Original Article
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Medical Journal of the Islamic Republic of Iran (MJIRI)

Med J Islam Repub Iran. 2026 (23 Sep);40.104. https://doi.org/10.47176/mjiri.40.104

Association between Hearing Loss and Frailty among Community-Dwelling Older Adults in Iran: A Cross-Sectional Study

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Received: 13 Feb 2026 Revised: 7 Sep 2026 Accepted: 13 Sep 2026 Published: 23 Sep 2026

Abstract

Background: Hearing loss is the most prevalent sensory impairment among older adults and has been associated with various adverse health outcomes. Frailty syndrome is another major geriatric condition associated with increased morbidity and mortality. This study aimed to evaluate whether hearing loss is independently associated with frailty after adjusting for potential confounding factors.

Methods: This cross-sectional analytical study included 600 older adults selected from the second phase of the Amirkola Health and Ageing Project (AHAP). After excluding participants with incomplete data, we randomly selected 300 participants from each hearing status group, yielding a final analytical sample of 600 participants: those with hearing loss and those without. This 1:1 allocation between hearing groups was created by the authors and does not reflect the natural distribution of hearing loss in the AHAP cohort. Frailty was assessed using the validated FRAIL questionnaire (frail: score ≥3; non-frail: robust + pre-frail: score 0–2). Multivariate logistic regression analyses were performed to examine the association between hearing loss and frailty, adjusting for age, sex, body mass index (BMI), diabetes, education level, marital status, and comorbid chronic diseases.

Results: In unadjusted analyses, hearing loss was significantly associated with higher odds of frailty (OR = 2.26, 95% CI: 1.60–3.20, $P < 0.001$). Frailty was present in 43.0% of participants with hearing loss compared to 25.0% of those with normal hearing. After adjusting for confounding variables, hearing loss remained significantly associated with frailty (OR = 1.90, 95% CI: 1.25–2.90, $P = 0.003$). Older age ($P < 0.001$), female sex ($P < 0.001$), multimorbidity ($P < 0.001$), and hearing loss ($P = 0.003$) were independently associated with frailty.

Conclusion: Hearing loss was independently associated with frailty, even after adjusting for major confounding factors. These findings suggest that hearing loss is associated with frailty in Iranian older adults. Longitudinal studies using objective audiometric measures are necessary to determine whether this association is causal.

Keywords: Hearing loss, Frailty, Elderly, Aging

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Cite this article as: Moghimi M, Ezoji K, Hosseini SR, Bijani A, Tavasoli A. Association between Hearing Loss and Frailty among Community-Dwelling Older Adults in Iran: A Cross-Sectional Study. *Med J Islam Repub Iran.* 2026 (23 Sep);40:104. https://doi.org/10.47176/mjiri.40.104pp

Introduction

Population aging is accelerating globally due to advances in healthcare and increased life expectancy (1). According to the World Health Organization (WHO), individuals aged 60 years and older constitute a rapidly expanding demographic group, particularly in low- and middle-income countries (2, 3). Iran is experiencing a similar demographic transition; national projections indicate that more than 30% of the population will be aged 60 years or older by 2050, highlighting the growing public health burden of age-related conditions (4, 5).

Hearing loss is one of the most prevalent chronic conditions among older adults and a significant contributor to disability worldwide (6, 7). Global estimates indicate that over 1.5 billion individuals are affected by some degree of hearing loss, with prevalence markedly increasing with age

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Key Messages:

↑What is "already known" in this topic:

Prior studies, primarily from Western and East Asian populations, have linked hearing loss to frailty; however, evidence from elderly populations in the Middle East is lacking.

→What this article adds:

This study among Iranian community-dwelling older adults suggests that hearing loss is associated with higher odds of frailty (OR=1.90); however, longitudinal studies are needed to establish causality and screening utility.

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[DOI: 10.47176/mjiri.40.104]

(8, 9). Age-related hearing loss is linked to adverse physical, psychological, and social outcomes, including social isolation, depression, reduced physical function, and an increased risk of falls (10–14). These consequences may expedite functional decline in later life.

