

alized in 1982, and 0.85 times as likely in 1989 (no longer significant).

### Conclusion

It is well known that older Blacks are three times as likely as older Whites to be in poverty and half as likely to have completed high school<sup>4</sup> and that these socioeconomic differences generally account for a significant portion of racial differences in health status.<sup>5,6</sup> Unfortunately, education and income measures are not available in the National Long Term Care Survey screener sample, and no other data are currently available to test these trends further. Nonetheless, the disability trends reported here are consistent with the diverging mortality trends of populations of low- and middle-socioeconomic status recently reported in the

literature.<sup>7-9</sup> Substantial, and perhaps increasing, racial disparities in disability coupled with a growing and aging older Black population<sup>3</sup> are likely to lead to considerable increases in the relative and absolute costs of caring for the older Black population of the United States. □

### References

1. Schneider EL, Guralnik JM. The aging of America: impact on health care costs. *JAMA*. 1990;263:2335-2340.
2. *Population Projections of the United States, by Age, Sex, Race, and Hispanic Origin: 1993 to 2050*. Washington, DC: US Bureau of the Census; 1993. Current Population Reports, P25-1104.
3. Manton KG, Corder LS, Stallard E. Estimates of change in chronic disability and institutional incidence and prevalence rates in the US elderly population from the 1982, 1984, and 1989 National Long-Term Care Survey. *J Gerontol*. 1993;48:S153-S166.
4. *Sixty-Five Plus in America*. Washington, DC: US Bureau of the Census; 1992. Current Population Reports, Special Studies, P23-178RV.
5. Clark DO, Maddox GL. Racial and social correlates of age-related changes in functioning. *J Gerontol*. 1992;47:S222-S232.
6. Mendes de Leon CF, Fillenbaum GG, Williams CS, Brock DB, Beckett LA, Berkman LF. Functional disability among elderly Blacks and Whites in two diverse areas: the New Haven and North Carolina EPESE. *Am J Public Health*. 1995;85:994-998.
7. Pappas G, Queen S, Hadden W, Fisher G. The increasing disparity in mortality between socioeconomic groups in the United States, 1960 and 1986. *N Engl J Med*. 1993;329:103-109.
8. Feldman JJ, Makuc DM, Kleinman JC, Comoni-Huntley J. National trends in educational differentials in mortality. *Am J Epidemiol*. 1989;129:919-933.
9. Preston SH, Elo IT. Are educational differentials in adult mortality increasing in the United States? *J Aging Health*. 1995;7:476-496.

## An Increasing Prevalence of Hearing Impairment and Associated Risk Factors over Three Decades of the Alameda County Study

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### ABSTRACT

**Objectives.** This study assessed changes in the prevalence of hearing impairment in persons aged 50 years and older over the past 30 years and identified risk factors.

**Methods.** Age-adjusted hearing impairment prevalence rates at four time intervals were calculated from the Alameda County Study (n = 5108). Logistic regression models analyzed risk factors from 1974 for 1994 incident hearing impairment.

**Results.** The prevalence of hearing impairment nearly doubled between 1965 and 1994. The increase was significantly greater for men. The higher incidence was associated with potentially high-noise-exposure occupations for men and with symptoms and conditions associated with ototoxic drug use for both men and women. Exercise was protective.

**Conclusions.** Given the serious health and social consequences of hearing impairment, its increasing prevalence is cause for concern. (*Am J Public Health*. 1997;87:440-442)

### Introduction

Hearing impairment is significantly associated with multiple negative outcomes including depression, loneliness, altered self-esteem, and diminished functional status.<sup>1-6</sup> It is thus a significant public health issue.

Known causes of hearing loss are multiple. Hearing impairment increases with age, and the most common loss occurs at higher frequencies, making speech especially difficult to understand when there is background noise.<sup>7</sup> Noise itself is considered one of the most common causes of hearing loss in industrial countries, and data support an association between hearing loss and service/blue collar occupations in the United States<sup>8-10</sup>; however, the impact of noise may become less with age.<sup>11</sup> Other causes include pharmacotherapeutic agents, industrial chemicals, rapid changes in ambient pressure, and a number of medical conditions.<sup>12-18</sup> In this study we sought to quantify changes in the preva-

lence of hearing impairment over the last three decades in a representative sample of older adults and to investigate potential risk factors.

