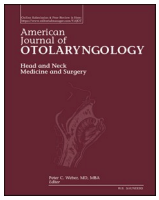
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Tinnitus severity and dizziness: The role of psychological distress in a population-based study

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ABSTRACT

Objective: To investigate the association between tinnitus severity and dizziness in a nationally representative sample of adults aged ≥40 years and to evaluate the contribution of psychological distress (anxiety and perceived stress).

Methods: We analyzed data from 7634 participants in the Korea National Health and Nutrition Examination Survey (2022–2023). Dizziness was defined as self-reported symptoms within the past 12 months. Tinnitus severity was categorized as mild, moderate, or severe compared with no tinnitus. Survey-weighted logistic regression models estimated odds ratios (ORs) and 95% confidence intervals (CIs) with sequential adjustment for sociodemographic factors, health behaviors, comorbidities, and psychological variables.

Results: Among adults aged 40 years and older, the weighted proportions of participants reporting dizziness and tinnitus symptoms were 33.7% and 10.2%, respectively. Tinnitus severity showed a graded association with dizziness (p for trend = 0.003 in Model 4). Compared with the no-tinnitus group, moderate and severe tinnitus were associated with higher odds of dizziness after full adjustment (OR 1.71, 95% CI 1.33–2.20; OR 2.43, 95% CI 1.75–3.39). Anxiety severity and perceived stress were independently associated with dizziness, and adjustment for these factors attenuated the tinnitus–dizziness association by approximately 9% and 19% for moderate and severe tinnitus.

Conclusions: Tinnitus severity was independently associated with dizziness in a graded manner. Psychological distress was also associated with dizziness and partially attenuated this relationship, supporting a clinical approach that integrates auditory and psychological factors in the assessment of dizziness.

1. Introduction

Tinnitus and dizziness are common neuro-otologic symptoms in middle-aged and older adults and are frequently associated with substantial distress, functional limitation, and reduced quality of life [1,2]. However, both symptoms represent heterogeneous clinical phenomena, encompassing a wide range of etiologies and symptom presentations.

Dizziness is a non-specific symptom that may arise from diverse peripheral and central mechanisms. Common peripheral vestibular disorders include benign paroxysmal positional vertigo, Ménière's disease, and vestibular neuritis, whereas central causes such as cerebrovascular disease, vestibular migraine, and other central nervous system pathologies are also well recognized [3]. Given this heterogeneity, dizziness often poses diagnostic challenges in clinical practice [4], especially in community and outpatient settings where detailed vestibular testing is not routinely available.

Tinnitus similarly represents a complex symptom with well-defined otological causes involving cochlear and auditory pathway dysfunction. However, accumulating evidence suggests that systemic and non-otologic factors may also contribute to tinnitus occurrence and severity, including metabolic, vascular, and inflammatory conditions [5,6]. These findings highlight that tinnitus, like dizziness, cannot be fully explained by peripheral pathology alone.

Although each symptom has distinct etiologic pathways, their co-occurrence is biologically plausible given shared inner ear anatomy and physiology. The cochlear and vestibular organs share common

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vascular supply and fluid dynamics within the membranous labyrinth, providing a structural basis for concurrent auditory and vestibular symptoms [6,7]. Nevertheless, both tinnitus and dizziness are inherently subjective experiences, and symptom severity and persistence are often disproportionate to objective clinical findings [8].

In addition to peripheral mechanisms, central sensory processing and psychological distress modulate symptom perception and maintenance [9]. Anxiety and perceived stress are closely associated with tinnitus-related distress and dizziness-related functional impairment, implicating mechanisms such as heightened symptom salience, defective habituation, and altered central sensory integration [10]. Studies of patients with vestibular disorders have demonstrated significant associations between vertigo severity, depressive symptoms, and reduced quality of life, underscoring the clinical relevance of psychological distress across vestibular conditions [11]. Similarly, tinnitus severity has been shown to correlate with anxiety and depressive symptoms, further supporting a modulatory rather than purely causal role of psychological factors [9,12,13].

Psychological factors have traditionally been regarded as secondary consequences or confounders rather than as integral components of symptom experience in tinnitus and dizziness. Recent multidisciplinary guidelines emphasize that this perspective has contributed to fragmented clinical pathways, in which evaluation has focused primarily on auditory and vestibular structures with limited or inconsistent assessment of psychological distress. Accordingly, these guidelines call for more integrated approaches that systematically incorporate psychological assessment into routine care [14].

Despite the clear clinical relevance of these considerations, population-level evidence examining the role of psychological distress in the co-occurrence of tinnitus and dizziness remains limited [15]. Although current tinnitus guidelines and contemporary vestibular frameworks underscore the importance of psychological factors in symptom persistence, population-based evidence characterizing their role in the tinnitus–dizziness relationship across symptom severity remains limited [16].

Therefore, using nationally representative data from the Korea National Health and Nutrition Examination Survey (KNHANES), we examined the association between tinnitus severity and dizziness among adults aged 40 years and older. Specifically, we aimed to evaluate the extent to which anxiety and perceived stress contribute to this association, providing epidemiological evidence to inform more integrated clinical assessment and management strategies.