Frailty is a multidimensional geriatric syndrome characterized by reduced physiological reserve and increased vulnerability to stressors (15, 16). Regardless of the conceptual framework employed—whether the physical phenotype or deficit accumulation model—frailty has been consistently associated with disability, hospitalization, loss of independence, and mortality (17–22). Thus, identifying modifiable or early markers of frailty is a key priority in geriatric research and clinical practice.

Emerging evidence suggests a potential association between age-related hearing loss and frailty, possibly mediated by shared mechanisms such as inflammation, vascular dysfunction, cognitive decline, and reduced physical and social engagement (23, 24). However, findings remain inconsistent, and it is unclear whether hearing loss independently contributes to frailty or merely reflects underlying age-related comorbidities (25, 26). Moreover, data from Middle Eastern populations, including Iran, are limited.

Given the rapid aging of the Iranian population and the high prevalence of both hearing loss and frailty, this study aimed to investigate whether hearing loss is independently associated with frailty among community-dwelling older adults. We hypothesized that hearing loss is associated with higher odds of frailty in the elderly population.

Methods

This cross-sectional analytical study was conducted using data from the second phase of the Amirkola Health and Ageing Project (AHAP), a population-based cohort study involving community-dwelling adults aged ≥60 years in northern Iran (27). From the total of 1616 participants in the second phase of the AHAP study, individuals with cognitive impairment, defined as a score of <22 on the Mini-Mental State Examination (MMSE) or an inability to provide informed consent, were excluded. Among the remaining participants, 520 reported hearing loss and 1096 had normal hearing. After excluding 220 participants with incomplete data, we performed stratified random sampling based on hearing status to ensure equal representation. Using a random number generator in SPSS, we randomly selected 300 participants from the hearing loss group and 300 from the normal hearing group**,** yielding a final analytical sample of 600 participants. Only hearing status was used for stratified random sampling; no matching or quota sampling by age or sex was performed. This 1:1 allocation between hearing groups was created by the authors and does not reflect the natural distribution of hearing loss in the AHAP cohort.

Hearing status was assessed through self-reported data obtained via structured interviews. Participants were classified as having hearing loss if they reported hearing loss and had either medical confirmation of hearing loss or hearing aid use. Participants who reported no hearing loss and had no medical confirmation or hearing aid use were classified as having normal hearing. Although audiometric assessments were not available, self-reported hearing loss and had either medical confirmation or hearing aid use has been shown to correlate reasonably well with objective hearing loss in large epidemiological studies.

Frailty status was assessed using the validated FRAIL questionnaire, a screening tool consisting of five components: fatigue, resistance, ambulation, illnesses, and weight loss. The total frailty score ranges from 0 to 5, with participants classified as frail (score ≥3) or non-frail (robust: score 0; pre-frail: score 1–2) (28). For the main analysis, frailty was dichotomized as frail (score ≥3) versus non-frail (score 0–2). The Persian version of the FRAIL questionnaire has been validated for the Iranian elderly population (29).

Demographic and clinical variables included age, sex, body mass index (BMI), educational level, marital status, marital status, diabetes mellitus, and the number of chronic underlying diseases. BMI was categorized as <25.0, 25.0–29.9, and ≥30.0 kg/m². Diabetes status and comorbid conditions were determined based on medical history and clinical records

Data analysis

Descriptive statistics were employed to summarize participant characteristics. Categorical variables were expressed as frequencies and percentages, while continuous variables were reported as means and standard deviations. Differences between groups were assessed using the chi-square test for categorical variables and the independent t-test for continuous variables. Multivariable logistic regression analyses were performed to examine the association between hearing loss and frailty status. Two categories of variables were considered:

1. Established confounders known to influence both hearing loss and frailty include age, sex, education level, and marital status.

2. Additional covariates that may potentially lie on the causal pathway (mediators) or represent underlying comorbidities include body mass index (BMI), diabetes mellitus, and the number of chronic diseases (multimorbidity).

