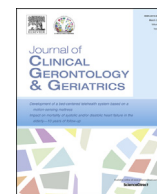


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Original article

## Functional assessment of elderly patients with hearing impairment: A preliminary evaluation



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## ABSTRACT

**Background:** The consequence of hearing impairment in elderly patients may affect daily living activities functions. This study assessed whether hearing impairment (HI) has an effect, and the extent of the effect, on the functionality of elderly patients. It also explored factors that may be associated with impaired functionality in hearing-impaired elderly patients.

**Methods:** This was a cross-sectional, comparative study of elderly patients (aged  $\geq 60$  years) with HI. The study was conducted in a specialist tertiary hospital in a suburban town in southwestern Nigeria. The study participants were administered a structured questionnaire to obtain information on sociodemographics, clinical and audiometric profiles, and functional capabilities relating to physical, cognitive, and emotional functioning. Differences in the functional capabilities between the test patients and the controls were explored using the Student *t* test and Chi-square test, based on the data generated by statistical software.

**Results:** One hundred and thirty individuals (78 test patients, 52 controls), aged 60–94 years (mean  $\pm$  standard deviation,  $71.4 \pm 7.4$  years) completed the study. In the physical and cognitive domains, the prevalence of functional impairment was 52.6%. Functions were different between hearing-impaired patients and normal hearing elderly patients. The HI patients had associated significant impairment in two domains of functional assessment ( $\chi^2 = 10.5, p = 0.001$ ). The factors associated with functional impairment included an age older than 70 years, unmarried status, the presence of combined distressing symptoms, the loss of right ear advantage, the presence of multiple comorbid systemic diseases, and the need for hearing aids.

**Conclusion:** Elderly patients with HI have vital functional limitations in daily living activities in Nigeria. The factors associated with the limitations deserve urgent attention.

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### 1. Introduction

Since the turn of the 21<sup>st</sup> century, the growing interest of medical research in the elderly and age-related changes in humans may be attributed to two major reasons. The first reason is that the elderly constitute an emerging population. Epidemiological data from the United Nations Population Division has projected that the elderly population—which was 11.0% of the world's total population in the year 2010—may double by the year 2050.<sup>1</sup> The second

reason is that elderly people are prone to having coexisting diseases and morbidities by virtue of generalized degeneration in tissues and a reduction in sensory, neural, and immunological activities.<sup>2</sup> This coexistence tends to limit the functional capability of the elderly in performing activities of daily living and thus influence the quality of their lives.

Among the elderly, age-related hearing loss is the most common form of sensory hearing impairment (HI) and communication disorders associated with aging.<sup>3</sup> It constitutes the third most prevalent chronic medical condition in older Americans.<sup>4</sup> The increasing number of elderly will translate into an increased population of hearing-impaired elderly patients. If left untreated, the impact of HI on patients, caregivers, and society as a whole will be considerable. The effects of the HI transcend different aspects of life of the

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affected individual, which may include physical, cognitive, emotional, psychological, and social activities. Thus, HI can accentuate precarious functional capabilities in the elderly. What effects the impairment has on the regular daily living activities on elderly patients may be pondered.

This study therefore aimed to assess whether HI has an effect, and the extent of the effect, on the functionality of elderly patients. Furthermore, it assesses various factors that may be associated with impaired functionality in hearing-impaired elderly patients. The study will help discern parameters that should be focused on when assisting hearing-impaired elderly maintain independent living.

## 2. Methods

This was a 5-year (2008–2012) cross-sectional, comparative study conducted at the ear, nose, and throat (ENT) clinic of the Olabisi Onabanjo University Teaching Hospital (Sagamu, Nigeria). The patients of the study were elderly patients (aged  $\geq 60$  years) who were clinically diagnosed with HI, which was confirmed by audiometric findings of bilateral sensorineural hearing loss. Comparable elderly patients attending the clinic but who did not have a history of HI and in whom pure tone audiometry (PTA) confirmed normal hearing were recruited as the control patients. Informed consent was obtained from the test patients and the controls. Patients excluded were those who did not give consent, did not have audiometric assessment, or had other forms of HI such as conductive hearing loss or mixed hearing loss.