2. Methods

2.1. Data source and study population

We used data from the Korea National Health and Nutrition Examination Survey (KNHANES), specifically the 9th cycle, 1st and 2nd years (2022–2023). KNHANES is a nationally representative, cross-sectional survey of the non-institutionalized Korean population conducted using a complex, multistage probability sampling design [17]. Otolaryngologic questionnaire items, including tinnitus and dizziness, were administered to adults aged ≥40 years. A total of 7675 eligible participants were included. After excluding participants with missing or "do not remember" responses for tinnitus ($n = 40$) and dizziness ($n = 1$), the final analytic sample comprised 7634 participants.

KNHANES data are publicly available and de-identified. All analyses were conducted in accordance with the KNHANES data-use policies and guidelines provided by the Korea Disease Control and Prevention Agency (KDCA) [17]. The study protocol was approved by the Institutional Review Board of Haeundae Paik Hospital (HPIRB 2025–11-023).

2.2. Measurement of tinnitus severity and chronicity

Tinnitus was assessed using KNHANES questionnaire items. Participants were asked whether they had experienced ringing, buzzing, roaring, or other sounds in the ear lasting for more than 5 min during the past 12 months. Those who responded affirmatively were further asked whether the symptom had persisted for 6 months or longer, which was used to define chronic tinnitus (≥6 months).

Subjective tinnitus severity was assessed using a numeric rating scale in response to the question, "How bothersome is the sound in your ear?", with scores ranging from 0 (not bothersome at all) to 10 (extremely bothersome). Among participants who reported tinnitus, severity was categorized into mild (0–2), moderate (3–5), and severe (6–10) based on the observed frequency distribution of tinnitus bother scores. Participants who reported no tinnitus in the past 12 months were categorized as "no tinnitus" and served as the reference group in all analyses.

Because tinnitus of shorter duration may represent heterogeneous clinical entities, including transient or reversible conditions, we conducted sensitivity analyses stratified by tinnitus duration. Specifically, participants with chronic tinnitus (≥6 months) and those with short-duration tinnitus (<6 months) were analyzed separately in relation to dizziness to evaluate the robustness of the association between tinnitus severity and dizziness across different duration groups. These stratified analyses are presented in Supplementary Tables S1 and S2.

2.3. Measurement of dizziness

Dizziness was assessed using a self-reported item. Participants were asked, "In the past 12 months, have you experienced dizziness or a problem with balance?" Responses were recorded as "yes," "no," or "do not remember." Participants who answered "yes" were classified as having dizziness, and those who answered "no" were classified as not having dizziness. Responses of "do not remember" were treated as missing and excluded from the analysis. This item captures self-reported dizziness or balance disturbance and does not distinguish specific vestibular subtypes.

2.4. Measurement of psychological factors

Psychological factors included perceived stress and anxiety severity.

Perceived stress was assessed using a self-reported item asking the usual level of stress in daily life and analyzed as a four-level categorical variable ("very much," "a lot," "a little," and "almost none").

Anxiety severity was measured using the Generalized Anxiety Disorder–7 (GAD-7) questionnaire [18] and categorized into four levels (minimal, mild, moderate, and severe) based on established cut-off points [19].

2.5. Health behaviors

Smoking status was classified into five categories based on cumulative lifetime exposure expressed in pack-years (PY): non-smoker or < 5 pack-years; past smoker ≤10 pack-years; past smoker >10 pack-years; current smoker ≤25 pack-years; and current smoker >25 pack-years [20].

Alcohol consumption was categorized into three risk groups. Participants who reported no alcohol consumption or drinking less than once per month were classified as low-risk drinkers. Those who reported drinking at least once per month without binge drinking were classified as moderate-risk drinkers. High-risk drinking was defined as engaging in binge drinking at least once per week, using sex-specific thresholds (≥7 drinks for men or ≥ 5 drinks for women per occasion) [21].

Physical activity was assessed using self-reported questionnaire items on the frequency and duration of moderate- and vigorous-intensity activities. Participants were classified as meeting the guideline if they engaged in ≥150 min per week of moderate-intensity activity, ≥75 min per week of vigorous-intensity activity, or an equivalent combination, corresponding to approximately ≥600 MET-minutes per week [22].

2.6. Comorbidities

Comorbidities included hypertension, diabetes mellitus, and dyslipidemia. These conditions were classified based on self-reported physician diagnosis obtained through the health interview questionnaire. Responses of "don't know" or "no response" were treated as missing.

2.7. Statistical analysis

All analyses accounted for the complex survey design of KNHANES by incorporating sampling weights, stratification variables, and primary sampling units. Survey-weighted analyses were conducted using the Complex Samples module in IBM SPSS Statistics for Windows, version 29.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize participant characteristics across tinnitus severity categories.

Multivariable logistic regression models were used to estimate odds ratios (ORs) and 95% confidence intervals (CIs) for the association between tinnitus severity and dizziness. Tinnitus severity was modeled as a categorical variable, and tests for linear trend were conducted by additionally modeling tinnitus severity as an ordinal variable.

