Functional Status and Hearing Impairments in Women at Midlife

Sandra K. Pope¹ and MaryFran Sowers²

¹Department of Geriatrics, University of Arkansas for Medical Sciences, Little Rock.
²Department of Epidemiology, School of Public Health, University of Michigan, Ann Arbor.

Objectives. The aim of this study was to address the prevalence of clinically assessed high-frequency hearing impairment (HFHI) and self-reported hearing impairment (SRHI) and examine the association of these hearing assessments with physical and mental functioning in African American and Caucasian women at midlife.

Methods. The sample included 467 women who participated in the Michigan Functioning Substudy of the Study of Women’s Health Across the Nation. Outcomes examined were physical and mental functioning from the Medical Outcomes Trust SF-12 Health Survey. HFHI was defined as threshold averages of 25 dB or greater over 4000, 6000, and 8000 Hertz.

Results. Prevalence of unilateral HFHI was 26.6% (n = 68), and prevalence of bilateral HFHI was 12.0% (n = 56). Prevalence of SRHI was 16.7% (n = 78), with minimal overlap between HFHI and SRHI (n = 36). In multiple variable logistic regression analyses, HFHI in one ear only was not associated with physical or mental functioning and bilateral HFHI was associated with limited mental functioning only. SRHI was associated with limited physical and mental functioning.

Discussion. Poor correlation of HFHI and SRHI in this population, combined with the significant association of SRHI with both measures of functioning, indicates that the two methods may be measuring different aspects of impairment. SRHI may facilitate early identification of individuals with hearing-related functional limitations.

Hearing impairment, defined as auditory structure or function outside the range of normal, can adversely affect physical, mental, and social functioning because of the critical role of hearing in navigating through and interacting with one’s environment (Laforge, Spector, & Stenberg, 1992; Rudberg, Furner, Dunn, & Cassel, 1993). Although hearing impairment is integral to functioning, the precise nature of the association is unclear. This may be due, in part, to substantial variations in hearing measurement methods and hearing impairment definitions (Carabellese et al., 1993; Clark, 1981).

Regardless of the method used for assessing hearing, associations between hearing impairment and adverse functioning have been repeatedly identified for older adults (Ensrud et al., 1994; Humes & Roberts, 1990). Adults younger than 65 years have rarely been examined for hearing-related functional limitations because prevalence of hearing loss and of functional limitations are typically lower in younger populations relative to older populations (Gates, Cooper, Kannel, & Miller, 1990). However, by the age of 65, degenerative processes may be fairly well advanced, reducing the possibilities of interventions designed to prevent or slow the decline in hearing and functioning. Identification and exploration of hearing-related functional limitations in adults at midlife can provide valuable information for development of education and intervention efforts that may delay or reduce limitations as a person ages.

The relationship between hearing and functioning has been examined primarily in men, largely because of the higher prevalence of impairment in men and the association of impairment with occupational noise exposure (Cruickshanks, Wiley, et al., 1998). Racial and ethnic minority populations have been infrequently studied in hearing research. Additionally, the full range of sound signals available to characterize hearing impairment is not widely employed (Clark, 1981).

In younger populations, a greater likelihood of diminished functioning exists among those who are hearing impaired, compared with those without impairment (Verbrugge & Patrick, 1995). In this study, therefore, we addressed the prevalence of clinically assessed high-frequency hearing impairment (HFHI) and self-reported hearing impairment (SRHI) and examined the association of both hearing assessments with physical and mental health functioning in African American and Caucasian women aged 42–52 years.

Methods

The sample included 490 women who participated in the Michigan Functioning Substudy of the Study of Women’s Health Across the Nation (SWAN). SWAN is a multicultural, population-based study of the menopausal transition located in seven U.S. cities. Women were enrolled in the Michigan site of the SWAN study were (a) 42–52 years of age at baseline; (b) African American or Caucasian; (c) cognitively able and willing to participate; (d) living within a defined geographic area; and (e) premenopausal (menstruated within the 3 months prior to enrollment). Seventy-three percent of the women eligible for participation took part in the Michigan SWAN study.