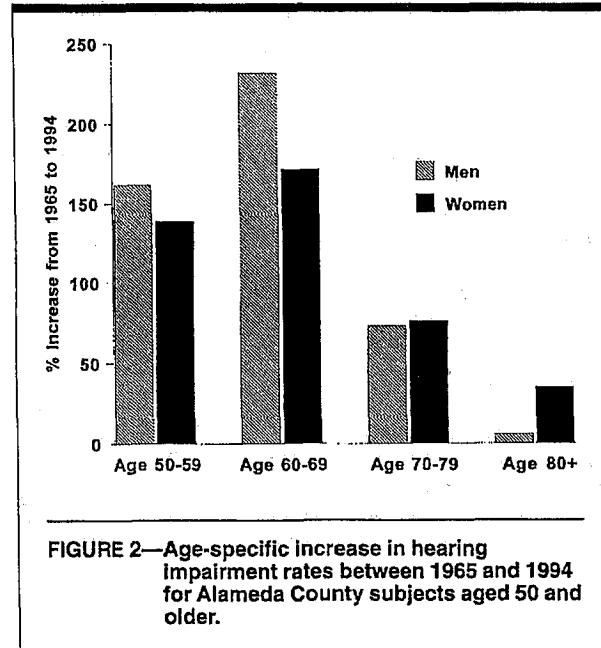
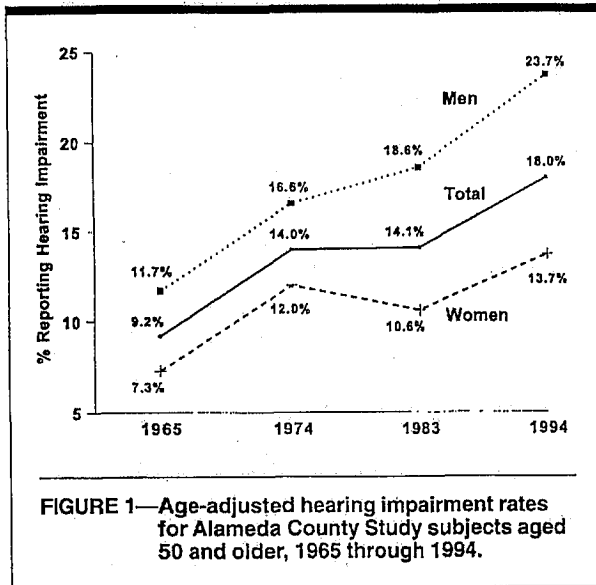
### Methods

The subjects were participants in the Alameda County Study, a longitudinal investigation of health and mortality started in 1965.<sup>19,20</sup> The original 6928 subjects, who were selected by a random household survey in Alameda County, California, have been followed regardless of subsequent location.

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For the first three surveys (conducted in 1965, 1974, and 1983), hearing impairment was measured with a simple yes/no response to the question, "Do you have trouble hearing (even with a hearing aid)?" In 1994 the question was asked in two parts: "Have you ever had trouble hearing (even with a hearing aid)?" and then, if yes, "Have you had it in the last 12 months?" Only those answering yes to both questions are counted as hearing impaired in 1994.

Hearing impairment prevalence rates are calculated for those aged 50 years and older and include 5108 participants who responded in any of four survey periods. Most are included in more than one period. To remove the effects of aging, results are age-adjusted to the 1994 survey population by the direct method.<sup>21</sup> The trend in gender differences in impairment was assessed with a logistic model with a gender-by-time-period interaction term.

The incidence analyses examine 2470 subjects who reported no hearing impairment in 1974 and who survived to 1994. Of these, 346 reported hearing impairment in 1994. Risk factors are from 1974. For occupational noise exposure we compared those classified by the 1970 census as craftsmen, operatives, or foremen with those working in other occupations. Occupational data were available for men only. For potential ototoxic drug exposure (e.g., diuretics, antibiotics) we selected three reported symptoms likely to be associated with their use: pain in the heart or tightness or heaviness in the chest; trouble

breathing or shortness of breath; and constant coughing or frequent heavy chest colds. Subjects reporting having any of these symptoms over the past 12 months were compared with those reporting none. We also compared subjects who reported having had an operation involving a 3-day hospital stay in the last 8 years or having been admitted to a hospital for any reason with those not reporting these events. Exercise was measured by comparing those who often engaged in at least one of four types of exercise (walking, swimming, active sports, or physical exercise) with those who did not often engage in any exercise. Incidence analyses use logistic regression and control for age, ethnicity, gender, and income.