Sequential survey-weighted logistic regression models were constructed. Model 1 adjusted for age and sex; Model 2 further adjusted for sociodemographic factors (education and household income); Model 3 additionally adjusted for health behaviors (smoking status, alcohol consumption, and aerobic physical activity), comorbidities (hypertension, diabetes mellitus, and dyslipidemia), and tinnitus chronicity. Model 4 was fully adjusted with further adjustment for psychological factors, including anxiety severity assessed using four-level GAD-7 categories and perceived stress (four-level). Anxiety severity and perceived stress were included as categorical variables, while trend tests treated them as ordinal variables.

Interaction effects were evaluated by including multiplicative interaction terms in the fully adjusted model, and statistical significance was assessed using a two-sided α level of 0.05.

Participants with missing values for key variables were excluded from the corresponding analyses. Given the low proportion of missing data (<2%), complete-case analysis was applied. Multicollinearity was assessed using variance inflation factors (VIFs). Most variables showed low collinearity (VIF < 2), whereas tinnitus severity and duration showed moderately elevated VIF values (approximately 5.7), which remained below commonly used thresholds for problematic multicollinearity and likely reflect their clinical relatedness. Attenuation of ORs after adjustment for psychological factors was interpreted descriptively and does not imply causality.

3. Results

Among adults aged 40 years and older, the weighted proportion of participants reporting dizziness was 33.7% (±0.7%).

The proportion of participants reporting dizziness increased with age, from 30.8% (±1.3%) among individuals in their 40s and 29.9% (±1.3%) in their 50s to 33.3% (±1.2%) in their 60s, 41.4% (±1.4%) in their 70s, and 46.7% (±2.4%) among those aged 80 years and older (estimates derived from survey-weighted cross-tabulations).

Participants reporting dizziness differed significantly from those without dizziness in several characteristics. Individuals with dizziness were more likely to be female and reported higher levels of psychological distress; 29.3% reported moderate-to-severe perceived stress compared with 18.5% among those without dizziness Table 1.

Tinnitus symptom experience was substantially more common among participants reporting dizziness, with moderate to severe tinnitus more frequently observed in this group. When stratified by tinnitus duration, dizziness was reported by 52.3% (±4.6%) of participants with tinnitus lasting less than 6 months and by 46.4% (±2.1%) of those with

Table 1
General characteristics of study participants according to dizziness.

Characteristics	Total	No Dizziness	Dizziness	*p* value
Weighted Number (non-weighted)	26,481,840 (*n* = 7674)	17,562,388 (*n* = 4958)	8,919,452 (*n* = 2716)	
Weighted % (SE)	100.0	66.3 (0.7)	33.7 (0.7)	
Demographics				
Age, years				
Mean ± SE	58.7 ± 0.25	57.9 ± 0.28	60.3 ± 0.32	<0.001
40–49	26.3 (0.9)	27.4 (1.1)	24.1 (1.1)	
50–59	28.0 (0.7)	29.6 (0.9)	24.9 (1.1)	
60–69	24.9 (0.7)	25.0 (0.9)	24.7 (1.0)	<0.001
70–79	15.3 (0.5)	13.5 (0.6)	18.8 (0.9)	
80 -	5.5 (0.3)	4.4 (0.3)	7.6 (0.6)	
Sex				
Male	47.5 (0.5)	51.7 (0.7)	39.2 (1.1)	<0.001
Female	52.5 (0.5)	48.3 (0.7)	60.8 (1.1)	
Socioeconomic Status				
Household Income				
1st Quintile, Lowest	15.4 (0.6)	12.8 (0.7)	20.5 (1.0)	
2nd Quintile	18.4 (0.5)	17.2 (0.8)	20.8 (1.0)	
3rd Quintile	19.8 (0.7)	20.0 (0.8)	19.8 (1.0)	<0.001
4th Quintile	22.3 (0.7)	23.9 (0.9)	19.0 (1.0)	
5th Quintile, Highest	24.0 (1.0)	26.1 (1.2)	19.9 (1.2)	
Years of Schooling				
≤ 6 years	17.2 (0.7)	14.3 (0.7)	22.9 (1.1)	
7–12 years	44.2 (0.9)	44.5 (1.0)	43.7 (1.2)	<0.001
> 12 years	38.6 (1.2)	41.2 (1.3)	33.3 (1.4)	
Health Behaviors				
Smoking Status				
Non-smoker/ Under 5 packs	58.5 (0.6)	56.4 (0.8)	62.4 (1.1)	
Past smoker, ≤ 10 PY	10.8 (0.4)	11.5 (0.5)	9.5 (0.7)	
Past smoker, > 10 PY	14.2 (0.4)	14.7 (0.5)	13.2 (0.8)	<0.001
Current smoker, ≤ 25 PY	9.4 (0.4)	10.3 (0.6)	7.7 (0.6)	
Current smoker, > 25 PY	7.1 (0.4)	7.1 (0.5)	7.2 (0.6)	
Alcohol Consumption				
No/ <1 per month	32.9 (0.7)	29.6 (0.8)	39.2 (1.1)	
≥1 per month, no binge	48.5 (0.8)	49.8 (0.9)	45.9 (1.2)	<0.001
≥1/week binge	18.7 (0.6)	20.6 (0.8)	14.9 (0.8)	
Physical Activity				
Meeting Aerobic Guidelines	42.8 (0.8)	44.0 (1.0)	40.5 (1.2)	0.016
Clinical Factors				
Hypertension	33.7 (0.8)	31.3 (0.8)	38.5 (1.1)	<0.001
Diabetes	14.5 (0.5)	13.4 (0.6)	16.7 (0.8)	<0.001
Dyslipidemia	31.1 (0.6)	29.3 (0.8)	34.7 (1.1)	<0.001
Tinnitus				
Severity				
None	89.7 (0.4)	91.9 (0.5)	85.5 (0.7)	
Mild	2.9 (0.2)	2.8 (0.3)	3.2 (0.4)	<0.001
Moderate	4.4 (0.3)	3.5 (0.3)	6.1 (0.5)	
Severe	3.0 (0.2)	1.8 (0.2)	5.2 (0.5)	
Chronicity				
None	89.7 (0.4)	91.9 (0.5)	85.5 (0.7)	
Less than 6 months	1.9 (0.2)	1.4 (0.2)	3.0 (0.4)	<0.001
More than 6 months	8.4 (0.4)	6.8 (0.4)	11.5 (0.6)	
Psychological Factors				
Level of Anxiety Severity (GAD-7 score)				