Michigan women who received the baseline SWAN clinical exam after August 1996 participated in the Michigan...
Functioning Substudy, and 96% (N = 467) of these women completed hearing assessments.

Hearing Measures

A Maico MA800 Automatic Computer Audiometer was used to clinically assess hearing. Each woman was tested in a soundproof booth and was presented with pure tone stimuli in 10-decibel (dB) steps, ranging from 0 to 95 dB. Frequencies measured included 500, 1000, 2000, 4000, 6000, and 8000 Hertz (Hz), with the threshold for each frequency charted as the lowest intensity (in decibels) at which the tone was heard. Average thresholds were calculated across frequencies for each ear separately. Normal hearing is in the range of 0–15 dB. Mild hearing impairment is defined as threshold averages of 25 dB or greater, and moderate hearing impairment is defined as 40 dB or greater (Clark, 1981). We defined mild HFHI as 25 dB or greater threshold averages over the high-frequency regions of 4000, 6000, and 8000 Hz (Cocchiarella, Sharp, & Persky, 1995).

SRHI was based on responses to two questions that characterize the difficulties most frequently identified by patients with hearing impairments: difficulty hearing when communicating with others and difficulty hearing when listening to television or radio (Stephens, Lewis, Charny, Farrow, & Francis, 1990). We combined and dichotomized these questions as a positive or negative report of difficulty hearing when communicating with others and when listening to television or radio. Sensitivity analyses supported our decision to code respondents who reported only one hearing difficulty as not impaired.

We combined clinical assessments of HFHI in either one or both ears and SRHI measures into four categories: “neither HFHI nor SRHI,” “HFHI but no SRHI,” “SRHI but no HFHI,” and “both HFHI and SRHI.”

Physical and Mental Health Functioning Measures

The outcomes we examined were physical and mental health functioning measures as assessed by the Medical Outcomes Trust SF-12 Health Survey (Ware, Kosinski, & Keller, 1996). In physical functioning questions, respondents were asked about difficulty doing moderate activities, such as moving a table, vacuuming, or climbing several flights of stairs, as well as being limited or accomplishing less than they would like because of physical limitations. In mental functioning questions, respondents were asked about feeling calm and peaceful, energetic, downhearted, or blue; accomplishing less; or not doing activities as carefully as usual because of emotional problems. These outcomes were dichotomized, with the lowest quartile representing functional limitation.

Other Measures

Sociodemographic variables included age, race–ethnicity, years of education, working status, and marital status. Respondents self-reported race–ethnicity as either “African American” or “Caucasian.” Working status was defined as “working” or “not working outside the home for pay.” Marital status was categorized as “single”; “married or living as married”; and “widowed, separated, or divorced.” Socioeconomic status was based on respondents’ reports that it was “very hard,” “somewhat hard,” or “not very hard at all” to pay for basics such as food and housing.

Body mass index (BMI) was clinically assessed and calculated as weight (kg)/height^2 (m^2), with the highest quartile (BMI > 40.6) categorized as high BMI. The disease conditions we examined included reported arthritis and heart conditions (including heart attack, angina, and high blood pressure), because of their high prevalence and potential association with both the outcome and the exposure (Susmano & Rosenbush, 1988).

We used the four-question scale of the Cohen short form perceived stress scale (Cohen & Williamson, 1988) to assess perceived stress. We measured social support with a 3-question scale modified from the Older Americans Resources and Services Multidimensional Functional Assessment questionnaire (Fillenbaum, 1988).