All variables were simultaneously entered into a fully adjusted model to estimate the independent association of hearing loss with frailty. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated after adjusting for potential confounding variables, including age, sex, BMI, education level, marital status, diabetes, and comorbid chronic diseases. A two-sided p-value < 0.05 was considered statistically significant. All statistical analyses were conducted using SPSS software (version 25). The sample size was calculated based on the findings of a meta-analysis by Assi et al. (30), who reported an odds ratio of 1.87 for frailty in individuals with hearing loss compared to those without. Assuming a two-sided type I error (α) of 0.05, a power of 80% (β = 0.20), and a frailty prevalence of 20–30% in the comparison group, the minimum required sample size was calculated as 175–195 participants per group. We selected 300 participants per group (total n = 600), with a 1:1 allocation chosen a priori to ensure balanced groups for multivariable logistic regression.

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Results

This cross-sectional descriptive–analytical study was conducted on 600 community-dwelling older adults aged ≥60 years, with a mean age of 70.97 years (SD = 7.70, range: 60–94 years) residing in Amirkola city. The highest proportion of participants was in the 60–69 age group (50%), followed by those aged 70–79 years (35%) and ≥80 years (15%). The sample included 300 men (50%) and 300 women (50%). The majority of participants were married (82.3%) and illiterate (60.8%). Regarding BMI, 27% had normal weight, 38.3% were overweight, and 34.7% were obese. Most participants (70.3%) had three or more chronic diseases, and 30.5% had diabetes. In terms of hearing status, 50% had hearing loss while the other 50% had normal hearing. Based on frailty status, 21.7% were robust, 44.3% were pre-frail, and 34% were frail (Table 1).

Among participants with normal hearing (n = 300), 26.0% (78) were classified as robust, 49.0% (147) as pre-frail, and 25.0% (75) as frail. In contrast, among participants with hearing loss (n = 300), 17.3% (52) were robust, 39.7% (119) were pre-frail, and 43.0% (129) were frail. The chi-square test indicated a statistically significant association between hearing loss and frailty status ($\chi^2 = 22.441$, df = 2, $P < 0.001$) (Figure 1).

Unadjusted Analysis

An analysis of Table 2, presenting the results of univariate associations between various demographic and clinical variables and frailty status (using the Chi-square test for categorical variables and the independent t-test to compare mean ages)—revealed that nearly all examined characteristics showed a significant association with frailty. Specifically, gender was significantly associated with frailty (P<0.001); the proportion of women in the frail group (72.5%) was markedly higher than that in the non-frail group (38.4%). Marital status also demonstrated a significant association with frailty (P=0.001), with a greater percentage of single individuals in the frail group (25.0%)

Table 1. Baseline demographic and clinical characteristics of the study participants stratified by hearing status (n = 600)

Variables	Category	Normal hearing (n=300)	hearing loss (n=300)	Unadjusted *P*-value
Sex, n (%)	Male	150 (50)	150 (50)	1.00+
	Female	150 (50)	150 (50)	
Marital status, n (%)	Single	52 (17.3)	54 (18.1)	0.816+
	Married	248 (82.7)	245 (81.9)	
Multimorbidity, n (%)	≤2 diseases	124 (41.3)	54 (18)	<0.001+
	≥3 diseases	176 (58.7)	246 (82)	
Education level, n (%)	Illiterate	171 (57)	194 (64.7)	0.014+
	Below diploma	62 (20.7)	69 (23)	
	Diploma	48 (16)	25 (8.3)	
	Above diploma	19 (6.3)	12 (4)	
BMI (kg/m²), n (%)	>24.99	70 (23.6)	90 (30.4)	0.098+
	25-29.99	113 (38.2)	114 (38.5)	
	≥30.0	113 (38.2)	92 (31.1)	
Diabetes mellitus, n (%)	No	201 (67)	216 (72)	0.183+
	Yes	99 (33)	84 (28)	
Age, Mean (SD)	-	69.54±6.94	72.39±8.17	<0.001++

BMI: Body mass index; SD: Standard deviation.
+ *P*-values were calculated using the chi-square test for categorical variables.
++ *P*-value was derived from an independent sample t-test comparing mean age between groups.

