137 (24)	179	0.39
Diastolic blood pressure (mmHg)	78 (11)	3,752	78 (12)	608	0.037	73 (12)	179	0.003

* Living nonparticipants versus participants; all p values with the exception of that for age distribution are adjusted for age.
† Deceased nonparticipants versus participants; all p values with the exception of that for age distribution are adjusted for age.
‡ Numbers in parentheses, standard deviation.

gesting that other risk factors are important contributors to the sex difference in risk. Similar results were obtained when income was included in the model in lieu of education (data not shown).

DISCUSSION

Hearing loss was very common in this population-based study, affecting 46 percent of adults 48–92 years of age. Differences between participants and nonparticipants suggest that these results may slightly underestimate the true population prevalence, as participants were slightly younger and in slightly better health than were nonparticipants. Comparisons with US census data suggest that these data should be generalizable to other groups of non-Hispanic whites (16).

The prevalence of hearing loss increased greatly with age. Among those over age 80 years, the prevalence of hearing loss was 89.5 percent. Men were four times as likely to have a hearing loss as were women after adjustment for age effects. These patterns are

TABLE 3. **Mean pure-tone air-conduction threshold (hearing level in decibels) by frequency, ear, sex, and age, Epidemiology of Hearing Loss Study, 1993–1995**

Sex and age (years)	250 Hz		500 Hz		1,000 Hz		2,000 Hz	
	No.	Mean	No.	Mean	No.	Mean	No.	Mean
				Right ear				
Females								
48–59	674	9.9 (10.6)*	672	8.5 (11.1)	674	10.7 (12.1)	674	10.5 (12.6)
60–69	566	13.6 (13.1)	565	12.9 (14.1)	566	15.7 (14.4)	566	18.0 (16.0)
70–79	534	19.8 (15.8)	533	19.7 (16.6)	534	22.9 (17.4)	532	27.6 (18.6)
80–92	243	29.7 (16.6)	242	30.4 (16.8)	244	34.9 (17.8)	244	41.4 (18.3)
All	2,017	15.9 (15.0)	2,012	15.3 (15.9)	2,018	18.3 (16.9)	2,016	20.8 (18.9)
Males								
48–59	572	11.0 (11.7)	572	8.8 (12.7)	572	11.1 (13.0)	572	15.1 (16.6)
60–69	490	15.2 (13.3)	488	12.2 (13.6)	490	15.8 (14.6)	490	26.2 (20.9)
70–79	356	20.3 (14.1)	356	18.8 (14.5)	358	23.6 (17.5)	358	35.5 (21.1)
80–92	114	30.6 (20.3)	114	31.8 (22.9)	115	38.2 (22.7)	115	52.3 (19.9)
All	1,532	15.9 (14.6)	1,530	13.9 (15.7)	1,535	17.5 (17.3)	1,535	26.2 (22.2)
				Left ear				
Females								
48–59	674	8.7 (11.1)	673	9.2 (11.1)	674	11.7 (11.5)	674	11.8 (12.2)
60–69	566	13.4 (13.8)	565	13.5 (13.1)	565	16.1 (14.0)	565	18.9 (15.3)
70–79	534	18.8 (15.9)	532	19.1 (16.5)	533	22.1 (17.6)	532	28.3 (18.7)
80–92	244	28.2 (16.7)	240	29.9 (16.4)	244	34.4 (18.0)	243	41.3 (17.7)
All	2,018	15.1 (15.3)	2,010	15.5 (15.4)	2,016	18.4 (16.5)	2,014	21.7 (18.4)
Males								
48–59	569	10.5 (12.8)	570	10.0 (13.4)	571	12.8 (13.5)	571	18.0 (17.5)
60–69	489	13.4 (11.5)	489	12.1 (11.6)	489	16.4 (12.8)	489	28.6 (19.3)
70–79	355	20.6 (16.6)	355	20.3 (17.1)	357	25.3 (19.4)	357	38.8 (21.5)
80–92	117	27.4 (16.8)	117	27.8 (18.1)	117	34.8 (19.5)	117	50.4 (17.7)
All	1,530	15.1 (14.7)	1,531	14.4 (15.3)	1,534	18.5 (16.8)	1,534	28.7 (21.6)

