

## Severe Hearing Impairment Among Military Veterans — United States, 2010

A substantial proportion of hearing loss in the United States is attributable to employment-related exposure to noise (1). Among military veterans, the most common service-connected disabilities are hearing impairments (2), suggesting that occupational noise exposure during military service might cause more veterans to have hearing loss than nonveterans. However, a recent analysis of data from the 1993–1995 Epidemiology of Hearing Loss Study did not find significant differences between the two groups (3). To further investigate hearing loss among veterans, specifically the prevalence of severe hearing impairment (SHI), data from the 2010 Annual Social and Economic Supplement (ASEC) to the Current Population Survey (CPS) were analyzed. This report describes the results of those analyses, which indicated that the prevalence of SHI among veterans was significantly greater than among nonveterans. Veterans were 30% more likely to have SHI than nonveterans after adjusting for age and current occupation, and veterans who served in the United States or overseas during September 2001–March 2010, the era of overseas contingency operations (including Operations Enduring Freedom and Iraqi Freedom), were four times more likely than nonveterans to have SHI. These findings suggest a need for increased emphasis on improving military hearing conservation programs (HCPs) and on hearing loss surveillance in military and veterans' health systems.

CPS is a monthly national survey of 57,000 households conducted by the Bureau of the Census for the Bureau of Labor Statistics. CPS obtains information on employment, demographics and other characteristics of the civilian, noninstitutionalized population aged  $\geq 16$  years. ASEC is conducted each year in conjunction with the March survey to collect additional data on work experience, income, noncash benefits, and migration. Data on all sample household members are collected from a single respondent by trained interviewers using a standardized questionnaire during in-person or telephone interviews. The combined 2010 CPS-ASEC response rate was 85.9% (4). For this report, data on 151,995 persons aged  $\geq 17$  years were analyzed to produce population-weighted estimates of SHI prevalence for the total population and various demographic and occupational subgroups by veteran status and period of most recent military service (before September 2001 versus September 2001–March 2010). Veteran status was defined as ever having served on active duty in the armed forces. SHI was identified based on self or proxy report of being deaf or having “serious difficulty hearing” (4). Prevalence ratios, adjusted for the effect of

demographic and occupational\* factors, were produced using multivariable Poisson regression. Two regression models were used. The first, model A, treated the independent variable, veteran status, as dichotomous, and was used to compare all veterans with nonveterans. The second, model B, included three categories for the independent variable and was used to compare veterans who served before and after September 2001 with nonveterans separately.

In 2010, 8.9% of the U.S. population aged  $\geq 17$  years were veterans, but only 0.7% of the population had served after September 2001. The prevalence of SHI among nonveterans was 2.5%. Among all veterans, the prevalence was 10.4%; among veterans who served after September 2001, the prevalence was 3.9% (Table 1).<sup>†</sup> The prevalence of SHI increased with age for veterans and nonveterans.

Among nonveterans, men and women reported similar prevalences of SHI (2.3% and 2.5%, respectively). Female veterans, however, had a significantly lower prevalence of SHI than male veterans (4.0% versus 10.9%;  $p < 0.05$ ), but a significantly higher prevalence than either male or female nonveterans. Among nonveterans and veterans alike, non-Hispanic blacks reported the lowest SHI prevalence of all racial/ethnic groups and non-Hispanic whites the highest. The prevalence of SHI was significantly higher for veterans than for nonveterans in all occupational categories ( $p < 0.05$ ) except farming, fishing, and forestry, and in production occupations.<sup>§</sup> Small sample sizes limited the ability to compare subgroups for veterans who served after September 2001.

In the multivariable analysis, increasing age was positively associated with SHI, as was working in certain occupational categories (Table 2) and unemployment or nonparticipation in the labor force, relative to working in management, business, and financial occupations. Female sex and race/ethnicity other than non-Hispanic white were significantly negatively associated with SHI ( $p < 0.05$ ). Controlling for demographic factors and occupation, all veterans were 30% more likely to have SHI than nonveterans in model A (adjusted prevalence ratio = 1.3). In model B, veterans who served after September 2001 were four times more likely than nonveterans to have SHI (adjusted prevalence ratio = 4.0) (Table 2).

\* Current occupation was defined based on the 11 major groupings of census occupation codes used in the CPS-ASEC. The CPS-ASEC uses 2002 census occupation codes, which, in turn, are based on the 2000 standard occupational classification (SOC) codes.

<sup>†</sup> Bivariate analyses not age-standardized.

<sup>§</sup> Production occupations include assemblers and fabricators; plant and system operators; machinists and machine operators; and food processing, metal, plastic, printing, textile, apparel, furnishing, and wood workers.