### Results

Age-adjusted hearing impairment prevalence rates over the four follow-up interviews, shown in Figure 1, demonstrate a near doubling in prevalence from 1965 to 1994. Rates for both sexes have increased, but the increase was greater for men ( $P = .08$  for the gender-by-time-period interaction test).

Figure 2 presents the proportional increase in hearing impairment between 1965 and 1994 for four age groups; it is clear that the increase has been much more pronounced among those under age 70.

Results of the incidence analyses are shown in Table 1. Significant risk factors

**TABLE 1—Adjusted Odds Ratios for 1974 Predictors of 1994 Incident Hearing Impairment among 2470 Adults Aged 50 to 101 Years: Alameda County Study, 1994**

| Predictor  | Adjusted OR (95% CI) <sup>a</sup> |
|--|-----------------------------------|
| Occupation: craftsman, operative, or foreman <sup>b</sup>    | 1.45 (1.01, 2.08)                 |
| Admittance to hospital in last 8 y                           | 1.42 (1.09, 1.85)                 |
| Operation requiring hospital stay in last 8 y                | 1.36 (1.05, 1.78)                 |
| Any of 3 medical symptoms <sup>c</sup> in past 12 mo         | 1.34 (1.01, 1.79)                 |
| Exercise: walking, swimming, sports, other physical exercise | 0.69 (0.54, 0.88)                 |

<sup>a</sup>Odds ratios (ORs) and confidence intervals (CIs) are based on logistic regression models with adjustments for age, ethnicity, gender, and income.

<sup>b</sup>Men only (n = 1049).

<sup>c</sup>Pain in the heart or tightness or heaviness in the chest; trouble breathing or shortness of breath; and constant coughing or frequent heavy chest colds.

include working as a craftsman, operative, or foreman (data available for men only); admittance to a hospital for any reason in the last 8 years; having had an operation involving a 3-day hospital stay in the last 8 years; and reporting any of the three medical symptoms. Exercise was protective.

## Discussion

These data document a progressive increase in hearing impairment over the last three decades. In fact, because the question asked about having trouble "even with a hearing aid," these prevalence rates may be conservative. And if true, they have important public health implications. The minor change in the question's wording in 1994 cannot be responsible for the findings because a similar increase occurred between 1965 and 1974, when the question remained the same. In addition, the gender and age differences in rate of increase make it unlikely that the observed increase is caused by increased awareness of hearing loss as a problem. Because the increase in impairment occurred mainly in subjects younger than age 70, it is also unlikely that these findings simply reflect that Americans are growing older but sicker. In accord with our findings, age-specific hearing impairment rates reported from the National Health Interview Survey reveal a large increase in hearing impairment between the early 1960s and 1993 for those aged 45 and older, a larger increase for men than for women, and proportionally larger increases for those aged 45 through 74 than for those over 75.<sup>10,22,23</sup>

Why should there be such an increase? These data do not allow us to answer this question, although several risk factors were identified. Whether general noise levels have increased over the last three decades is unclear. Noise complaints in England and Wales have increased,<sup>8</sup> but much environmental noise may not be at a decibel level (approximately 85dB or higher) that damages hearing and thus probably creates stress rather than hearing impairment.<sup>24</sup> Because of their age, the Alameda County subjects are not likely to have had much exposure to rock concerts or earphone-type portable music players. However, the effect of noise is cumulative,

so that leisure time exposure would be additive to job-related noise exposure.<sup>8</sup> Other data indicate that hearing-impaired adults often attribute their hearing loss to occupational or environmental noise exposure.<sup>10</sup>

In terms of ototoxic drug exposure, the use of ototoxic agents such as antibiotics and diuretics has increased since 1965. The three categories of risk factors that we identified (specific symptoms, operation, and hospitalization) could involve the use of such drugs. Exercise, on the other hand, may be beneficial because of its overall health effect and its relationship to lower incidence of cardiovascular and pulmonary conditions.

