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Association of Symptomatic Dizziness With All-Cause and Cause-Specific Mortality

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IMPORTANCE Dizziness is a highly prevalent complaint with wide-ranging causes and resultant morbidity. Whether symptomatic dizziness and its various manifestations are associated with all-cause and cause-specific mortality is unknown.

OBJECTIVE To examine the associations of symptomatic dizziness and its manifestations with all-cause and cause-specific mortality.

DESIGN, SETTING, AND PARTICIPANTS This cohort study is a mortality follow-up study based on the 1999-2004 National Health and Nutrition Examination Survey. The study cohort included adults 40 years and older who completed questions about symptomatic dizziness, including problems with dizziness, balance, falling, and positional dizziness, within the past 12 months. Respondents were linked to mortality data through December 31, 2019. Data were analyzed from February to August 2023.

EXPOSURE Self-reported symptomatic dizziness.

MAIN OUTCOMES AND MEASURES All-cause and cause-specific (cardiovascular disease, diabetes, cancer, and unintentional injuries) mortality. Cox proportional hazard regression models were used to examine associations between symptomatic dizziness and all-cause and cause-specific mortality while adjusting for demographics and medical history.

RESULTS In this nationally representative cohort of 9000 middle-aged and older US adults (mean [SD] age, 61.8 [13.8] years; 4570 [50.8%] female), prevalence of symptomatic dizziness was 23.8%. Specifically, 18.3% reported problems with dizziness, 14.5% reported problems with balance, 5.7% reported problems with falling, and 3.8% reported dizziness when turning in bed (positional dizziness). At a median (range) of 16.2 (0.1-20.6) years of follow-up, all-cause mortality for adults with symptomatic dizziness was higher than for those without (45.6% vs 27.1%). Symptomatic dizziness was associated with elevated risk for cause-specific mortality from diabetes (hazard ratio [HR], 1.66; 95% CI, 1.23-2.25), cardiovascular disease (HR, 1.33; 95% CI, 1.12-1.55), and cancer (HR, 1.21; 95% CI, 0.99-1.47) but not unintentional injuries (HR, 0.98; 95% CI, 0.51-1.88). Reporting problems with balance or falling was associated with increased all-cause mortality (balance: HR, 1.27; 95% CI, 1.17-1.39; and falling: HR, 1.52; 95% CI, 1.33-1.73), cardiovascular disease–specific mortality (balance: HR, 1.41; 95% CI, 1.20-1.66; and falling: HR, 1.49; 95% CI, 1.15-1.94), and diabetes-specific mortality risks (balance: HR, 1.74; 95% CI, 1.26-2.39; and falling: HR, 2.01; 95% CI, 1.26-3.18). There was no association between positional dizziness and mortality (HR, 0.98; 95% CI, 0.82-1.19).

CONCLUSIONS AND RELEVANCE In this cohort study, symptomatic dizziness was associated with increased risk for all-cause and diabetes-, cardiovascular disease–, and cancer-specific mortality. The imprecision of the effect size estimate for cancer-specific mortality prevents making a definitive conclusion. Future studies are needed to determine whether symptomatic dizziness indicates underlying health conditions contributing to mortality or if early intervention for imbalance and falls can reduce mortality risk.

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Supplemental content

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Dizziness is one of the most common health complaints present in the general population, with a lifetime prevalence of 15% to 36%.[1-4] Dizziness has been associated with increased risk for falls, health care visits, hospital admissions, and disability.[5-7] Although nearly half of those with dizziness do not consult health care professionals about their condition, dizziness remains one of the most common reasons for ambulatory care visits and accounts for 2.8 million emergency department visits annually.[8-10] The frequency of these health care visits has only increased over time, as have rates of computed tomography and magnetic resonance imaging use in patient workup for this condition.[11] As such, health care costs associated with dizziness have been as high as $49.5 billion annually and represent a considerable financial health care and patient burden.[10]

There is a plethora of causes for dizziness that range from relatively benign conditions, such as benign paroxysmal positional vertigo, to serious disorders, such as stroke and brain tumors.[12,13] The wide range of underlying causes contributes to the nonspecific nature of symptomatic dizziness, which can present in various ways, including vertigo, lightheadedness, imbalance, and disequilibrium.[14-16] Given that patients frequently present with nonspecific dizziness and a combination of vestibular symptoms without objective examination findings, it is important to understand the magnitude of symptomatic dizziness and its manifestations on health outcomes.