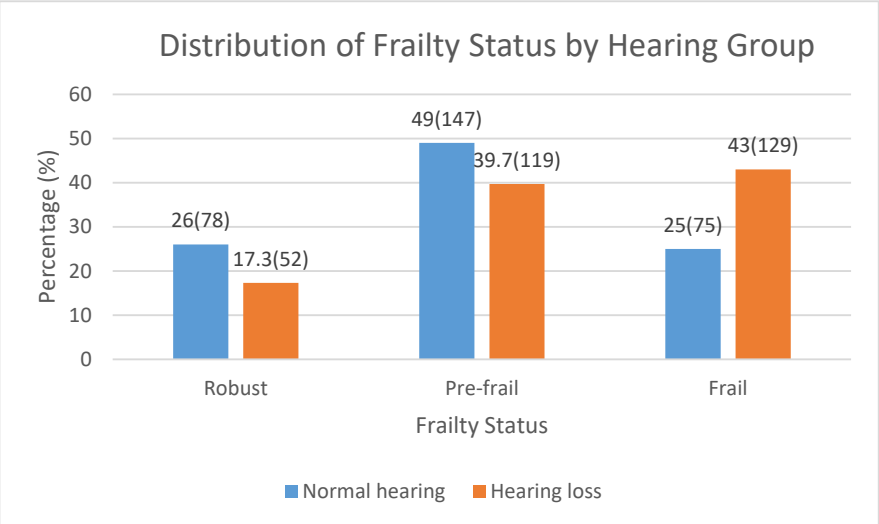


Figure 1. Distribution of frailty status within each hearing group (normal hearing vs. hearing loss).

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Table 2. Factors Associated with Frailty in Unadjusted and Multivariable-Adjusted Logistic Regression Analyses

Variables	Category	Non-frail (n=396)	frail (n=204)	Unadjusted OR (95% CI)	Unadjusted *P*-value	Adjusted OR (95% CI)	Adjusted *P*-value
Hearing loss	No	225 (56.8)	75 (36.8)	Ref.		Ref.	
	Yes	171 (43.2)	129 (63.2)	2.26 (1.60, 3.20)	<0.001[+]	1.90 (1.25, 2.90)	0.003
sex, n (%)	Male	244 (61.6)	56 (27.5)	Ref.	<0.001[+]	Ref.	
	Female	152 (38.4)	148 (72.5)	4.24 (2.92, 6.16)		4.52 (2.82, 7.31)	<0.001
Marital status, n (%)	Single	55 (13.9)	51 (25)	Ref.	0.001[+]	Ref.	
	Married	341 (86.1)	153 (75)	0.48 (0.32, 0.74)		0.94 (0.55 , 1.59)	0.770
Multimorbidity, n (%)	≤2 diseases	157 (39.6)	21 (10.3)	Ref.	<0.001[+]	Ref.	
	≥3 diseases	239 (60.4)	183 (89.7)	5.73 (3.52, 9.32)		3.18 (1.82, 5.58)	<0.001
Education level, n (%)	Illiterate	206 (52)	159 (77.9)	Ref.	<0.001[+]	Ref.	
	Below diploma	99 (25)	32 (15.7)	0.42 (0.27, 0.65)		0.74 (0.43, 1.25)	0.266
	Diploma	62 (15.7)	11 (5.4)	0.23 (0.12, 0.45)		0.49 (0.23, 1.06)	0.071
	Above diploma	29(7.3)	2(1)	0.09 (0.02, 0.38)		0.24 (0.05, 1.14)	0.073
	Overall test						0.041
BMI (kg/m²), n (%)	>24.99	116 (29.3)	46 (22.5)	Ref.	0.023[+]	Ref.	
	25-29.99	159 (40.2)	71 (34.8)	1.13 (0.73, 1.74)		1.29 (0.76, 2.21)	0.336
	≥30.0	121 (30.6)	87 (42.6)	1.81 (1.18, 2.78)		1.72 (0.99, 2.97)	0.051
	Overall test						0.096
Diabetes mellitus, n (%)	No	289 (73)	128(62.7)	Ref.	0.010[+]	Ref.	
	Yes	107 (27)	76(37.3)	1.60 (1.13, 2.28)		1.41 (0.90, 2.22)	0.132
Age, Mean (SD)	-	69.68 (7.15)	73.47 (8.13)	1.07 (1.04, 1.10)	<0.001[++]	1.08 (1.05, 1.12)	<0.001