The study protocol was approved by the Health Research and Ethics Committee of the Olabisi Onabanjo University Teaching Hospital (Sagamu, Nigeria). The study was conducted in accordance with the principles of the Helsinki declaration.

The study instrument was a structured questionnaire comprising three sections. Section A obtained information about the patients' sociodemographics such as the patients' age, sex, marital status, level of education, and class of occupation (i.e., skilled or trained specifically for a particular duty and vocation, or unskilled or no specific training). Section B elicited information on the clinical profile and the audiometric findings of the patients. The clinical parameters included other symptoms associated with HI, the duration of symptoms of HI prior to presentation, and the presence of other systemic diseases. Multiple comorbidities were at least two other systemic diseases in the patients besides HI. The questionnaires were administered by the interviewers (O.A.S. and T.O.M.) and some responses, particularly chronic systemic diseases, prolonged use of medications and the number of medications and their combinations, and past medical records were corroborated by checking the case record files of the patients. The patients were asked questions relating specifically to the use of potentially ototoxic medications that can cause HI such as acetylsalicylic acid and loop diuretics used as antihypertensive drugs. Pure tone audiometry was performed in a sound-proof booth using the diagnostic audiometer GS I67 (Kaplan) (Entomed AB Bariumgatan 29, S-213 64, Malmo, Sweden), and performed by the same audiologist on all patients. Pure tone audiometry assessed the air conduction and bone conduction thresholds at frequencies ranging 125–8000 Hz for the air conduction and 250–4000 Hz for bone conduction hearing.

The pure tone average (PTAv) was calculated by the arithmetic mean of the air conduction hearing thresholds of each ear. Hearing impairment was indicated by a PTAv of  $\geq 25$  decibel hearing level (dB HL) in the better ear. For the controls, normal hearing was indicated by PTAv of  $< 25$  dB HL in both ears. The need for hearing aids was indicated by an audiometric PTAv of  $\geq 40$  dB HL in the better ear. In the audiograms, we noted the presence, extent, and laterality of the HI.

Section C contained information, based on interviewer-administered questions, related to the functional ability and capability of the patients in three functional domains: physical functioning, cognitive functioning, and emotional functioning. All patients were encouraged to come with their spouses or other close relatives to corroborate their responses, especially on functional capabilities. The Katz index<sup>35</sup> was used in assessing the physical functional domain; patients were classified by the scores obtained from the six item questionnaire as “independent” (6) or “dependent” (5–0). Cognitive function was assessed using the short portable mental status questionnaire,<sup>36</sup> modified as applicable to the patients and the local setting. The cognitive scores were classified, based on wrong answers on a total of ten questions, as “good” (0–3) or “poor” (4–10). Emotional function was assessed and scored using the short form of the Geriatric Depression Scale–15.<sup>37</sup> Responses on emotional function were classified, based on the scores on the 15-item questionnaire, as “not depressed” (i.e., interested in most living activities) (0–5) or as “depressed” (i.e., loss of interest in most living activities) (6–15). Comparisons were based on independent/dependent (physical), good/poor (cognition), and not depressed/depressed (emotional). The patients had PTA and the questionnaires administered during the same visit.

The study data were managed on a spreadsheet and presented in simple descriptive forms as proportions in tabular form. The patients were categorized, based on their hearing status, as “test” (i.e., patients with HI) or “control” (i.e., patients without HI). The second category was based on functional status: “no functional impairment” (i.e., impairment in no or 1 functional parameters) or “functional impairment” (i.e., impairment in 2 functional parameters—namely, the physical and cognition parameters). Differences between discrete variables were analyzed using the Chi-square test, whereas differences between continuous variables were explored using the sample *t* test. The level of statistical significance was set at  $p < 0.05$ . Statistical analyses were performed using SPSS version 17.0 software (SPSS Inc., Chicago, IL, USA).