In this cohort study, we examined the association of symptomatic dizziness with all-cause and cause-specific mortality in middle-aged and older US adults. Prior epidemiological studies have demonstrated the association between abnormal findings for objective balance function tests and mortality,[17,18] but few have investigated the association between symptomatic dizziness and mortality.[19] One prior study based on the National Health Interview Survey reported the association between symptomatic dizziness and 5-year all-cause mortality; however, data on various dizziness manifestations and cause-specific mortality were not available.[19] The present cohort from the National Health and Nutrition Examination Survey (NHANES) includes mortality data using a nationally representative sample of middle-aged and older US adults, with the longest follow-up mortality data at an average of 15 years, and provides detailed analyses examining the association of symptomatic dizziness and its manifestations with all-cause and cause-specific mortality.

Key Points

Question Is there an association between symptomatic dizziness and mortality?

Findings In this cohort study of a nationally representative sample of 9000 US adults, symptomatic dizziness was independently associated with all-cause, cardiovascular disease–specific, diabetes-specific, and cancer-specific mortality but not with unintentional injury–specific mortality. Among manifestations of symptomatic dizziness, report of problems with balance or falls was associated with mortality, but positional dizziness was not.

Meaning Identification and intervention for patients with symptomatic dizziness is paramount considering the association of symptomatic dizziness and mortality; therefore, future studies are needed to understand the role of early intervention for imbalance and falls in reducing mortality risks.

Methods

Study Design

This is a mortality follow-up study of a cross-sectional cohort based on NHANES. This study examines a population-based cohort of a nationally representative sample of 9000 US adults aged 40 years and older who completed surveys on dizziness in the 1999-2004 NHANES, a cross-sectional survey of the civilian, noninstitutionalized population of the US. The NHANES study cycle uses a multistage and stratified probability sampling design that selectively oversamples racial minority groups and individuals with low income. Sampling weights account for NHANES' complex survey design and allow analyses to produce results that are generalizable to the US population. NHANES is deidentified and, thus, this study was deemed exempt from institutional review board approval by the University of Southern California. No patient data were used, and waiver of informed consent was not needed. This study followed Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines.

Dizziness Assessment and Treatment

Symptomatic dizziness was assessed through the following questions found in the NHANES database: "During the past 12 months, have you had dizziness, difficulty with balance, or difficulty with falling? (Yes/No); which of these problems have you had? (Dizziness, difficulty with balance, difficulty with falling)."[20-22] Any symptomatic dizziness was defined based on answering yes to the first question. Three additional dizziness variables were defined based on the respondents' answers to the second question to assess the differences in the associations between symptomatic dizziness and mortality based on the presentation of dizziness. Positional dizziness was defined based on answering yes to the question "Do you get dizzy when you turn over in bed?" Additional assessment for detailed types of dizziness such as room-spinning sensation, lightheadedness, and disequilibrium was unable to be performed in this study because the questionnaires did not further characterize dizziness into differentiating terms in this dataset.[23]

Mortality Status

The primary outcomes included all-cause and cause-specific mortality. The public-use mortality data linked to the NHANES data were obtained from the National Center for Health Statistics.[24] In a process completed by the National Center for Health Statistics, mortality status was determined by probabilistic matching between NHANES data and death certificate records from the National Death Index through December 31, 2019.[25] Follow-up time was assigned using person-months from the date of interview to the date of death or the end of the mortality period (censored December 31, 2019) for a follow-up range of 1 to 249 months. Cause-specific mortality

was based on *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision,* code categories found in the database for the following underlying causes of death: cardiovascular disease (I00-I09, I11, I13, I20-151, and I60-69), diabetes (E10-E14), cancer (C00-C97), and accidents (unintentional injuries; V01-X59 and Y85-Y86). The process of assignment of codes to cause-specific mortality was specified by the National Center for Health Statistics, and these linked underlying cause of death codes were used in analysis.[26]

