

data, in conjunction with the emerging evidence on potential futility and even harm of aggressive care,<sup>3,5</sup> emphasize the need for developing models of caring for elderly patients with advanced dementia, with the intention of building ethically congruent infrastructures for this predicted explosion of neurologic disease.

Marya D. Zilberberg, MD, MPH  
Jennifer Tjia, MD, MSCE

**Author Affiliations:** Department of Epidemiology, EviMed Research Group, LLC, Goshen, Massachusetts (Dr Zilberberg); School of Public Health and Health Sciences, University of Massachusetts, Amherst (Dr Zilberberg); Jefferson School of Population Health, Thomas Jefferson University, Philadelphia, Pennsylvania (Dr Zilberberg); and School of Medicine, University of Massachusetts, Worcester (Dr Tjia).

**Correspondence:** Dr Zilberberg, Department of Epidemiology, EviMed Research Group, LLC, PO Box 303, Goshen, MA 01032 (evimedgroup@gmail.com).

**Author Contributions:** Dr Zilberberg had full access to all the data and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Zilberberg. *Acquisition of data:* Zilberberg. *Analysis and interpretation of data:* Zilberberg and Tjia. *Drafting of the manuscript:* Zilberberg. *Critical revision of the manuscript for important intellectual content:* Zilberberg and Tjia. *Statistical analysis:* Zilberberg.

**Financial Disclosure:** None reported.

**Online-Only Material:** The eAppendix and eTables are available at <http://www.archinternmed.com>.

1. The US Census Bureau Web page. <http://www.census.gov>. Accessed March 18, 2011.
2. Hoover DR, Crystal S, Kumar R, Sambamoorthi U, Cantor JC. Medical expenditures during the last year of life: findings from the 1992-1996 Medicare current beneficiary survey. *Health Serv Res.* 2002;37(6):1625-1642.
3. Givens JL, Jones RN, Shaffer ML, Kiely DK, Mitchell SL. Survival and comfort after treatment of pneumonia in advanced dementia. *Arch Intern Med.* 2010; 170(13):1102-1107.
4. Volicer L. End-of-life Care for People with Dementia in Long Term Care Settings. Chicago, IL: Alzheimer's Association. 2005. <http://www.alz.org/national/documents/endoflifelitreview.pdf>. Accessed January 20, 2010.
5. Marengoni A, Corrao S, Nobili A, et al. In-hospital death according to dementia diagnosis in acutely ill elderly patients: the REPOSI study [published online November 9, 2010]. *Int J Geriatr Psychiatry.* doi:10.1002/gps.2627.
6. HCUPnet. Healthcare Cost and Utilization Project (HCUP). Rockville, MD: Agency for Healthcare Research and Quality. 2000-2008. <http://hcupnet.ahrq.gov/> Accessed February 15, 2011.
7. Zilberberg MD, de Wit M, Pirone JR, Shorr AF. Growth in adult prolonged acute mechanical ventilation: implications for healthcare delivery. *Crit Care Med.* 2008;36(5):1451-1455.
8. Mitchell SL, Teno JM, Kiely DK, et al. The clinical course of advanced dementia. *N Engl J Med.* 2009;361(16):1529-1538.

## HEALTH CARE REFORM

### Hearing Loss Prevalence in the United States

The prevalence of hearing loss in the US population has been estimated from self-reported data<sup>1</sup> or in age-restricted cohorts.<sup>2</sup> These estimates may not accurately reflect the true burden of hearing loss in the United States. We estimated the overall prevalence of audiometric hearing loss among all individuals (age  $\geq$  12 years) in the United States using data from a nationally representative data set and with a definition of hearing loss recommended by the World Health Organization (WHO).

**Methods.** We analyzed data from the 2001 through 2008 cycles of the National Health and Nutritional Examination Surveys (NHANES), an ongoing epidemiological survey designed to assess the health and functional status of the civilian, noninstitutionalized US population.<sup>3</sup> Air conduction pure-tone audiometry was administered to all participants aged 12 to 19 years from 2005 through 2008 (n=3143), a half sample of all participants aged 20 to 69 years from 2001 through 2004 (n=3630), and all participants 70 years and older from 2005 through 2006 (n=717). Audiometry was performed in a sound-attenuating booth according to established NHANES protocols. A speech-frequency pure-tone average (average of hearing thresholds at 0.5, 1, 2, and 4 kHz) of greater than 25 dB HL (hearing level) in both ears was defined as hearing loss per WHO criteria,<sup>4</sup> and this is the level at which hearing loss begins to impair communication in daily life. Hearing loss prevalence was estimated by age decade, sex, and the 3 largest categories of race/ethnicity (non-Hispanic white [white], non-Hispanic black [black], and Mexican American or other Hispanic [Hispanic]). There were insufficient individuals from other racial/ethnic groups to derive reliable age-stratified estimates. However, individuals from all racial and ethnic categories were included in estimates of overall prevalence. US population counts were estimated using the midpoint of population totals in each cycle and averaged across combined cycles when appropriate. We accounted for the complex sampling design in all analyses by using sample weights according to National Center for Health Statistics (NCHS) guidelines.