## 3. Results

One hundred and thirty patients, which comprised 78 test patients (i.e., with HI) and 52 controls (i.e., no HI), participated in the study. Most (63.8%) patients were male. The age of the patients ranged 60–94 years with a median age of 71 years [mean  $\pm$  standard deviation (SD),  $71.4 \pm 7.4$  years]. Approximately one-third (36.2%) of participants were unmarried at the time of the study. Nearly three-fourths (72.3%) of patients had at least a secondary school education and one-third (33.9%) of the patients were retired. Table 1 shows the sociodemographic characteristics of the patients, based on the hearing status. The parameters were well matched between the two categories of patients.

Besides hearing loss, other common symptoms experienced by the patients were tinnitus (58.5%, which comprised 18 controls with no hearing impairment and 58 test patients with HI); heaviness in the ear (21.5%, which comprised 9 control and 19 test group patients); and vertigo (18.5%, which comprised 2 controls and 22 test group patients). Furthermore, 13.8% of patients with HI had a combination of at least two of these distressing symptoms. The duration of HI symptoms prior to presentation ranged between 3 months and 22 years with a median duration of 36 months, which was used as the dividing line between early and late presentation. Less than one-half (42.6%) of our patients presented late. Common comorbid systemic diseases in our patients were hypertension (36.9%, which comprised 15 controls and 33 test group patients); diabetes (20.8%, which comprised 16 controls and 11 test group patients); and osteoarthritis of the knee joints (16.9%, which comprised 9 controls and 13 test group patients).

**Table 1**  
Sociodemographic characteristics of patients with and without hearing impairment.

Variable	Control	Test	Statistic	p
	(No HI; n = 52)	(HI; n = 78)		
Age group (y)				
60–69	26 (50.0)	29 (37.2)		
70–79	21 (40.4)	34 (43.6)		
80–99	5 (9.6)	15 (19.2)		
Mean ± SD	70.0 ± 6.1	72.3 ± 8.1	1.740 <sup>a</sup>	0.084
Sex				
Male	29 (55.8)	39 (50.0)	0.416	0.519
Female	23 (44.2)	39 (50.0)		
Marital status				
Married	38 (73.1)	45 (57.7)	3.577	0.167
Others	14 (26.9)	33 (42.3)		
Level of education				
No formal education	1 (1.9)	2 (2.6)	1.870	0.600
Primary	10 (19.2)	13 (29.5)		
Secondary	29 (55.8)	37 (47.4)		
Tertiary	12 (23.1)	16 (20.5)		
Occupational class				
Unskilled (no specific training)	6 (11.5)	16 (20.5)	1.875	0.392
Skilled (specific training)	28 (53.8)	36 (46.2)		
Retired	18 (34.6)	26 (33.3)		

Data are presented as n (%) or mean ± SD.

HI = hearing impairment; SD = standard deviation.

<sup>a</sup> Statistical analysis is by sample *t* test. All other statistical analyses were performed with the Chi-square test.

More than one-third (36.9%) of test group patients had a combination of these diseases.

Table 2 shows the comparison of the physical, cognitive, and emotional functions between patients with HI and without HI. Most patients (86.5% of the control group and 59.0% of the test group) had relatively good physical functional status; 96.2% of the control group and 64.1% of the test group had relatively good cognitive function; and 82.7% of the control group and 38.5% of the test group had relatively good emotional function. There were statistically significant differences in all three domains of functional assessment between the categories of patients. However, less emphasis was focused on emotional function because of its high subjectivity. Thus, the functions dealt primarily with the physical and cognitive assessments. The functions between the two patient categories were comparatively analyzed.