BMI: Body mass index; OR = odds ratio; CI = confidence interval.
Unadjusted ORs were calculated using univariable logistic regression. Adjusted ORs were calculated using multivariable logistic regression including age, sex, BMI, education level, marital status, diabetes, and multimorbidity (n = 600).

compared to the non-frail group (13.9%). The presence of three or more underlying chronic diseases exhibited the strongest association with frailty in the unadjusted analysis ($p < 0.001$), with 89.7% of frail individuals having at least three comorbidities, compared to 60.4% of non-frail individuals. Educational level showed a significant inverse relationship with frailty ($P < 0.001$); the proportion of illiterate individuals was substantially higher in the frail group (77.9%) than in the non-frail group (52.0%), and the prevalence of frailty decreased markedly with increasing educational attainment. Body mass index (BMI) was significantly associated with frailty ($P = 0.023$), with a higher percentage of obese individuals (BMI ≥ 30 kg/m²) in the frail group (42.1%) compared to the non-frail group (30.9%). Diabetes mellitus was also significantly associated with frailty ($P = 0.010$), with a higher prevalence of diabetes in the frail group (37.3%) versus the non-frail group (27.0%). The mean age was significantly higher in the frail group (73.47 years) than in the non-frail group (69.68 years, $P < 0.001$). Finally, hearing loss was strongly associated with frailty in the unadjusted analysis ($P<0.001$), with a significantly higher prevalence of hearing loss in the frail group (63.2%) compared to the non-frail group (43.2%).

Multivariable-Adjusted Analysis

To estimate the independent association of hearing loss with frailty and to adjust for potential confounders, all aforementioned variables were simultaneously entered into a multivariable logistic regression model, and adjusted odds ratios (OR) with 95% confidence intervals (CI) were calculated (Table 2). After adjusting for confounders, hearing loss remained significantly associated with frailty (OR = 1.90, 95% CI: 1.25–2.90, $P = 0.003$). Female sex was also significantly associated with frailty, with women exhibiting more than 4.5 times higher odds of frailty compared to men (OR = 4.52, 95% CI: 2.82–7.31, $P < 0.001$). The presence of three or more chronic diseases was also significantly associated with frailty, increasing the odds of frailty by more than threefold (OR = 3.18, 95% CI: 1.82–5.58, $P< 0.001$). Increasing age was also significantly associated with frailty, with each one-year increment in age associated with an 8% increase in the odds of frailty (OR = 1.08, 95% CI: 1.05–1.12, $P < 0.001$). Other covariates, including marital status, education, BMI, and diabetes, were not statistically significant after adjustment; however, obesity (BMI ≥30) had an OR of 1.72 (95% CI: 0.99–2.97, $P = 0.051$), which is compatible with a meaningful effect and warrants further investigation.

Discussion

In this population-based cross-sectional study involving 600 community-dwelling Iranian older adults, hearing loss was independently associated with frailty after adjusting for potential confounders. Individuals with hearing loss exhibited 90% higher odds of being frail compared to those with normal hearing (adjusted odds ratio = 1.90). This finding supports our initial hypothesis that hearing loss is associated with frailty in older adults and is consistent with a substantial body of previous research (30, 32, 33).