Statistical Analyses

We used univariate analyses to describe the sample population and functioning outcomes. We used bivariate analyses to examine the unadjusted relationship of hearing impairment and functioning. We used multivariate logistic regression analyses to examine the relationship of the hearing impairment measures with functional outcomes while controlling for the confounding effects of other variables in the model. We used the Hosmer-Lemeshow statistic and Receiver Operating Characteristic curves to examine goodness of fit and predictability of the models. We examined improvement of model fit with hierarchical models in which covariates were entered in the first model (S1) and the hearing measure was added to the covariates in the second model (S2). We calculated the −2 Log Likelihood (−2LogL) of S1 minus the −2LogL of S2 to obtain a chi-square value. We determined significant model improvement from adding the hearing measure by examining this chi-square value with degrees of freedom (df) = S2 df − S1 df (Hosmer & Lemeshow, 1989).

Results

All women in this sample (N = 467) were between the ages of 42 and 52 years: 41% aged 42–44 years, 33% aged 45–47 years, and 26% aged 48–52 years. Almost 59% of the women were African American and 41% were Caucasian.

Prevalence of clinically assessed mild HFHI (>25 dB) in only one ear of women in this sample was 14.6% (n = 68), and prevalence in both ears was 12.0% (n = 56). Prevalence of moderate HFHI (>40 dB) in only one ear was 6.9% (n = 32) and in both ears was 2.8% (n = 13). Problems with hearing were self-reported by 16.7% (n = 78) of the women. There was little overlap between HFHI and SRHI. Less than half (46%) of the women with SRHI were clinically assessed as having HFHI. Only 30% of women with HFHI also exhibited SRHI.

Approximately 12% of women reported that it was very hard and 34% reported that it was somewhat hard to pay for basics. Almost 8% of women had less than a high school education, 24% had a high school degree, and 68% had post–high school education. More than 52% of the women were married, and 30% did not work outside the home. One third
of the women reported arthritis, and one third reported heart conditions.

Associations of Functioning and Hearing

Results of both crude and adjusted analyses of the relationship of clinically assessed mild HFHI and SRHI with functional limitations are shown in Table 1. In crude analyses, when compared with women with no HFHI, women with HFHI in one ear only were no more likely to report physical limitations but were more likely to report limited mental functioning. Women with HFHI in both ears were less likely to report physical functioning limitations than women without HFHI; there was no association with mental functioning. In crude analyses, SRHI was strongly associated with both physical ($p < .0002$) and mental ($p < .0001$) functional limitation.

However, crude analyses do not control for confounding effects. In multivariate logistic regression analyses that controlled for sociodemographic, health, and behavioral variables, the relationship between HFHI and functioning differed from crude results. In the multivariate analyses, mild HFHI in one ear only was not associated with measures of physical or mental functioning. Women with HFHI in both ears did not differ in measures of physical functioning but were 2.4 times more likely to report limited mental functioning than women without HFHI. Hierarchical logistic regression models showed no improvement in the physical functioning model after HFHI was added to the other variables in the model but showed improvement in the mental health functioning model after HFHI was added ($p = .02$).

In multivariate logistic regression analyses, SRHI was associated with lower physical and mental functioning: women with SRHI were 2.4 times more likely to report limited physical functioning and 2 times more likely to report limited mental functioning, compared with women without SRHI. Hierarchical modeling showed significant improvement in both physical and mental functioning models when SRHI was added to the other variables in the model ($p < .05$ and $p < .01$, respectively).

When we combined performance-based HFHI and SRHI into one variable (Table 2), results of crude analyses were similar to results with SRHI alone. “HFHI but no SRHI” was not associated with lower physical or mental functioning, “SRHI but no HFHI” was associated with lower physical but not lower mental functioning, and the combination “both HFHI and SRHI” was associated with both lower physical and lower mental functioning. In multivariate logistic regression analyses, women with “HFHI but no SRHI” did not differ in functioning from women with “neither HFHI nor SRHI.” However, women with “SRHI but no HFHI” were 2.7 times more likely to report lower physical functioning, and women with “both HFHI and SRHI” were 2.4 times more likely to report lower mental functioning, compared with women with “neither HFHI or SRHI.” Women with “both HFHI and SRHI” were also 2.2 times more likely to report lower physical functioning, although this finding did not reach statistical significance ($p = .07$). Although there were some significant associations of this combined hearing variable with physical and mental functioning, model fit did not improve when we added this combination variable to the other variables in the model.