Significantly more patients with HI had associated impairments in two domains of functional assessments, compared to patients without HI (52.6% versus 3.8%, respectively;  $\chi^2 = 10.5$ ;  $p = 0.001$ ). Among patients with HI, 37 (47.4%) patients had no functional impairment (NFI), whereas 41 (52.6%) patients had functional impairment (FI). The PTA<sub>v</sub> for the better ear in the hearing-impaired elderly was 42.0 dB HL (for patients with NFI) and

**Table 2**  
A comparison of physical, cognitive, and emotional functions between the patients with and without hearing impairment.

Variable	Control	Test	Statistics	p
	(No HI; n = 52)	(HI; n = 78)		
Physical function				
Independent	45 (86.5)	46 (59.0)	11.29	0.001
Dependent	7 (13.5)	32 (41.0)		
Cognitive function				
Good	50 (96.2)	50 (64.1)	18.06	< 0.001
Poor	2 (3.8)	28 (35.9)		
Emotional function (interest in daily living activities)				
Not depressed	43 (82.7)	30 (38.5)	24.79	< 0.001
Depressed	9 (17.3)	48 (61.5)		

Data are presented as n (%).

HI = hearing impairment.

59.1 dB HL (for patients with FI) ( $p = 0.001$ ); the PTA<sub>v</sub> at the low frequencies (i.e., 0.125–2.0 kHz) was 32.9 dB HL (for NFI) and 52.8 dB HL (for FI) ( $p < 0.001$ ), and the PTA<sub>v</sub> at the high frequencies (i.e., 4.0–8.0 kHz) was 48.1 dB HL (for NFI) and 64.7 dB HL (for FI) ( $p = 0.005$ ). Table 3 shows the factors associated with FI in the two combined domains. The various factors that were associated with FI included age > 70 years ( $p < 0.001$ ), unmarried status ( $p = 0.014$ ), level of education ( $p = 0.041$ ), a combination of distressing symptoms ( $p = 0.014$ ), a worse HI in the right ear ( $p = 0.003$ ), the presence of multiple comorbid systemic diseases ( $p = 0.003$ ), and the need for hearing aids ( $p < 0.001$ ). However, sex ( $p = 0.485$ ), retirement ( $p = 0.070$ ), and duration of symptoms prior to presentation to the clinic ( $p = 0.150$ ) were not associated with FI in these hearing-impaired elderly.

#### 4. Discussion

Findings from this study indicated that HI in elderly patients had negative effects on their daily life activities and functionality, but more so in the emotional domain. More than half of these elderly had some form of impairment in two domains (i.e., the physical and cognitive domains) of function. The factors associated with impaired functionality in elderly patients were aged > 70 years, unmarried status, minimum of secondary school education, a combination of distressing otologic symptoms, multiple comorbidities, loss of right ear advantage, and the need for hearing aids.

Hearing loss is a common disability that can profoundly impact daily functioning in the elderly.<sup>5</sup> As age advances, the elderly frequently have reduced cognition and vigor, which has been regarded as part of the aging process. However, all of these factors become aggravated when the patients have an attendant difficulty in hearing.<sup>6</sup> The everyday competence model hypothesizes that sensory loss such as HI will have a differential effect on functional ability.<sup>7</sup> The loss of competence would initially manifest in instrumental activities of daily living (ADL) tasks before it impacts simpler self-care ADL tasks.<sup>7</sup> In the Baltimore longitudinal study of aging, Lin et al<sup>8</sup> found that hearing loss was independently associated with incident all-cause dementia. Dalton et al<sup>9</sup> similarly report that the severity of hearing loss was significantly associated with decreased function in the summary scores of the mental and physical components in older adults.