(*continued on next page*)

Table 1 (*continued*)

Characteristics	Total	No Dizziness	Dizziness	*p* value
Minimal (0–4)	85.9 (0.5)	89.3 (0.6)	79.1 (0.9)	
Mild (5–9)	10.3 (0.4)	8.2 (0.5)	14.5 (0.8)	
Moderate (10–14)	2.5 (0.2)	1.7 (0.2)	4.0 (0.4)	<0.001
Severe (15–21)	1.3 (0.1)	0.7 (0.1)	2.4 (0.3)	
Perceived Stress				
Almost none	18.7 (0.5)	20.8 (0.7)	14.4 (0.8)	
A little	59.2 (0.7)	60.7 (0.8)	56.2 (1.2)	<0.001
A lot	18.4 (0.6)	15.7 (0.6)	23.6 (1.1)	
Very much	3.8 (0.2)	2.8 (0.3)	5.7 (0.5)	

Values are presented as weighted percentages (standard errors) or means (standard errors).
Statistical significance was assessed using survey-weighted chi-square tests for categorical variables and survey-weighted *t*-tests for continuous variables. Weighted numbers may not sum exactly to totals because of rounding.
Dizziness was defined as self-reported dizziness or balance disturbance experienced within the past 12 months.
Abbreviations: BMI, body mass index; GAD-7, Generalized Anxiety Disorder–7.

tinnitus lasting 6 months or longer.

The weighted proportion of participants reporting tinnitus was 10.2% (±0.4%) (Table 2).

The proportion reporting tinnitus increased steadily with age, from 6.3% (±0.7%) in individuals in their 40s and 8.7% (±0.8%) in their 50s to 12.0% (±0.8%) in their 60s, 14.9% (±1.0%) in their 70s, and 16.1% (±1.8%) among those aged 80 years and older (estimates derived from survey-weighted cross-tabulations). Participant characteristics varied according to tinnitus severity. As tinnitus severity increased, the prevalence of dizziness rose in a graded manner. Higher tinnitus severity was also associated with greater psychological distress, including higher levels of perceived stress and anxiety. Although tinnitus severity and tinnitus chronicity were positively correlated, tinnitus chronicity itself was not significantly associated with dizziness after multivariable adjustment (Table 3).

In survey-weighted logistic regression analyses, tinnitus severity was positively associated with dizziness in a graded manner (Table 3). Compared with participants without tinnitus, moderate and severe tinnitus were associated with higher odds of dizziness after adjustment for sociodemographic factors, health behaviors, comorbidities, and tinnitus chronicity (OR 1.78, 95% CI 1.38–2.28, $p < .001$; and OR 2.77, 95% CI 2.00–3.83, $p < .001$, respectively), whereas the association was not statistically significant for mild tinnitus (OR 1.15, 95% CI 0.80–1.66, $p = .258$). Tinnitus severity showed a graded association with dizziness (p for trend <0.001 in Models 1–3; p for trend = 0.003 in Model 4).

In the fully adjusted model incorporating psychological factors, the association between tinnitus severity and dizziness was modestly attenuated but remained statistically significant for moderate and severe tinnitus (Table 3, Fig. 1). Compared with participants without tinnitus, the odds of dizziness were OR 1.19 (95% CI 0.83–1.72, $p = .101$) for mild tinnitus, OR 1.71 (95% CI 1.33–2.20, $p < .001$) for moderate tinnitus, and OR 2.43 (95% CI 1.75–3.39, $p < .001$) for severe tinnitus.

Anxiety severity and perceived stress were each independently associated with dizziness in a graded pattern. Compared with minimal anxiety, mild, moderate, and severe anxiety were associated with higher odds of dizziness (OR 1.66, 95% CI 1.36–2.02, $p < .001$; OR 1.78, 95% CI 1.23–2.59, $p = .003$; and OR 2.27, 95% CI 1.34–3.84, $p = .002$, respectively; p for trend <0.001).