**Results.** We estimate that 30.0 million or 12.7% of Americans 12 years and older had bilateral hearing loss from 2001 through 2008, and this estimate increases to 48.1 million or 20.3% when also including individuals with unilateral hearing loss (**Table**). Overall, the prevalence of hearing loss increases with every age decade. The prevalence of hearing loss is lower in women than in men and black vs white individuals across nearly all age decades.

See also page 1850

See Invited Commentary  
on page 1852

**Comment.** For individuals 12 years and older in the United States, nearly 1 in 8 has bilateral hearing loss, and nearly 1 in 5 has a unilateral or bilateral hearing loss. These are the first national estimates of hearing loss in the US population based on audiometric data and a large, well-characterized representative sample. Previous national estimates based on self-reported data<sup>1</sup> and age-restricted cohorts<sup>2</sup> have been lower, in a range of 21 to 29 million. Other estimates of hearing loss prevalence have come from population-based cohorts<sup>3</sup> that are not representative of the US population. While the overall risk of hearing loss may be decreasing over time,<sup>6,7</sup> the prevalence of hearing loss is expected to rise because of the aging of the population. Research is needed to understand the impact of hearing loss on cognition<sup>8</sup> and other functional

**Table. Prevalence and Number of Individuals in the United States With Hearing Loss<sup>a</sup>**

Variable	% (95% CI) <sup>b</sup>								
	Prevalence of Hearing Loss ≥25 dB (Bilateral) <sup>c</sup>						Prevalence of Hearing Loss ≥25 dB (Bilateral and Unilateral) <sup>c</sup>		
	Sex		Race/Ethnicity <sup>d</sup>			Total		Total	
	Female	Male	White	Black	Hispanic	Overall Prevalence	No. With Hearing Loss (in Millions)	Overall Prevalence	No. With Hearing Loss (in Millions)
Age, y									
12-19	0.42 (0-0.91)	0.20 (0-0.41)	0.26 (0-0.66)	0.48 (0.11-0.85)	0.43 (0.04-0.82)	0.31 (0.04-0.57)	0.10	2.3 (1.5-3.1)	0.76
20-29	0.35 (0-0.79)	0.48 (0-1.4)	0.43 (0-1.3)	0.63 (0-1.9)	0.35 (0-0.90)	0.42 (0-0.97)	0.16	3.2 (1.4-5.1)	1.2
30-39	0.79 (0-1.8)	2.5 (0.14-4.9)	1.8 (0-3.8)	1.7 (0-3.9)	1.6 (0.22-3.1)	1.6 (0.23-3.1)	0.68	5.4 (3.3-7.6)	2.3
40-49	4.5 (0.94-8.1)	8.7 (5.0-12.4)	7.4 (4.5-10.3)	1.3 (0-3.3)	7.3 (2.0-12.5)	6.5 (4.1-8.8)	2.8	12.9 (9.8-15.9)	5.6
50-59	6.1 (3.6-8.6)	20.3 (14.5-26.2)	14.5 (9.9-19.2)	7.1 (3.0-11.2)	13.8 (6.4-21.2)	13.1 (9.4-16.8)	4.4	28.5 (23.3-33.7)	9.6
60-69	16.8 (12.1-21.5)	39.2 (31.7-46.8)	26.6 (21.1-32.1)	15.9 (9.8-22.1)	28.9 (17.0-40.8)	26.8 (22.3-31.4)	5.7	44.9 (40.9-48.9)	9.5
70-79	48.5 (38.5-58.5)	63.4 (56.2-70.5)	55.8 (47.6-63.9)	39.0 (26.2-51.7)	66.8 (52.3-81.2)	55.1 (48.0-62.2)	8.8	68.1 (61.2-75.1)	10.8
≥80	75.6 (69.7-81.5)	84.6 (79.0-90.3)	81.5 (78.5-84.5)	54.8 (40.6-69.0)	60.7 (34.8-86.6)	79.1 (76.0-82.2)	7.3	89.1 (86.1-92.0)	8.3
Estimated total No. of individuals with hearing loss, (in millions)							30.0 <sup>e</sup>	48.1	

<sup>a</sup>National Health and Nutritional Examination Surveys 2001 through 2008 (n=7490)

<sup>b</sup>All values represent prevalence percentage except for the column titled "No. With Hearing Loss (in Millions)," which represents the number of prevalent cases.