The prevalence of functional limitations among the elderly reportedly ranges 8.2–32.7% with values higher when there are

**Table 3**  
Factors associated with functional impairment in hearing-impaired elderly patients.

Factor	NFI	FI	Statistic	p
	n = 37 (47.4%)	n = 41 (52.6%)		
Age > 70 y	29.6	70.4	17.82	< 0.001
Sex, male	45.1	54.9	0.49	0.485
Unmarried	27.7	72.3	6.04	0.014
At least 2° education	12.8	87.2	4.17	0.041
Retired	25.0	75.0	5.16	0.070
Combined distressing symptoms	38.9	61.1	7.17	0.014
Multiple comorbidities	29.2	70.8	8.11	0.004
Late presentation (> 36 mo)	33.3	66.7	2.08	0.150
HI worse in right ear	31.3	68.8	11.76	0.003
Need for hearing aids	28.4	71.6	12.86	< 0.001

The data in the NFI and FI columns are presented as %. All statistics were performed by Chi-square test.

Combined distressing symptoms are –HI, ±vertigo, and ±tinnitus.

2° = secondary school; FI = functional impairment (i.e., impairment in both cognitive and physical function); HI = hearing impairment; NFI = no functional impairment (i.e., no or 1 impairment in cognitive and physical function).

concomitant pathologies.<sup>10,11</sup> The prevalence of 52.6% in FI in this study is comparatively high and may be because of the coexistence with HI. However, the hospital-based nature of our study, compared to a community-based population survey, could have introduced selection bias in the patients. Furthermore, the data may not adequately represent the elderly population in the country. We could have an exaggerated prevalence rate, which thus limits its validity.

Hearing impairment affects most frequencies, although HI in the elderly is often accentuated at the higher frequencies (which was found in this study), which are more important in understanding speech. Impaired hearing is also correlated with impaired postural balance, which may underlie mobility decline and thus cause functional disability.<sup>12</sup> Furthermore, auditory cues are important for spatial orientation.<sup>13</sup> Thus, a significant decrease in environmental acoustic information due to hearing loss can manifest as uncertainty and poorer functioning in ADL tasks.<sup>12</sup> Communication is an important aspect of daily living and particularly in performing instrumental ADL tasks. It is therefore not surprising that hearing loss with its resultant communication problems would be associated with difficulty in performing these activities.<sup>12</sup>

Hearing high-frequency sounds leads to higher metabolism, better motility, an activation of the gamma nervous system, and better transfer of information.<sup>14</sup> Thus, poor speech understanding can manifest with inappropriate responses to instructions and conversations simulating cognitive impairment. A combination of these impairments culminates in a tendency for patients to be disinterested in daily living activities with an inclination toward depression and other forms of distortion.<sup>15</sup> In this study, significantly more hearing-impaired elderly patients were physically dependent and depressed, compared to the control patients. Previous studies<sup>16,17</sup> indicate that a regular program of physical activity or proper physical assistance is beneficial in reducing depressive symptoms in elderly people with sensory loss. More efforts need to be made toward functional improvement in elderly people with HI.

A study conducted in the United States of America among Native Americans and native Alaskans reported that, among other factors, individuals with functional limitations were older, less likely to be married, and less likely to be employed.<sup>18</sup> This is similar to some findings in this study. The prevalence, magnitude, and effects of age-related hearing loss—including reduced functionality—increase with age<sup>19</sup>; however, most dimensions are preserved until after 70 years of age.<sup>20</sup> FI in our patients was significantly associated with an age > 70 years.

In Burkina Faso in sub-Saharan Africa, a study conducted on disabilities that affect mobility, communication, and mental function in elderly people living at home showed that all individuals affected by disability were able to manage them with a stable support network, which was primarily a spouse and other family members.<sup>21</sup> In concordance with the study in the United States,<sup>18</sup> we found that FI was associated with an unmarried state. The physical performance score of body functioning is significantly, albeit negatively, associated with an unmarried status.<sup>22</sup> However, in a Brazilian study, being married significantly reduced clinical depressive symptoms among community elderly patients.<sup>23</sup>

Retirement is often related to age because government social services expect retirement once a particular age is attained. Approximately one-third (33.9%) of the test patients in this study were retired, although retirement was not associated with FI among hearing-impaired patients. More essential to the connection between the health and well-being of older individuals is the ability to be productively engaged and remain active in meaningful, but not necessarily economic, activities—even after retirement.<sup>24</sup> The concept of active aging is presently being promoted.