Sex and age (years)	3,000 Hz		4,000 Hz		6,000 Hz		8,000 Hz	
	No.	Mean	No.	Mean	No.	Mean	No.	Mean
				Right ear				
Females								
48–59	674	13.1 (13.6)	674	17.2 (15.3)	673	24.1 (16.7)	674	26.8 (19.3)
60–69	566	21.8 (16.7)	563	27.5 (17.6)	565	35.9 (19.8)	566	42.6 (21.9)
70–79	531	32.5 (19.0)	529	39.0 (19.8)	532	50.1 (21.6)	532	60.3 (21.2)
80–92	233	47.1 (18.1)	243	54.3 (17.5)	233	65.0 (17.5)	242	74.7 (17.0)
All	2,004	24.7 (19.9)	2,009	30.3 (21.3)	2,003	39.1 (23.5)	2,014	45.8 (26.3)
Males								
48–59	572	28.5 (21.8)	570	38.3 (22.7)	571	38.8 (21.7)	571	38.6 (22.5)
60–69	488	43.3 (23.6)	489	54.0 (23.7)	489	57.0 (23.8)	489	59.5 (23.9)
70–79	356	51.7 (20.0)	355	62.0 (19.0)	356	66.8 (20.6)	356	71.9 (18.4)
80–92	110	63.5 (17.1)	114	70.5 (17.3)	110	77.0 (16.9)	115	81.3 (15.5)
All	1,526	41.2 (24.4)	1,528	51.2 (24.4)	1,526	53.9 (25.4)	1,531	56.2 (26.3)
				Left ear				
Females								
48–59	674	14.5 (13.9)	673	18.4 (15.7)	673	26.0 (17.0)	673	28.1 (19.2)
60–69	565	23.9 (17.2)	562	28.7 (17.6)	566	38.2 (19.5)	566	44.7 (22.0)
70–79	531	34.9 (19.1)	531	40.9 (19.8)	533	52.4 (21.2)	532	61.6 (20.4)
80–92	233	48.3 (16.8)	243	54.6 (17.0)	234	66.2 (17.2)	242	74.0 (15.8)
All	2,003	26.5 (20.0)	2,009	31.6 (21.3)	2,006	41.2 (23.3)	2,013	47.1 (25.8)
Males								
48–59	571	33.7 (21.8)	564	42.0 (22.6)	569	43.8 (22.0)	570	41.9 (22.9)
60–69	489	46.6 (21.6)	486	55.1 (21.7)	489	59.6 (22.4)	489	61.2 (22.7)
70–79	355	56.1 (19.1)	352	64.6 (19.3)	355	69.7 (18.8)	355	74.1 (18.0)
80–92	112	63.4 (16.4)	117	71.3 (16.8)	112	77.0 (17.3)	117	79.7 (15.5)
All	1,527	45.2 (23.1)	1,519	53.7 (23.5)	1,525	57.3 (24.1)	1,531	58.4 (25.4)

* Numbers in parentheses, standard deviation.

consistent with published reports (1–5, 19–21). The increase of hearing loss with age may reflect the cumulative effects of oxidative damage or other exposures (22). The male excess in hearing loss has been noted by others (4, 5, 19, 23). Men may have a greater risk of hearing loss due to greater noise exposure in occupational settings. However, since the male excess remained after controlling for occupation, history of noise exposure, and education (or income), the male excess may reflect sex differences in exposure to smoking, atherosclerosis, or other potential risk factors for hearing loss (23–25). The associations between