Statistical Analysis

Descriptive statistics, including mean (SD) and 95% CIs for proportions, were used to characterize the cohort, including mortality rates. Kaplan-Meier analysis and log-rank tests were used to estimate the survival curve, with statistical significance assessed through the log-rank test. Cox proportional hazard models were used to examine the association between symptomatic dizziness and mortality. Two subgroup analyses were performed, including (1) among only those with symptomatic dizziness to compare mortality in those with symptomatic dizziness and problems with balance or falls with those without problems with balance or falls and (2) to compare participants reporting symptomatic dizziness without problems with falls with those without any symptomatic dizziness. These subgroup analyses were performed to assess the role of problems with balance and falls, which are clinically associated with higher rates of fall-related injuries and increased risks of morbidity and mortality. Schoenfeld residuals were used to verify the proportional hazard assumption. Multivariable models controlled for age, sex, race and ethnicity (Black, Hispanic, White, and other race, including multiracial), education, income, insurance, body mass index, smoking status, hypertension, and stroke, as summarized in **Table 1**; cardiovascular disease and diabetes were used in all models except for their respective cause-specific mortality analyses. Medical history variables included hypertension (self-reported diagnosis by a health care professional on ≥2 visits with high blood pressure or taking antihypertensive medication), cardiovascular disease (self-reported diagnosis of congestive heart failure, coronary artery disease, angina pectoris, or myocardial infarction), diabetes (self-reported diagnosis of diabetes and/or current use of insulin or other diabetic medications), and stroke (self-reported history), as in a prior study.[27]

Collinearity diagnostics were conducted, including all explanatory variables (variance inflation factor >2.5, defined as problematic correlation among variables a priori), and no concerning collinearity was observed. Sample weights were used to account for the complex sampling design based on the NHANES analytic guidelines.[23] Statistical significance was set at a 2-tailed $P < .05$. Stata, version 16.1 (StataCorp LLC), was used for all analyses.

Results

Cohort Demographics

The study cohort consisted of 9000 adults who participated in the 1999-2004 NHANES survey (mean [SD] age, 61.8 [13.8] years; 4570 [50.8%] female). Weighted participant characteristics used for analysis are summarized in Table 1. In US adults 40 years and older, the prevalence of any symptomatic dizziness in the 12 months prior to assessment was 23.8%. The prevalence of subjective dizziness, balance, and falling problems were 18.3%, 14.5%, and 5.7%, respectively (**Figure 1**). The prevalence of positional dizziness (dizziness when turning in bed) was 3.8%. Among those who reported any symptomatic dizziness, 65.1% reported problems with balance or falling.

Mortality Rates

All-cause mortality rates were estimated by symptomatic dizziness at a median (range) of 16.2 (0.1-20.6) years of follow-up. Mortality rate among those reporting any symptomatic dizziness was 45.6%, higher when compared with 27.1% for those without any symptomatic dizziness. Mortality rates among those reporting problems with dizziness, balance, and falls were 41.3%, 51.0%, and 61.7%, respectively. Those with dizziness on turning in bed had a mortality rate of 38.5%.

Association Between Symptomatic Dizziness and Mortality

Kaplan-Meier survival estimates based on symptomatic dizziness illustrated that participants with symptomatic dizziness had increased mortality risks for all-cause mortality and cause-specific mortality from cardiovascular disease, diabetes, and cancer (**Figure 2**). There was no difference in mortality risks from unintentional injuries between those with and without symptomatic dizziness.

In adjusted multivariable Cox proportional hazard models that examined the association between various manifestations of symptomatic dizziness and mortality (**Table 2**), any symptomatic dizziness was associated with all-cause mortality (hazard ratio [HR], 1.29; 95% CI, 1.18-1.41), cardiovascular disease–specific mortality (HR, 1.32; 95% CI, 1.12-1.55), and diabetes-specific mortality (HR, 1.66; 95% CI, 1.23-2.25). Symptomatic dizziness was also associated with cancer-specific mortality (HR, 1.21; 95% CI, 0.99-1.47), although no definitive conclusion can be made about the strength of the association. There was no association between dizziness and unintentional injury-specific mortality (HR, 0.98; 95% CI, 0.51-1.88).