A meta-analysis of 14 observational studies reported that hearing loss was associated with 87% higher odds of frailty in cross-sectional studies and 56% higher odds in longitudinal studies (30). A study of older men found that hearing loss was associated with higher odds of frailty (31). In the U.S. older adult population, a study using NHANES data

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[DOI: 10.47176/mjiri.40.104]

demonstrated that moderate or greater hearing loss was associated with 62% higher odds of frailty relative to normal hearing (32). Similarly, a study using Health and Retirement Study (HRS) data reported that hearing loss was associated with greater odds of both frailty and pre-frailty compared to being robust (33). Our findings from the Iranian population align with this global evidence, suggesting that the association between hearing loss and frailty is independent of confounders such as age, sex, body mass index, diabetes, and multimorbidity.

Several biological pathways may elucidate the relationship between hearing loss and frailty. Hearing loss is associated with impaired auditory processing, increased cognitive load (34), social isolation (34), depression (35), reduced physical activity (35), slower gait speed (36), and an elevated risk of falls (37). These factors can interact in a vicious cycle, mutually reinforcing one another and ultimately leading to physical frailty. Furthermore, some studies have suggested that hearing aid use may be associated with lower odds of frailty (33), although data on hearing aid use were not available in our study. Given that frailty is a dynamic and potentially reversible condition (18), early identification of hearing loss and appropriate intervention may be hypothesized to play a role in frailty prevention, but this requires longitudinal or trial evidence.

In the present study, among the covariates examined, older age, female sex, and multimorbidity —the presence of three or more chronic diseases—were also significantly associated with frailty in the fully adjusted model. These findings are consistent with prior studies; for instance, a study using HRS data also identified older age (33), female sex (33), and multimorbidity (32, 33) as being associated with frailty.e Interestingly, a previous cross-sectional study using NHANES data found that the association between hearing loss and frailty was statistically significant only in women, and not in men (38).

The study by Tian and colleagues further emphasized that age and chronic diseases are among the most significant correlates of frailty in older adults (31). However, marital status, educational level, body mass index, and diabetes mellitus—although significantly associated with frailty in univariate analyses— were not statistically significant after multivariable adjustment. This pattern aligns with the findings of the NHANES and HRS studies, in which BMI, diabetes, and education were primarily regarded as confounding variables rather than exposure variables of interest for frailty (33, 34).

Limitations and Suggestions: This study has several limitations. First, although hearing loss was validated by medical confirmation or hearing aid use, pure-tone audiometry was not available. Second, excluding participants with cognitive impairment may have introduced selection bias, as hearing loss, frailty, and cognitive decline are interrelated. Third, the cross-sectional design precludes causal inference, and residual confounding cannot be excluded. Despite these limitations, this study has strengths, including a community-dwelling sample, adjustment for a comprehensive range of covariates, and being among the first to report this association in Iranian older adults.

Conclusion

In this population-based cross-sectional study of community-dwelling Iranian older adults, self-reported hearing loss was found to be independently associated with frailty after adjusting for age, sex, body mass index, diabetes, education, marital status, and multimorbidity. Due to the cross-sectional design and reliance on self-reported hearing status, these findings do not establish a causal relationship between hearing loss and frailty. Prospective studies utilizing objective audiometric measures and comprehensive information on hearing-aid use are necessary to ascertain whether hearing loss contributes to the development or progression of frailty and whether hearing interventions can modify frailty risk.

Acknowledgment

The authors thank the Department for Research and Technology, Babol University of Medical Sciences.

Conflict of Interests

The authors declare that they have no competing interests.

Authors' Contributions

All authors have contributed equally to the development of the concept, implementation, processing of results, and writing of the article. We declare that this material has not been previously published and is not under consideration by other publishers.

Ethical Considerations

This study was approved by the Ethics Committee of Babol University of Medical Sciences (IR.MUBABOL.HRI.REC.1401.145), and informed consent was obtained from all participants.

Funding Support

This study was supported by the Babol University of Medical Sciences, Iran.

Data Availability

The data are available upon requesting the corresponding author.

AI Use Statement

The authors did not use artificial intelligence or AI-assisted technologies in the preparation of this manuscript.

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[DOI: 10.47176/mjiri.40.104]