Similarly, compared with the lowest perceived stress category, increasing levels of perceived stress were associated with higher odds of dizziness (OR 1.46, 95% CI 1.24–1.71, $p < .001$; OR 2.02, 95% CI 1.63–2.51, $p < .001$; and OR 2.27, 95% CI 1.63–3.16, $p < .001$ and p for trend <0.001 overall).

No evidence of problematic multicollinearity was observed when both variables were included in the model. An interaction between anxiety severity (GAD-7) and perceived stress was identified ($p = .038$) indicating that the association between perceived stress and dizziness may vary according to anxiety level. However, inclusion of this interaction term did not substantially change the association between tinnitus severity and dizziness. No significant interaction was observed between sex and tinnitus severity in the fully adjusted model (p for interaction = 0.870). No significant effect modification was observed for interactions between tinnitus severity and other covariates, including sociodemographic factors, health behaviors, comorbidities, and psychological factors.

Sensitivity analyses stratified by tinnitus duration (Supplementary Tables S1 and S2) showed consistent findings. Among participants with chronic tinnitus (≥6 months, $n = 687$), the graded association between tinnitus severity and dizziness persisted in fully adjusted models (p for trend <0.001), with moderate and severe tinnitus showing significant associations (OR 1.81, 95% CI 1.39–2.36; OR 2.19, 95% CI 1.55–3.09). Among those with tinnitus lasting <6 months ($n = 158$), only severe tinnitus showed a significant association (OR 4.98, 95% CI 2.30–10.79), whereas estimates for mild and moderate tinnitus were less stable.

Fig. 1 illustrates changes in odds ratios for dizziness across tinnitus severity categories after additional adjustment for psychological distress. The odds ratios were reduced by 8.9% for moderate tinnitus and 19.1% for severe tinnitus, with minimal change observed for mild tinnitus; however, the overall association remained statistically significant across severity categories.

4. Discussion

In this nationally representative sample of Korean adults aged 40 years and older, tinnitus severity showed a graded association with dizziness. Moderate and severe tinnitus remained significantly associated with dizziness after adjustment for sociodemographic factors, health behaviors, comorbidities, and psychological distress. Anxiety and perceived stress attenuated this relationship by approximately 9% in moderate tinnitus and 19% in severe tinnitus, but did not eliminate it, indicating that shared sensory mechanisms may contribute to the co-occurrence while psychological factors exert a meaningful modulatory influence [23].

The biological plausibility of this association is supported by shared auditory–vestibular anatomy and physiology. The cochlear and vestibular end organs share vascular supply via the labyrinthine artery, an end artery vulnerable to ischemic injury [24], and disturbances in endolymphatic homeostasis can produce concurrent auditory and vestibular symptoms, as observed in Ménière's disease [7,25]. Beyond peripheral mechanisms, both tinnitus and dizziness involve altered central sensory processing, and anxiety may amplify symptom perception and persistence through increased sensory gain and attentional bias [9,23].

Our findings align with clinical frameworks integrating sensory and psychological contributors. In persistent postural-perceptual dizziness (PPPD), anxiety and hypervigilance interact with altered vestibular processing and may contribute to the persistence of symptoms [12,26], and co-occurring tinnitus may represent an additional chronic sensory burden that reinforces this maladaptive processing [27,28]. Similarly, psychological distress correlates with symptom severity in Ménière's disease and other vestibular disorders [11,13]. By quantifying the psychological contribution to the tinnitus–dizziness association at the population level, our study extends these clinic-based observations to a community-dwelling population [29].

From a clinical perspective, these results suggest that patients presenting with either tinnitus or dizziness—particularly those with more severe tinnitus—may benefit from assessment of co-occurring symptoms and psychological distress [30]. Brief instruments such as the GAD-7 are feasible in routine practice [18,19], and multidisciplinary approaches combining audiologic management with psychological interventions have shown benefit in tinnitus populations [14,31]. Whether such integrated strategies improve outcomes in patients with co-occurring

Table 2
General characteristics of study participants according to tinnitus severity and chronicity.