When examining by manifestation of symptomatic dizziness, reported problems with dizziness, balance, and falling were each associated independently with increased all-cause mortality (dizziness: HR, 1.16; 95% CI, 1.06-1.28; balance: HR, 1.27; 95% CI, 1.17-1.39; and falling: HR, 1.52; 95% CI, 1.33-1.73). When examining the association of each symptomatic dizziness manifestation with cause-specific mortality, problems with balance and falling were associated with cardiovascular disease–specific mortality (balance: HR, 1.41; 95% CI, 1.20-1.66; and falling: HR, 1.49; 95% CI, 1.15-1.94) and diabetes-specific mortality (balance: HR, 1.74; 95% CI, 1.26-2.39; and falling: HR, 2.01; 95% CI, 1.26-3.18). Reporting positional dizziness (getting dizzy when turning in bed) was not associated with all-cause mortality (HR, 0.98; 95% CI, 0.82-1.19) or any cause-specific mortality.

A subgroup analysis was performed, consisting of participants who reported symptomatic dizziness only. Among those with symptomatic dizziness, those who reported problems

Table 1. Weighted Population Characteristics by Symptomatic Dizziness

Characteristic	Weighted % (95% CI)[a]		
		Symptomatic dizziness	
	Overall	No	Yes
Unweighted No.	9000	6617	2383
Weighted No.	115 548 908	88 062 751	27 486 157
Age, mean, y	56.6 (56.2-57.1)	55.5 (55.1-56.0)	60.2 (59.4-61.0)
Sex			
Female	52.8 (51.8-53.8)	49.6 (48.3-50.9)	63.1 (60.9-65.2)
Male	47.2 (46.2-48.2)	49.6 (48.3-50.9)	63.1 (60.9-65.2)
Race and ethnicity			
Black	9.8 (9.0-12.0)	9.7 (7.7-12.9)	10.0 (7.7-12.9)
Hispanic	9.2 (6.7-12.5)	8.9 (6.7-11.7)	10.1 (6.4-15.5)
White	76.8 (73.4-80.0)	77.6 (74.3-80.6)	74.4 (69.6-78.6)
Other race, including multiracial	4.2 (3.4-5.1)	3.7 (3.1-4.6)	5.5 (3.9-7.8)
Education			
<High school	21.7 (20.0-23.6)	19.2 (17.6-20.9)	29.9 (27.0-32.9)
High school graduate	26.2 (24.7-27.7)	25.6 (23.8-27.4)	28.2 (25.8-30.7)
Some college or higher	52.1 (49.8-54.4)	55.3 (52.9-57.6)	42.0 (38.7-45.3)
Income, $			
<20 000	18.0 (16.2-20.0)	14.5 (13.0-16.0)	29.6 (26.0-33.4)
20 000-<45 000	26.0 (24.3-27.8)	25.0 (23.0-27.1)	29.4 (26.8-32.1)
45 000-<75 000	21.4 (19.9-27.8)	22.3 (20.7-23.9)	18.5 (16.3-21.0)
≥75 000	25.0 (22.5-27.7)	28.6 (25.9-31.5)	13.3 (11.0-15.9)
Unknown[b]	9.6 (8.1-11.3)	9.7 (8.1-11.5)	9.3 (7.7-11.2)
Health insurance			
None	10.9 (9.9-12.0)	10.5 (9.3-11.7)	12.2 (10.7-14.0)
Private	55.4 (53.1-57.7)	60.4 (58.3-62.4)	39.5 (35.6-43.6)
Medicare	25.0 (23.5-26.5)	21.7 (20.3-23.1)	35.7 (32.8-38.7)
Medicaid	4.8 (4.0-5.8)	3.6 (3.1-4.3)	8.7 (6.9-10.9)
Unknown[b]	3.9 (3.2-4.7)	3.9 (3.1-4.9)	3.9 (2.9-5.1)
BMI categories			
Normal	27.4 (25.6-29.3)	27.4 (25.3-29.5)	27.7 (25.1-30.5)
Underweight	1.2 (1.0-1.4)	0.9 (0.7-1.3)	1.9 (1.4-2.6)
Overweight	35.8 (34.5-37.1)	36.7 (35.1-38.3)	33.0 (30.8-35.2)
Obese	32.6 (30.8-34.4)	32.3 (30.2-34.5)	33.5 (31.5-35.6)
Unknown[b]	3.0 (2.5-3.7)	2.7 (2.2-3.4)	4.0 (2.9-5.3)
Smoking status			
Never	46.7 (45.0-48.4)	47.8 (46.1-49.4)	43.3 (40.0-46.6)
Former	32.7 (31.3-34.3)	32.4 (30.9-34.0)	33.8 (31.5-36.2)
Current	20.6 (19.3-21.9)	19.9 (18.4-21.4)	23.0 (20.0-26.1)
Hypertension	35.1 (33.1-37.2)	31.1 (29.3-33.1)	48.0 (44.7-51.2)
Cardiovascular disease	11.5 (10.4-12.7)	9.0 (8.0-10.2)	19.5 (17.3-21.8)
Diabetes	10.7 (9.8-11.7)	8.7 (7.9-9.5)	17.2 (15.2-19.4)
Stroke	3.8 (3.3-4.4)	2.2 (1.9-2.7)	9.0 (7.7-10.4)