**Discussion**

In this study we examined women at midlife and how sensory impairment may contribute to their perception of functioning. After we controlled for potentially confound-

### Table 1. Crude and Adjusted Odds Ratios (OR) and 95% Confidence Intervals (CI) for the Associations of Clinically Assessed and Self-Reported Hearing Measures With Physical and Mental Functioning

<table>
<thead>
<tr>
<th>Condition</th>
<th>Physical Health</th>
<th>Mental Health</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td><strong>Clinically assessed high-frequency hearing impairment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neither ear</td>
<td>1.00 (referent)</td>
<td>1.00 (referent)</td>
</tr>
<tr>
<td>One ear only</td>
<td>1.52 (0.86, 2.70)</td>
<td><strong>1.85 (1.06, 3.22)</strong></td>
</tr>
<tr>
<td>Both ears</td>
<td><strong>0.52 (0.28, 0.94)</strong></td>
<td>1.26 (0.62, 2.55)</td>
</tr>
<tr>
<td><strong>Adjusted</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neither ear</td>
<td>1.00 (referent)</td>
<td>1.00 (referent)</td>
</tr>
<tr>
<td>One ear only</td>
<td>1.28 (0.63, 2.59)</td>
<td>1.84 (0.98, 3.48)</td>
</tr>
<tr>
<td>Both ears</td>
<td>0.92 (0.43, 1.99)</td>
<td><strong>2.43 (1.03, 5.72)</strong></td>
</tr>
<tr>
<td><strong>Self-reported hearing impairment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Unadjusted</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.00 (referent)</td>
<td>1.00 (referent)</td>
</tr>
<tr>
<td>Yes</td>
<td><strong>3.48 (2.09, 5.80)</strong></td>
<td><strong>2.43 (1.40, 3.92)</strong></td>
</tr>
<tr>
<td><strong>Adjusted</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.00 (referent)</td>
<td>1.00 (referent)</td>
</tr>
<tr>
<td>Yes</td>
<td><strong>2.41 (1.28, 4.54)</strong></td>
<td><strong>1.99 (1.08, 3.68)</strong></td>
</tr>
</tbody>
</table>

*Note: Boldfaced results are significant at $p < .05$.  
*Adjusted for age, ethnicity, marital status, working status, difficulty paying for basics, body mass index, health conditions, stress, and social support variables.

**Table 2. Crude and Adjusted Odds Ratios (OR) and 95% Confidence Intervals (CI) for the Associations Between Combined Measures of Hearing Impairment and Functioning**

<table>
<thead>
<tr>
<th>Hearing Assessment</th>
<th>Physical Health</th>
<th>Mental Health</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td><strong>Unadjusted</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neither HFHI nor SRHI</td>
<td>1.00 (referent)</td>
<td>1.00 (referent)</td>
</tr>
<tr>
<td>HFHI but no SRHI</td>
<td>1.35 (0.77, 2.32)</td>
<td><strong>0.95 (0.53, 1.68)</strong></td>
</tr>
<tr>
<td>SRHI but no HFHI</td>
<td><strong>3.04 (1.55, 5.98)</strong></td>
<td>1.72 (0.85, 3.45)</td>
</tr>
<tr>
<td>Both HFHI and SRHI</td>
<td><strong>4.81 (2.33, 9.94)</strong></td>
<td><strong>3.24 (1.58, 6.65)</strong></td>
</tr>
<tr>
<td><strong>Adjusted</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neither HFHI nor SRHI</td>
<td>1.00 (referent)</td>
<td>1.00 (referent)</td>
</tr>
<tr>
<td>HFHI but no SRHI</td>
<td>1.13 (0.58, 2.23)</td>
<td>0.75 (0.39, 1.44)</td>
</tr>
<tr>
<td>SRHI but no HFHI</td>
<td><strong>2.71 (1.20, 6.15)</strong></td>
<td>1.50 (0.66, 3.41)</td>
</tr>
<tr>
<td>Both HFHI and SRHI</td>
<td><strong>2.24 (0.91, 5.51)</strong></td>
<td><strong>2.39 (1.02, 5.62)</strong></td>
</tr>
</tbody>
</table>