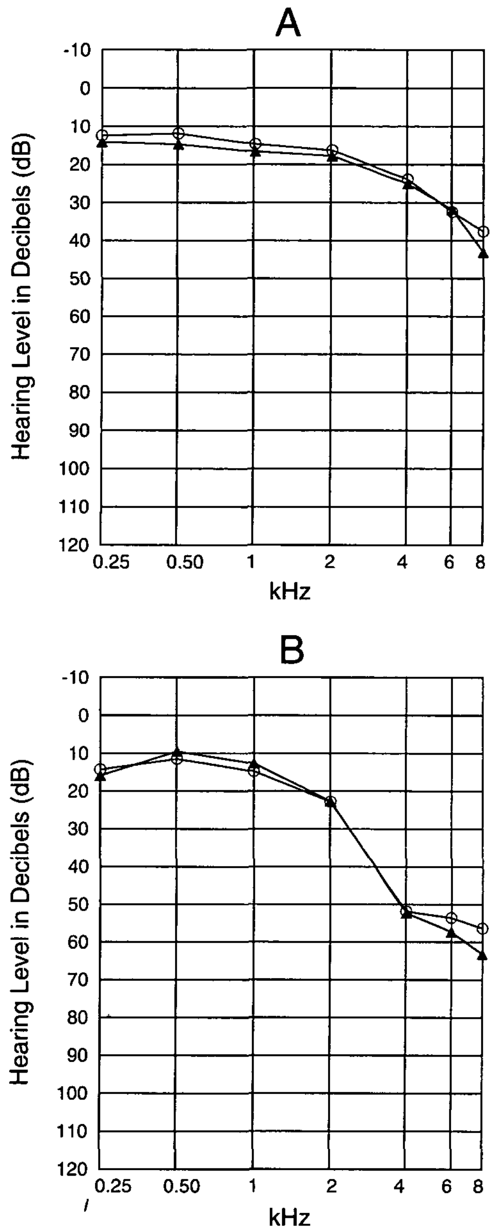

FIGURE 1. Mean air-conduction thresholds for participants 60–64 years old in Framingham, Massachusetts (▲), and Beaver Dam, Wisconsin (○), for females (A) and males (B), Epidemiology of Hearing Loss Study, Beaver Dam, Wisconsin, 1993–1995. Framingham data were published previously (Ear Hear 1990;11:247–56).

indicators of lower socioeconomic status and employment in noisy occupations and hearing loss are consistent with the damaging effects of exposure to loud noise, but they also may be markers of less healthy lifestyle factors.

Comparisons of our prevalence findings with those from other published data are difficult because of the lack of agreement on a standard definition of hearing loss for use in epidemiologic studies, differences in age and sex in the populations tested, and differences

TABLE 4. Hearing loss and self-assessment- and performance-based measures of hearing handicap, Epidemiology of Hearing Loss Study, 1993–1995

Hearing loss	HHIE-S* >8 (%)	Word recognition score (mean)	
		Quiet	Competing message
Absent	5.5	93 (5)†	63 (13)
Present	33.7	83 (15)	40 (21)
p value	<0.001	<0.0001	<0.0001

* HHIE-S, Hearing Handicap Inventory for the Elderly (screening version).

† Numbers in parentheses, standard deviation.

TABLE 5. Prevalence of hearing loss in Beaver Dam, Wisconsin, Epidemiology of Hearing Loss Study, 1993–1995

Sex and age (years)	No. at risk	%
All	3,556	45.9
48–59	1,246	20.6
60–69	1,056	43.8
70–79	892	66.0
80–92	362	90.0
Males	1,538	58.6
48–59	572	32.7
60–69	490	61.8
70–79	359	83.0
80–92	117	96.6
Females	2,018	36.2
48–59	674	10.2
60–69	566	28.1
70–79	533	54.6
80–92	245	86.1

in the test frequencies. Definitions vary regarding which frequencies were included in the pure-tone average and which ear was used for classifying the individual.