TABLE 1. Percentage of persons aged ≥17 years reporting severe hearing impairment (SHI), by veteran status and selected characteristics — Current Population Survey, United States, 2010

Characteristic	Veterans								
	Nonveterans			All service periods			September 2001–2010 service period		
	No.*	% with SHI <sup>†</sup>	(95% CI)	No.*	% with SHI <sup>†</sup>	(95% CI)	No.*	% with SHI <sup>†</sup>	(95% CI)
<b>Total</b>	<b>212,237</b>	<b>2.5</b>	<b>(2.3–2.6)</b>	<b>20,634</b>	<b>10.4</b>	<b>(9.8–11.0)</b>	<b>1,696</b>	<b>3.9</b>	<b>(2.6–5.8)</b>
<b>Age group (yrs)</b>									
17–24	33,463	0.4	(0.4–0.5)	197	0.8	(0.1–4.9)	197	0.8	(0.1–4.9)
25–34	39,425	0.5	(0.4–0.6)	1,286	2.0	(1.2–3.5)	869	2.8	(1.6–4.9)
35–44	38,142	1.0	(0.8–1.1)	2,051	1.8	(1.1–2.8)	257	3.7	(1.4–9.7)
45–54	41,128	1.5	(1.3–1.7)	3,186	3.9	(3.0–5.0)	257	4.4	(1.7–11.3)
55–64	30,334	3.0	(2.7–3.3)	5,045	8.2	(7.1–9.5)	111	17.8	(8.4–33.7)
≥65	29,745	10.0	(9.4–10.6)	8,869	17.4	(16.2–18.6)	4	0.0	—
<b>Sex</b>									
Male	93,494	2.3	(2.2–2.5)	19,141	10.9	(10.3–11.6)	1,397	4.3	(2.8–6.3)
Female	118,743	2.5	(2.4–2.7)	1,493	4.0	(2.7–5.7)	299	2.5	(0.8–7.1)
<b>Race/Ethnicity</b>									
White, non-Hispanic	141,442	2.9	(2.7–3.0)	16,825	11.3	(10.6–12.0)	1,155	4.8	(3.0–7.5)
Black, non-Hispanic	24,804	1.5	(1.3–1.7)	2,056	4.6	(3.5–5.8)	262	0.8	(0.1–4.8)
Hispanic	31,513	1.6	(1.4–1.8)	1,107	8.3	(6.5–10.7)	203	3.1	(0.9–10.5)
Other, non-Hispanic	14,479	1.8	(1.5–2.1)	645	8.8	(6.7–11.5)	77	4.0	(1.0–14.8)
<b>Current occupation</b>									
Management, business, and financial	20,401	1.0	(0.8–1.2)	1,936	4.7	(3.4–6.5)	212	2.3	(0.7–7.7)
Professional and related	30,665	0.9	(0.8–1.1)	1,911	3.7	(2.6–5.2)	254	2.6	(0.8–8.6)
Service	25,854	1.0	(0.8–1.1)	1,439	4.0	(2.8–5.7)	271	2.3	(0.7–7.2)
Sales and related	16,305	1.1	(0.9–1.4)	935	4.0	(2.5–6.3)	88	0.0	—
Office and administrative support	18,876	1.0	(0.8–1.2)	874	5.2	(3.3–8.2)	146	5.0	(1.8–13.0)
Farming, fishing, and forestry	1,119	1.6	(0.8–3.1)	41	9.0	(1.2–45.1)	4	0.0	—
Construction and extraction	8,394	1.3	(1.0–1.6)	861	5.5	(3.4–8.8)	99	3.4	(0.4–23.7)
Installation, maintenance, and repair	4,682	1.3	(0.9–2.0)	776	5.4	(3.3–8.9)	91	6.1	(2.1–16.4)
Production <sup>§</sup>	8,299	1.7	(1.3–2.2)	790	3.2	(1.9–5.1)	101	4.4	(1.0–17.4)
Transportation and material moving	8,301	1.3	(0.9–1.7)	1,053	5.0	(3.2–7.7)	119	2.7	(0.4–17.5)
Other	11	0.0	—	29	5.1	(0.7–30.4)	27	5.5	(0.7–32.3)
Unemployed or not in labor force	69,328	5.3	(5.0–5.6)	9,989	16.7	(15.6–17.9)	285	8.4	(4.5–15.1)

Abbreviation: CI: confidence interval.

\* Estimated population, in thousands.

† Bivariate analyses not age-standardized.

§ Production occupations include assemblers and fabricators; plant and system operators; machinists and machine operators; and food processing, metal, plastic, printing, textile, apparel, furnishing, and wood workers.

### Reported by

Matthew R. Groenewold, PhD, Sangwook Tak, ScD, Elizabeth Masterson, MPH, Div of Surveillance, Hazard Evaluations and Field Studies, National Institute for Occupational Safety and Health, CDC. **Corresponding contributor:** Matthew Groenewold, mgroenewold@cdc.gov, 513-841-4329.