<sup>c</sup>Hearing defined by the average of hearing thresholds at 0.5-, 1-, 2-, and 4-kHz tones presented by air conduction.

<sup>d</sup>Prevalence estimates by race/ethnicity are only presented for the 3 largest racial/ethnic groups. Individuals from all racial/ethnic groups are included in the overall prevalence.

<sup>e</sup>Numbers do not sum to group total because of rounding.

domains and the role of aural rehabilitative strategies in possibly mitigating these effects.

Frank R. Lin, MD, PhD  
John K. Niparko, MD  
Luigi Ferrucci, MD, PhD

**Author Affiliations:** Department of Otolaryngology–Head & Neck Surgery, The Johns Hopkins School of Medicine (Drs Lin and Niparko), Center on Aging and Health, The Johns Hopkins Medical Institutions (Dr Lin), and Longitudinal Studies Section, Clinical Research Branch, National Institute on Aging (Dr Ferrucci), Baltimore, Maryland.

**Correspondence:** Dr Lin, Department of Otolaryngology–Head & Neck Surgery, The Johns Hopkins Center on Aging & Health, 2024 E Monument St, Ste 2-700, Baltimore, MD 21205 (flin1@jhmi.edu).

**Author Contributions:** Dr Lin had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Lin. *Analysis and interpretation of data:* Lin, Niparko, and Ferrucci. *Drafting of the manuscript:* Lin. *Critical revision of the manuscript for important intellectual content:* Lin, Niparko, and Ferrucci. *Statistical analysis:* Lin. *Obtained funding:* Lin. *Administrative, technical, and material support:* Lin, Niparko, and Ferrucci. *Study supervision:* Niparko and Ferrucci.

**Financial Disclosure:** None reported.

**Funding/Support:** This work was supported by grant K23DC011279 from the National Institutes of Health.

**Role of the Sponsors:** The funding organization had no role in the design and conduct of the study; in the collection, analysis, and interpretation of the data; or in the preparation, review, or approval of the manuscript.

- Ries PW. Prevalence and characteristics of persons with hearing trouble: United States, 1990-91. *Vital Health Stat 10*. 1994;(188):1-75.
- Agrawal Y, Platz EA, Niparko JK. Prevalence of hearing loss and differences by demographic characteristics among US adults: data from the National Health and Nutrition Examination Survey, 1999-2004. *Arch Intern Med*. 2008;168(14):1522-1530.
- Centers for Disease Control and Prevention and National Center for Health Statistics. National Health and Nutrition Examination Survey. Hyattsville, MD: US Department of Health and Human Services, Centers for Disease Control and Prevention. <http://www.cdc.gov/nchs/nhanes.html>. Accessed June 1, 2011.
- World Health Organization Prevention of Blindness and Deafness (PBD) Program. Prevention of deafness and hearing impaired grades of hearing impairment. [http://www.who.int/pbd/deafness/hearing\\_impairment\\_grades/en/index.html](http://www.who.int/pbd/deafness/hearing_impairment_grades/en/index.html). Accessed June 1, 2011.
- Nash SD, Cruickshanks KJ, Klein R, et al. The prevalence of hearing impairment and associated risk factors: the Beaver Dam Offspring Study. *Arch Otolaryngol Head Neck Surg*. 2011;137(5):432-439.
- Zhan W, Cruickshanks KJ, Klein BE, et al. Generational differences in the prevalence of hearing impairment in older adults. *Am J Epidemiol*. 2010;171(2):260-266.
- Hoffman HJ, Dobie RA, Ko CW, Themann CL, Murphy WJ. Americans hear as well or better today compared with 40 years ago: hearing threshold levels in the unscreened adult population of the United States, 1959-1962 and 1999-2004. *Ear Hear*. 2010;31(6):725-734.
- Lin FR, Metter EJ, O'Brien RJ, Resnick SM, Zonderman AB, Ferrucci L. Hearing loss and incident dementia. *Arch Neurol*. 2011;68(2):214-220.

## INVITED COMMENTARY

### Creating the Future of Aging

If dementia were a company, it would have the world's largest annual revenue, estimated at \$604 billion (2010).<sup>1</sup> Already, 5.4 million people in the United States live with Alzheimer-type dementia, which afflicts nearly half of us if we live past 85 years.<sup>2</sup> As Zilberberg and Tjia<sup>3</sup> estimate, with current utilization and diagnosis patterns, hospitalizations of persons with de-