The presence of distressing otologic symptoms that aggravate HI was associated with poor functional abilities. There is an intimate

and reciprocal connection between the pathophysiology of HI and tinnitus,<sup>25</sup> presenting as distortions in understanding speech. When HI is combined with other symptoms such as tinnitus, a feeling of ear blockage, and vertigo, there is a tremendous effect on cognitive function, and emotional responses are often poor.<sup>26</sup> The occurrence of comorbidities and multiple simultaneous pathologies has been a major challenge in managing diseases in the elderly. The major associated comorbid systemic diseases with HI in this study were hypertension and diabetes. The combined presence of these pathologies is associated with higher functional disability and cognitive impairment in older individuals.<sup>27</sup> Thus when hearing loss is combined with other comorbidities, their synergistic effects can be associated with functional limitations.<sup>2,28</sup>

The ubiquitous right ear advantage for verbal material assists in attention and in cognitive activities of the brain.<sup>29</sup> When age-related hearing loss develops, the right ear advantage is lost, and this manifests as worse hearing in the right ear, which was associated with deleterious effect on functionality.<sup>3</sup> Reduced functionality may also be associated with the intensity of the hearing loss. Patients with pure tone average of at least 40 dB theoretically qualify for hearing aids. The Epidemiology of Hearing Loss Study (EHLS) reports that individuals with moderate to severe hearing loss were more likely to have impaired ADL, compared to people without hearing loss.<sup>9</sup> The need for hearing aids was associated with FI in this study. This finding also resonates with a Norwegian study that showed an association between previous hearing aid experience and activity limitation.<sup>30</sup> However, hearing aid use has conversely been shown to improve a person's ability to communicate, and thus improve the quality of life and prevent social isolation and hearing-related depression.<sup>31,32</sup>

Some authors have reported less emotional stability in men, compared to women, in the ability to cope with stressful situations.<sup>33</sup> The findings of this study, however, revealed that factors such as male sex and late presentation (i.e., > 36 months) were not associated with FI.

In this preliminary evaluation, because of the relatively small sample size, we performed univariate analyses (rather than multivariate analyses of variables) in which confounding factors would have been controlled. We consequently were only able to detect the general factors rather than independent factors associated with FI in hearing-impaired elderly patients. The study was processed from 2008 to 2012; despite this length of time, the effects of aural rehabilitation or hearing aids that could assist in determining a causal relationship between depression and HI in these patients could not be evaluated because only a few patients were available for follow up. Because the study has not been terminated, we hope in later communications to present the findings of the subsequent Geriatric Depression Scale-15 results and the independent factors associated with FI when sufficient data are available. Furthermore, only peripheral changes in HI were measured by PTA, but HI in elderly patients represents a combination of deteriorated function of the auditory periphery and central auditory system.<sup>34</sup> It is also noteworthy that inferences from a hospital database may be difficult to generalize into the real world. In consideration of these limitations, a longitudinal analysis between HI and functional limitations will be required to investigate the actual effects of HI on functional limitations.

It may suffice to conclude that a sizeable proportion of elderly patients with HI have associated functional limitations in daily living activities. Thus functional assessment should be incorporated into the audiological assessment of elderly patients. Some factors associated with these FIs are treatable and controllable. We recommend early screening for detecting and treating HI, fitting hearing aids and other rehabilitation devices, active aging, social

support for the elderly, control of concomitant systemic diseases, and specialized geriatric care. These are more germane in resource-poor communities where it is difficult to attain an elderly status.

### Conflicts of interest

The authors hereby declare that they have no financial support or relationship that may pose any conflicts of interest.

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