### Editorial Note

Military service can entail harmful exposure to high-intensity noise from firearms, explosives, jet engines, machinery, and other sources during combat operations, training, or in the course of general job duties. Such exposures can cause or contribute to hearing impairments, including hearing loss, if adequate hearing protection is not available and properly used (2,5). The findings in this report indicate that prior military service is associated with increased prevalence of SHI, independent of demographic factors and current occupation.

For veterans who served after September 2001, the prevalence is even higher than for other veterans.

Noise-induced hearing loss is a permanent disability, although the impairment sometimes can be rehabilitated with hearing aids. Since 1978, the Department of Defense (DoD) policy has required each of the armed services to have in place HCPs incorporating noise hazard identification, safety signs and labels, noise mitigation, education and training, audiometric surveillance, and program evaluation (2). However, a 2005 Institute of Medicine report identified certain shortcomings in military HCPs (5). Between 10% and 18% of service members enrolled in military HCPs had standard threshold shifts in hearing,<sup>¶</sup> a prevalence two to five times higher than would be considered acceptable in a

¶ A standard threshold shift is a change of 10 dB or more in the average hearing thresholds at 2,000, 3,000, and 4,000 Hz in comparison with a baseline audiogram.

**TABLE 2. Adjusted prevalence ratios (APRs)\* for severe hearing impairment among persons aged ≥17 years — Current Population Survey, United States, 2010**

Characteristic	Model A		Model B	
	APR	(95% CI)	APR	(95% CI)
Age <sup>†</sup>	1.1	(1.1–1.1)	1.1	(1.1–1.1)
Sex				
Male	Referent		Referent	
Female	0.6	(0.6–0.7)	0.6	(0.6–0.7)
Race/Ethnicity				
White, non-Hispanic	Referent		Referent	
Black, non-Hispanic	0.6	(0.6–0.7)	0.6	(0.6–0.7)
Hispanic	0.9	(0.8–1.0)	0.9	(0.8–1.0)
Other, non-Hispanic	0.8	(0.7–1.0)	0.8	(0.7–1.0)
Current occupation				
Management, business, and financial	Referent		Referent	
Professional and related	1.0	(0.8–1.3)	1.0	(0.8–1.3)
Service	1.3	(1.1–1.7)	1.3	(1.1–1.7)
Sales and related	1.3	(1.0–1.7)	1.3	(1.0–1.7)
Office and administrative support	1.3	(1.0–1.7)	1.3	(1.0–1.7)
Farming, fishing, and forestry	1.9	(1.0–3.9)	1.9	(1.0–3.9)
Construction and extraction	1.5	(1.2–2.0)	1.5	(1.2–2.0)
Installation, maintenance, and repair	1.5	(1.1–2.2)	1.5	(1.0–2.2)
Production <sup>§</sup>	1.7	(1.3–2.2)	1.7	(1.3–2.2)
Transportation and material moving	1.4	(1.0–2.0)	1.4	(1.0–2.0)
Other	4.9	(0.4–54.4)	2.0	(0.2–21.4)
Unemployed or not in labor force	2.5	(2.1–3.0)	2.5	(2.1–3.0)
Veteran				
Yes	1.3	(1.2–1.5)	—	
No	Referent		—	
Period of military service				
September 2001–2010	—		4.0	(2.7–6.0)
Before September 2001	—		1.3	(1.2–1.4)
None	—		Referent	

**Abbreviation:** CI = confidence interval.

\* Prevalence ratios statistically adjusted for the effects of all other variables in the table.

<sup>†</sup> Prevalence ratio associated with a 1-year increase in age.

<sup>§</sup> Production occupations include assemblers and fabricators; plant and system operators; machinists and machine operators; and food processing, metal, plastic, printing, textile, apparel, furnishing, and wood workers.

#### What is already known on this topic?

Military service entails hazardous exposure to high-intensity noise. Hearing impairments are the most common types of service-connected disability for which veterans are being compensated by the Department of Veterans Affairs.

#### What is added by this report?

The prevalence of severe hearing impairment (SHI) among veterans is significantly greater than among nonveterans. After adjusting for age and current occupation, veterans are 30% more likely to have SHI than nonveterans, and veterans who served after September 2001 are four times more likely than nonveterans to have SHI.

#### What are the implications for public health?

Improvements in military hearing conservation programs and increased emphasis on hearing loss surveillance in military and veterans' health systems will be needed to reduce the prevalence of disability caused by hearing impairments among veterans.

civilian, industrial HCPs (5). A more recent report from the Government Accountability Office (GAO) also concluded that improvements in military HCPs would lead to improved outcomes (2). For its part, DoD has acknowledged the increase in sequelae from auditory injuries among service members and the need for improvements to military HCPs, and has concurred with the GAO's recommendations (2).