Characteristics	Total	No Tinnitus	Tinnitus, Severity			p value	Tinnitus, Chronicity		p value
			Mild	Moderate	Severe		Less than 6 months	More than 6 months	
Weighted Number (non-weighted)	26,349,207 (*n* = 7634)	23,641,754 (*n* = 6789)	771,758 (*n* = 256)	1,152,513 (*n* = 339)	783,182 (*n* = 250)		505,923 (n = 158)	2,201,530 (n = 687)	
Weighted % (SE)	100	89.7 (0.4)	2.9 (0.2)	4.4 (0.3)	3.0 (0.2)		1.9 (0.2)	8.4 (0.4)	
Demographics									
Age, years									
Mean ± SE	58.7 ± 0.25	58.3 ± 0.26	62.0 ± 0.87	62.4 ± 0.72	63.0 ± 0.95	<0.001	58.4 ± 1.07	63.4 ± 0.53	<0.001
40–49	26.3 (0.9)	27.5 (1.0)	16.8 (3.0)	14.7 (2.4)	17.5 (3.1)		25.3 (4.5)	14.0 (1.7)	
50–59	28.1 (0.7)	28.6 (0.8)	27.5 (4.1)	23.6 (2.8)	20.3 (3.3)		33.3 (4.6)	21.6 (2.1)	
60–69	24.9 (0.7)	24.4 (0.7)	24.3 (3.3)	33.5 (3.0)	27.7 (3.1)	<0.001	20.3 (3.5)	31.3 (2.0)	<0.001
70–79	15.2 (0.5)	14.4 (0.5)	22.6 (2.6)	20.6 (2.4)	24.5 (3.0)		16.6 (2.9)	23.6 (1.9)	
80 -	5.5 (0.3)	5.1 (0.3)	8.9 (1.7)	7.5 (1.4)	10.0 (2.2)		4.6 (1.5)	9.6 (1.1)	
Sex									
Male	47.5 (0.5)	46.7 (0.6)	63.6 (3.3)	56.4 (2.9)	42.6 (3.5)	<0.001	45.5 (4.2)	56.5 (2.1)	<0.001
Female	52.5 (0.5)	53.3 (0.6)	36.4 (3.3)	43.6 (2.9)	57.4 (3.5)		54.5 (4.2)	43.5 (2.1)	
Socioeconomic Status									
Household Income									
1st Quintile, Lowest	15.3 (0.7)	14.5 (0.7)	19.6 (2.7)	19.4 (2.4)	28.3 (3.3)		25.0 (4.5)	21.4 (1.7)	
2nd Quintile	18.4 (0.7)	18.1 (0.7)	22.7 (2.9)	19.1 (2.3)	21.1 (2.9)		17.8 (3.3)	21.4 (1.8)	
3rd Quintile	19.9 (0.7)	20.1 (0.7)	14.6 (2.4)	20.7 (2.5)	19.2 (3.3)	<0.001	19.1 (3.8)	18.4 (1.8)	<0.001
4th Quintile	22.3 (0.7)	22.3 (0.8)	23.4 (3.8)	25.7 (2.8)	16.2 (3.0)		18.2 (4.1)	23.2 (2.1)	
5th Quintile, Highest	24.0 (1.0)	24.9 (1.0)	19.6 (3.4)	15.2 (2.3)	15.1 (2.9)		19.9 (4.1)	15.6 (1.8)	
Years of Schooling									
≤ 6 years	17.1 (0.7)	16.2 (0.7)	23.1 (2.7)	20.9 (2.5)	31.5 (3.5)		19.1 (3.3)	25.8 (1.9)	<0.001
7–12 years	44.3 (0.9)	44.1 (1.0)	39.8 (3.8)	51.1 (3.3)	42.4 (3.7)	<0.001	47.3 (4.7)	44.9 (2.3)	
> 12 years	38.6 (1.2)	39.6 (1.2)	37.2 (3.9)	28.0 (3.0)	26.2 (3.5)		33.6 (4.7)	29.3 (2.3)	
Health Behaviors									
Smoking Status									
Non-smoker/Under 5 packs	58.4 (0.6)	59.0 (0.7)	46.1 (3.6)	49.8 (2.8)	66.1 (3.4)		56.0 (4.6)	52.9 (2.2)	
Past smoker, ≤ 10 PY	10.8 (0.4)	10.6 (0.4)	13.3 (2.7)	14.0 (2.1)	9.9 (2.5)		12.9 (3.4)	12.6 (1.6)	
Past smoker, > 10 PY	14.2 (0.4)	13.8 (0.5)	22.3 (3.5)	18.2 (2.4)	13.1 (2.2)	0.003	12.4 (3.0)	19.2 (1.7)	0.085
Current smoker, ≤ 25 PY	9.4 (0.4)	9.4 (0.5)	12.4 (2.8)	10.0 (2.1)	4.6 (1.3)		9.5 (3.2)	9.0 (1.4)	
Current smoker, > 25 PY	7.2 (0.4)	7.2 (0.4)	6.0 (1.7)	7.9 (1.9)	6.3 (1.8)		9.2 (3.0)	6.4 (1.1)	
Alcohol Consumption									
No/ <1 per month	32.8 (0.7)	31.7 (0.8)	38.4 (3.6)	40.8 (3.0)	46.4 (3.7)		44.6 (4.6)	41.1 (2.2)	
≥1 per month, no binge	48.5 (0.8)	49.7 (0.8)	37.7 (4.0)	39.4 (2.7)	38.7 (3.5)	<0.001	33.9 (4.3)	39.8 (2.2)	<0.001
≥1/week binge	18.7 (0.6)	18.6 (0.7)	23.9 (3.6)	19.8 (2.5)	14.9 (2.9)		21.5 (4.1)	19.1 (1.9)	
Physical Activity									
Meeting Aerobic Guidelines	42.8 (0.8)	43.2 (0.9)	39.4 (4.0)	39.9 (3.1)	38.8 (3.8)	0.396	39.2 (4.7)	39.5 (2.3)	0.234
Clinical Factors									
Hypertension	33.7 (0.8)	32.6 (0.8)	41.0 (3.3)	45.8 (3.2)	40.9 (3.9)	<0.001	38.3 (4.2)	44.1 (2.2)	<0.001
Diabetes	14.5 (0.5)	14.2 (0.5)	20.7 (2.8)	15.5 (2.2)	17.1 (2.8)	0.062	14.7 (3.1)	18.1 (1.6)	<0.001
Dyslipidemia	31.2 (0.6)	30.4 (0.7)	39.7 (3.5)	36.3 (2.8)	37.4 (3.7)	0.002	30.8 (4.0)	39.1 (2.1)	0.045
Psychological Factors									
Level of Anxiety Severity (GAD-7 score)									
Minimal (0–4)	85.9 (0.5)	86.3 (0.5)	91.7 (2.3)	80.7 (2.5)	74.5 (3.1)		82.5 (3.6)	81.9 (1.7)	
Mild (5–9)	10.3 (0.4)	10.2 (0.4)	5.8 (2.1)	12.7 (2.0)	15.3 (2.6)	<0.001	10.2 (2.6)	11.8 (1.4)	0.015
Moderate (10–14)	2.5 (0.2)	2.3 (0.2)	1.7 (0.9)	4.6 (1.4)	5.9 (1.5)		4.7 (2.3)	4.0 (0.8)	
Severe (15–21)	1.3 (0.1)	1.2 (0.1)	0.8 (0.6)	2.0 (0.7)	4.3 (1.7)		2.5 (1.3)	2.3 (0.7)	
Perceived Stress									
Almost none	18.7 (0.5)	18.8 (0.6)	20.3 (2.5)	18.1 (2.3)	13.6 (2.7)		14.4 (3.1)	18.1 (1.5)	
A little	59.1 (0.7)	59.3 (0.7)	60.6 (3.8)	57.4 (3.3)	55.2 (3.6)	0.032	51.1 (4.8)	59.1 (2.3)	0.022
A lot	18.4 (0.6)	18.3 (0.6)	16.9 (3.0)	18.2 (2.3)	24.3 (3.2)		29.5 (4.3)	17.3 (1.7)	
Very much	3.8 (0.2)	3.6 (0.2)	2.3 (1.1)	6.3 (1.6)	6.9 (1.8)		5.0 (2.4)	5.5 (1.0)	
Tinnitus Severity									
None	89.7 (0.4)								
Mild	2.9 (0.2)						30.9 (4.0)	28.0 (2.1)	
Moderate	4.4 (0.3)						43.7 (4.9)	42.3 (2.2)	<0.001
Severe	3.0 (0.2)						25.4 (3.9)	29.7 (2.1)	