In the Health and Nutrition Examination Survey (3), using an average of the thresholds at 500, 1,000, 2,000, and 4,000 Hz for the better ear, 30 percent had a hearing loss. This definition classified people with unilateral losses as unaffected. Applying this definition, the overall prevalence of hearing loss in Beaver Dam was 32.4 percent. Since most older people have bilateral symmetric hearing losses, there was a high percentage of agreement between prevalence estimates using the better or worse ear. We have chosen to focus on the worse ear to include all people affected with a hearing loss, although better ear hearing may be a more important predictor of functional impact. Although the prevalence in Beaver Dam appears similar to that in the Health and Nutrition Examination Survey, the latter data were limited to people 65–74 years of age, while the Beaver Dam Study included people 48–92 years of age.

TABLE 6. Adjusted odds ratios* for hearing loss by indicators of socioeconomic status, Epidemiology of Hearing Loss Study, 1993–1995

	No.	Odds ratio	95% CI†
Education			
College or greater	527	1.00	Referent group
Some college	549	1.63	1.21–2.20
High school	632	1.89	1.48–2.42
Less than high school	847	2.42	1.84–3.20
Income ($)			
≥60,000	355	1.00	Referent group
45,000–59,000	402	1.29	0.89–1.85
30,000–44,000	700	1.75	1.27–2.42
20,000–29,000	646	1.91	1.37–2.66
10,000–19,000	756	2.06	1.47–2.88
0–9,000	330	1.91	1.28–2.84
Occupation			
Management	640	1.00	Referent group
Technical/sales	809	1.26	0.97–1.65
Service	597	1.85	1.40–2.43
Farming/forestry	126	1.28	0.80–2.04
Production	405	3.48	2.53–4.79
Operations/fabricators	700	1.99	1.53–2.59
Occupational exposure to noise			
No	1,557	1.00	Referent group
Yes	1,969	1.31	1.10–1.56

* Adjusted for age and sex.
† CI, confidence interval.

In Framingham (4, 5), several different definitions were used. Moscicki et al. (4) reported a prevalence of 83 percent with hearing loss defined as any threshold >20 dB of hearing loss at any frequency in either ear from 0.5 to 4 kHz; of 31 percent with a better ear pure-tone average of >25 dB of hearing loss for 0.5–2 kHz; and of 47 percent with a pure-tone average of >25 dB of hearing loss for 0.5–4 kHz. Applying these definitions to Beaver Dam yielded prevalence estimates of 80.2 percent, 19.0 percent, and 32.4 percent, respectively. Participants in Framingham were older than those in Beaver Dam, although similar proportions of women were included.

At examination 18, Gates et al. (5) reported the prevalence of hearing loss as 29 percent using a pure-tone average for frequencies 0.5–2 kHz in the better ear of ≥26 dB of hearing loss. Forty-two percent were affected if the threshold at 3,000 Hz was included in the pure-tone average, and 41 percent had an American Medical Association handicap of >10 percent (26). In Beaver Dam, 19.3 percent had an American Medical Association handicap (26) of >10 percent, and 28.1 percent had a hearing loss in the better ear using the definition of Gates et al. (5) that included 3,000 Hz.

Regardless of definition, hearing loss is a frequent problem among older adults. Age- and sex-adjusted comparisons are necessary to determine if the prevalence of hearing loss is increasing as suggested by self-reported data from the Health Interview Survey (2). However, age- and sex-specific comparisons of hearing thresholds in Framingham and Beaver Dam suggest that there are few differences between these two cohorts in mean hearing sensitivity.

The low prevalence of hearing screening reported in the Beaver Dam population and the high prevalence of hearing loss indicate that hearing loss is an important public health problem. While the epidemiology of hearing loss lags behind epidemiologic investigations of other chronic diseases and sensory impairments, there is a clear need to improve our understanding of the etiology of this disorder and to identify intervention strategies to improve hearing-related health and quality of life among older adults. Traditional epidemiologic approaches have the potential to make important contributions to our understanding of age-related hearing loss.

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