Beyond the effect of SHI on the well-being of individual veterans, higher rates of SHI are costly to the nation because of increased use of medical services and disability payments. According to the Department of Veterans Affairs (VA), hearing impairments have been the most common type of service-connected disability since 2005, and the number of veterans being awarded compensation for hearing impairment has continued to grow each year. In fiscal year 2009, the VA paid approximately \$1.1 billion to compensate 1.2 million veterans who filed claims for service-connected hearing impairments (6,7).

The findings in this report are subject to at least six limitations. First, ascertainment of SHI was based on self or proxy report by the survey household respondent and was not validated by audiometric testing. Although self report has been found to have acceptable sensitivity and specificity compared with audiometric measurement of hearing loss in past studies (8), proxy report has not been similarly validated. This could have resulted in some misclassification errors. Second, although physical requirements for military service ensured that SHI

was not present in the exposed group before entering military service, the specific cause of subsequent hearing impairment was not determined. Third, these analyses assume equal incidence of age-related hearing loss and other hearing loss unrelated to noise among veterans and nonveterans. This assumption most likely resulted in underestimation of prevalence ratios. Persons with congenital deafness and hearing loss resulting from childhood infections or other nonservice-related causes were not excluded from the reference group. Fourth, although attempts were made to adjust for current occupation and demographic characteristics, data on past occupations and on recreational and other nonoccupational noise exposures (e.g., hunting or listening to loud music) were not available. To the extent such factors were differentially distributed between veterans and nonveterans, adjustments might have been insufficient to control for all potential confounding factors. Fifth, because data on length of service were unavailable,

adjustments for duration of exposure were not possible. Finally, the cross-sectional nature of these analyses precludes making direct causal inferences.

Noise-induced hearing loss is preventable. The observed association of SHI with military service, and particularly with service in the United States or overseas after September 2001, underscores the need for improved HCPs in the various service branches and the importance of hearing loss surveillance in military and VA health systems. The study results also suggest a need for further research to identify possible causes for the increased prevalence of SHI among veterans with service after September 2001. Increased exposure to combat and its attendant uncontrolled noise hazards is a potential hypothesis, but data on specific exposures during military service were unavailable in the CPS-ASEC. In 2008, serious auditory injuries sustained by service members in Operations Enduring Freedom and Iraqi Freedom led Congress to mandate that DoD create a Hearing Center of Excellence to improve hearing loss prevention and treatment and to establish an electronic registry to track and share information with the VA on military personnel with hearing loss.\*\* DoD is finishing plans for the center and the registry (2). GAO also has made specific recommendations to DoD for improvement of military HCPs (2).

---

\*\* Duncan Hunter National Defense Authorization Act for Fiscal Year 2009, Pub. L. No. 110-417, Sect. 721, 122 Stat. 4506 (2008).

## References

1. Tak S, Calvert GM. Hearing difficulty attributable to employment by industry and occupation: An analysis of the National Health Interview Survey—United States, 1997 to 2003. *J Occup Environ Med* 2008;50:46–56.
2. US Government Accountability Office. Hearing loss prevention: improvements to DOD hearing conservation programs could lead to better outcomes. Washington, DC: US Government Accountability Office; 2011. Available at <http://www.gao.gov/new.items/d11114.pdf>. Accessed July 20, 2011.
3. Wilson RH, Noe CM, Cruickshanks KJ, et al. Prevalence and degree of hearing loss among males in Beaver Dam cohort: comparison of veterans and nonveterans. *J Rehabil Res Dev* 2010;47:505–20.
4. US Census Bureau. Current population survey, 2010 annual social and economic (ASEC) supplement. Washington, DC: US Census Bureau; 2010. Available at <http://www.census.gov/apsd/techdoc/cps/cpsmar10.pdf>. Accessed July 15, 2011.
5. Committee on Noise-Induced Hearing Loss and Tinnitus Associated with Military Service from World War II to the Present. Noise and military service: implications for hearing loss and tinnitus. Humes LE, Joellenbeck LM, Durch JS, eds. Washington, DC: The National Academies Press; 2004.
6. National Center for Rehabilitative Auditory Research. Calendar year 2009 annual report. Portland, OR: Department of Veterans Affairs, Rehabilitation Research and Development; 2010.
7. Veterans Benefits Administration. Annual benefits report, fiscal year 2009. Washington, DC: US Department of Veterans Affairs; 2010. Available at [http://www.vba.va.gov/reports/abr/2009\\_abr.pdf](http://www.vba.va.gov/reports/abr/2009_abr.pdf). Accessed July 15, 2011.
8. Sindhusake D, Mitchell P, Smith W, et al. Validation of self-reported hearing loss: the Blue Mountain hearing study. *Int J Audiol* 2006;45:309–17.