Values are weighted estimates accounting for the complex survey design. Percentages are presented with standard errors (SEs). *p* values were calculated using Rao–Scott adjusted F statistics. Age values represent estimated marginal means derived from survey-weighted general linear models. The total number of participants may vary slightly across tables due to missing data for specific variables.
Abbreviations: GAD-7, Generalized Anxiety Disorder–7.

Table 3
Association of Tinnitus Severity With Dizziness (Survey-weighted logistic regression).

	Model 1 OR (95% CI)	p value	Model 2 OR (95% CI)	p value	Model 3 OR (95% CI)	p value	Model 4 OR (95% CI)	p value
Tinnitus severity	p for trend <0.001		p for trend <0.001		p for trend <0.001		p for trend = 0.003	
None	Reference		Reference		Reference		Reference	
Mild	1.17 (0.84, 1.63)	0.174	1.14 (0.81, 1.60)	0.275	1.15 (0.80, 1.66)	0.258	1.19 (0.83, 1.72)	0.101
Moderate	1.78 (1.38, 2.28)	<0.001	1.86 (1.45, 2.40)	<0.001	1.78 (1.38, 2.28)	<0.001	1.71 (1.33, 2.20)	<0.001
Severe	2.74 (2.02, 3.73)	<0.001	2.77 (2.04, 3.76)	<0.001	2.77 (2.00, 3.83)	<0.001	2.43 (1.75, 3.39)	<0.001
Level of Anxiety Severity (GAD-7 score)							p for trend <0.001	
Minimal (0–4)							Reference	
Mild (5–9)							1.66 (1.36, 2.02)	<0.001
Moderate (10–14)							1.78 (1.28, 2.59)	0.003
Severe (15–21)							2.27 (1.34, 3.84)	0.002
Perceived Stress							p for trend <0.001	
Almost none							Reference	
A little							1.46 (1.24, 1.71)	<0.001
A lot							2.02 (1.63, 2.51)	<0.001
Very much							2.27 (1.63, 3.16)	<0.001

Survey-weighted logistic regression models estimating odds ratios (ORs) and 95% confidence intervals (CIs) for dizziness according to tinnitus severity. Dizziness was defined as self-reported dizziness or balance disturbance experienced within the past 12 months.
Model 1: Adjusted for age and sex.
Model 2: Model 1 + sociodemographic factors (education level, household income).
Model 3: Model 2 + health behaviors (smoking status, alcohol consumption, aerobic physical activity) + comorbidities (hypertension, diabetes, dyslipidemia) + tinnitus chronicity (no tinnitus, <6 months, ≥6 months).
Model 4: Model 3 + psychological factors (anxiety severity [GAD-7] and perceived stress).
Tinnitus severity was modeled as a categorical variable, and p values for trend were calculated by additionally modeling tinnitus severity as an ordinal variable. All analyses accounted for the complex survey design using sampling weights, stratification variables, and primary sampling units.
Abbreviations: OR, odds ratio; CI, confidence interval; GAD-7, Generalized Anxiety Disorder-7.