*Note: HFHI = High-frequency hearing impairment; SRHI = self-reported hearing impairment. Boldfaced results are significant at $p < .05$.  
*Adjusted for age, ethnicity, marital status, working status, difficulty paying for basics, body mass index, health conditions, stress, and social support variables.

*Functioning was assessed with the Medical Outcomes Trust SF-12 Health Survey.*
ing variables, SRHI was associated with lower physical and mental functioning; clinically assessed HFHI in one ear only was not associated with lower physical or mental functioning, and HFHI in both ears was associated with lower mental functioning only. Although combining HFHI with SRHI slightly improved detection of lower mental functioning, detection of lower physical functioning was not improved compared with SRHI alone, and the model fit was not improved when we added the combined hearing impairment measure.

Difficulties in understanding speech contribute more to functioning deficits than any other auditory problems (Bess, Lichtenstein, Logan, & Berger, 1989). Speech usually occurs in situations where background noises and competing sensory demands are present. Perception of sound in a totally quiet environment, such as occurs in clinical assessment, is appropriate for identifying and measuring specific types of impairments (Coren & Hakstain, 1992; Humes & Roberts, 1990), but may not present the complex nature of hearing in everyday environments (Newman, Weinstein, Jacobson, & Hug, 1990; Slawinski, Hartel, & Kline, 1993). Self-report allows the respondent to average hearing limitations over a range of circumstances appropriate to her life and weigh her response according to her perception of numerous components of limitations, such as difficulties perceiving speech in noisy environments and accommodation to limitations (Lutman, 1991; Newman et al., 1990).

Clinically assessed impairments and self-reported impairments are often poorly correlated in older populations (Slawinski et al., 1993). This correlation may be even lower for younger adults as they become more sensitized to an early deficit and less acclimated to existing limitations than older adults (Gatehouse, 1991; Lutman, 1991). Adults at midlife may be less likely than older adults to dismiss a slight reduction in hearing acuity as a normal aging process. Coupled with the overall fear of aging that plagues our society, this may lead to oversensitivity to slight reductions in sensory perceptions.

In this sample of women at midlife, the poor correlation between SRHI and HFHI, together with the significant association between SRHI and functioning, supports the hypothesis that the two methods often measure different aspects of hearing. This low concordance may explain, in part, why use of hearing aids is generally poor because many individuals who are detected clinically to have hearing impairments do not experience problems that they attribute to their hearing (Garstecki & Erler, 1998).

The association of SRHI with both lower physical and lower mental functioning in this study indicates that administration of simple, self-report hearing measures may facilitate early identification of individuals with hearing-related functional limitations. For patients who self-report hearing impairments, providers could suggest audiometric testing and recommend modification of risk factors associated with impaired hearing and functioning, such as cigarette smoking (Cruckshanks, Klein, et al., 1998) and noise exposure (Helfer & Wilber, 1990). For patients who elect to have their hearing tested clinically and are detected to have hearing impairments, providers could encourage treatment through amplification and assistive listening devices (Gates et al., 1990). Education of providers and adults about prevention and treatment of hearing impairments and associated functional limitations may improve patient and provider acceptance of auditory screening and inform development of intervention programs designed to improve hearing abilities and reduce limitations consequent to hearing impairment (Gates et al., 1990; Laforge et al., 1992).

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Address correspondence to Sandra Kay Pope, Department of Geriatrics, University of Arkansas for Medical Sciences, 4301 W. Markham St., Slot 748, Little Rock, AR 72205. E-mail: popesandra@exchange.uams.edu

References


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