From a public health perspective, these data suggest that more attention should be paid to the identification of hearing impairment so that appropriate interventions can be initiated. Current technological advances have refined hearing testing and hearing aids so that many persons who have hearing impairments can receive assistance. In addition, further longitudinal research is needed both to monitor this trend and to identify potentially correctable causes of hearing impairment. □

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## References

- Chen HL. Hearing in the elderly: relation of hearing loss, loneliness, and self-esteem. *J Gerontol Nurs.* 1994;20:22-28.
- Dugan E, Kivett VR. The importance of emotional and social isolation to loneliness among very old rural adults. *Gerontologist.* 1994;34:340-346.
- Jerger J, Chmiel R, Wilson N, Luchi R. Hearing impairment in older adults: new concepts. *J Am Geriatr Soc.* 1995;43:928-935.
- Mulrow CD, Aguilar C, Endicott JE, et al. Association between hearing impairment and the quality of life of elderly individuals. *J Am Geriatr Soc.* 1990;38:45-50.
- Slawinski EB, Hartel DM, Kline DW. Self reported hearing problems in daily life throughout adulthood. *Psychol Aging.* 1993; 8:552-561.
- Wallhagen MI, Strawbridge WJ, Kaplan GA. Six-year impact of hearing impairment on psychosocial and physiologic functioning. *Nurse Pract.* 1996;21(9): 11-14.
- Weinstein BE. Age-related hearing loss: how to screen for it, and when to intervene. *Geriatrics.* 1994;49:40-45.
- Godlee F. Noise: breaking the silence. *BMJ.* 1992;304:110-113.
- Marvel ME, Pratt DS, Marvel LH, Regan M, May JJ. Occupational hearing loss in New York dairy farmers. *Am J Ind Med.* 1991;20:517-531.
- Ries PW. Prevalence and characteristics of persons with hearing trouble: United States, 1990-91. *Vital Health Stat [10].* 1994; no. 188. DHHS publication PHS 94-1516.
- Rosenthal U, Pedersen K, Svanborg A. Presbycusis and noise induced hearing loss. *Ear Hear.* 1990;11:257-263.
- Chiodo AA, Alberti PW. Experimental, clinical, and preventive aspects of ototoxicity. *Eur Arch Otorhinolaryngol.* 1994;251: 375-392.
- Clark K, Sowers MR, Wallace RB, Jan- nausch ML, Lemke J, Anderson CV. Age-related hearing loss and bone mass in a population of rural women aged 60-85 years. *Ann Epidemiol.* 1995;5:8-14.
- Gatland D, Tucker B, Chalstrey S, Keene M, Baker L. Hearing loss in chronic renal failure—hearing threshold changes following haemodialysis. *J R Soc Med.* 1991;84: 587-589.
- Hariri MA, Lakshmi MV, Larner S, Connolly MJ. Auditory problems in elderly patients with stroke. *Age Ageing.* 1994;23: 312-316.
- Lim DP, Stephens SDS. Clinical investigation of hearing loss in the elderly. *Clin Otolaryngol.* 1991;16:288-293.
- Shusterman DJ, Sheedy JE. Occupational and environmental disorders of the special senses. *Occup Med.* 1992;7:515-542.
- Vasquez EM, Maddux MS, Sanchez J, Pollak R. Clinically significant hearing loss in renal allograft recipients treated with intravenous erythromycin. *Arch Intern Med.* 1993;153:879-882.
- Berkman LF, Breslow L. *Health and Ways of Living: The Alameda County Study.* New York, NY: Oxford University Press; 1983.
- Hochstim JR. Health and ways of living: The Alameda County population laboratory. In: Kessler II, Levin ML, eds. *The Community as an Epidemiologic Laboratory.* Baltimore, Md: Johns Hopkins University Press; 1970:149-176.
- Fleiss JL. *Statistical Methods for Rates and Proportions.* 2nd ed. New York, NY: John Wiley & Sons Inc; 1981.
- Jackson AL. Prevalence of selected impairments, United States, July 1963-1965. *Vital Health Stat [10].* 1968; no. 48. DHEW publication PHS 1000.
- Benson V, Marano MA. Current estimates from the National Health Interview Survey, 1993. *Vital Health Stat [10].* 1994; no. 190. DHHS publication PHS 95-1518.
- Gulya AJ. Evaluation of impaired hearing. In: Goroll AH, May LA, Mulley AG, eds. *Primary Care Medicine: Office Evaluation and Management of the Adult Patient.* Philadelphia, Pa: JB Lippincott Co; 1995: 985-989.

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