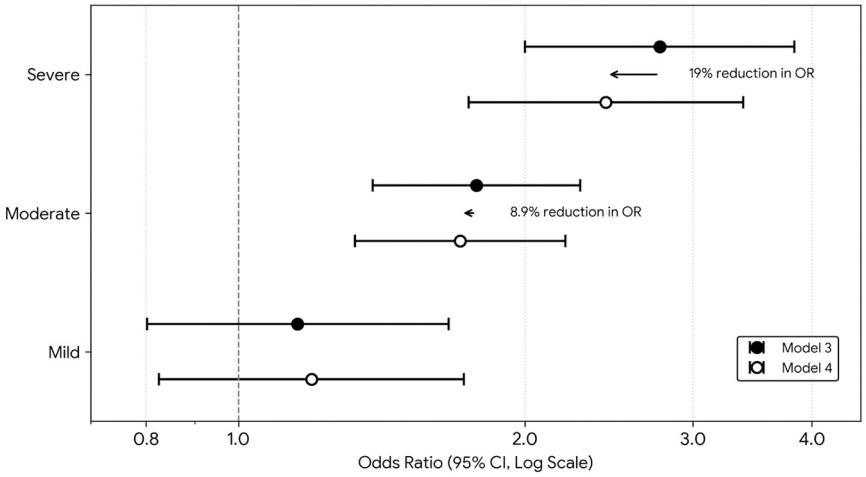


Fig. 1. Changes in the association between tinnitus severity and dizziness after accounting for psychological factors. Filled circles represent estimates from Model 3, which was adjusted for age, sex, sociodemographic factors, health behaviors, comorbidities, and tinnitus chronicity (no tinnitus, <6 months, ≥6 months). Open circles represent estimates from Model 4, which additionally adjusted for psychological factors, including four-level measures of anxiety severity (GAD-7) and perceived stress. Odds ratios (ORs) and 95% confidence intervals (CIs) are shown on a logarithmic scale. Percentage attenuation was calculated based on the change in regression coefficients after additional adjustment for psychological factors. Tinnitus severity categories are defined as mild, moderate, and severe among participants reporting tinnitus, with participants without tinnitus as the reference group.

tinnitus and dizziness remains an important question for future investigation.

Taken together, these findings indicate that tinnitus severity is a clinically relevant auditory correlate of dizziness. While shared auditory–vestibular mechanisms may underlie this association, psychological distress also contributes to, but does not fully explain, the relationship between tinnitus severity and dizziness.

Nevertheless, several limitations merit consideration. First, tinnitus, dizziness, psychological distress, health behaviors, and comorbidities were assessed using self-reported questionnaires, which may be subject to recall bias or misclassification. In particular, dizziness was assessed using a single survey item without clinical subtype classification, which may have introduced heterogeneity in symptom interpretation. As the clinical implications of episodic vertigo differ from those of chronic non-vertiginous disequilibrium, this limitation may obscure subtype-specific associations. Future studies incorporating objective vestibular or functional assessments may help refine symptom characterization while maintaining population representativeness.

Second, the influence of psychological distress on the association between tinnitus and dizziness may differ across individuals. This variability could not be fully quantified in the present analysis, and further research is needed to better characterize how psychological factors modify this relationship across individuals.

Finally, the study population was restricted to adults aged 40 years

and older, which may limit generalizability to younger individuals. Future surveys incorporating broader or rotating age ranges, while maintaining epidemiologic efficiency, may help extend these findings across age groups [32,33].

In conclusion, tinnitus severity was associated with dizziness in a graded manner. Psychological distress was also associated with dizziness and partially attenuated this relationship, supporting a clinical approach that integrates auditory and psychological factors in the assessment of dizziness.

Authorship confirmation

All authors have approved the manuscript and agree with submission to American Journal of Otolaryngology. The work is original, has not been published previously, and is not under consideration elsewhere.

CRediT authorship contribution statement

Hyunji Kim: Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Kyoungwoo Kim:** Writing – review & editing, Visualization, Validation, Software, Resources, Data curation.

Ethical approval

The study protocol was reviewed and approved by the Institutional Review Board of Haeundae Paik Hospital (HPIRB 2025-11-023).

The study used publicly available, de-identified data from the Korea National Health and Nutrition Examination Survey.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT (OpenAI) and Gemini (Google) to improve the English language and readability of the manuscript and to assist in drafting programming code for data visualization. These tools were not used to generate, modify, or alter any figures or study results. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The Korea National Health and Nutrition Examination Survey (KNHANES) data are publicly available and de-identified. The data can be accessed from the KNHANES website (https://knhanes.kdca.go.kr/). All analyses were conducted in accordance with the KNHANES data-use policies and guidelines provided by the Korea Disease Control and Prevention Agency (KDCA).

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjoto.2026.104842.

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