Abbreviation: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared).

[a] Survey weights were applied according to the 1999-2004 National Health and Nutrition Examination Survey; percentages were based on the weighted survey sample.

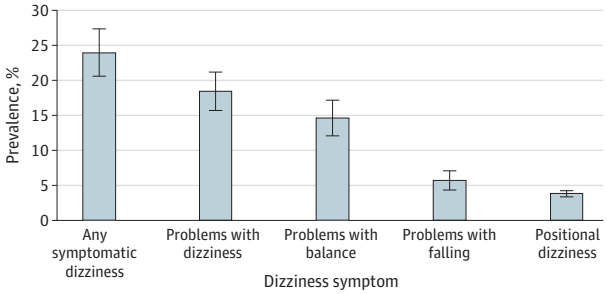
[b] Unknown includes the following responses: refused, missing, and do not know.

with balance or falls had increased risks of mortality compared with those with symptomatic dizziness but without problems with balance or falls (HR, 1.20; 95% CI, 1.00-1.44). An additional subgroup analysis, comparing participants reporting symptomatic dizziness without problem with balance or falls and those without any symptomatic dizziness, demonstrated a weak association, although no definitive conclusion can be made due to the imprecision of the confidence interval (HR, 1.12; 95% CI, 0.94-1.31).

Discussion

In this study, we examined the association of symptomatic dizziness with all-cause and cause-specific mortality at an average of 15-year follow-up in a nationally representative sample of middle-aged and older US adults. Mortality risk was higher among participants with any symptomatic dizziness in the prior 12 months and with its manifestations (difficulty with dizzi-

Figure 1. Weighted Prevalence of Symptomatic Dizziness and Its Manifestations Among US Adults 40 Years and Older



Symptomatic dizziness was defined based on answering yes to the question "During the past 12 months, have you had dizziness, difficulty with balance, or difficulty with falling?" Each manifestation of dizziness was estimated based on the follow-up questions. Participants were allowed to check multiple options. Positional dizziness was defined based on answering yes to the question "Do you get dizzy when you turn over in bed?" Error bars represent 95% CIs.

ness, difficulty with balance, and difficulty with falls). Mortality risks were higher when considering all-cause mortality and cardiovascular disease–, diabetes–, and cancer-specific mortality, although no definitive conclusion can be made about the true strength of association with cancer-specific mortality due to imprecision in the effect size estimate. Mortality risks were not associated with unintentional injuries. Participants who reported positional dizziness did not show increased mortality for all-cause or any cause-specific mortality. Multivariable Cox proportional hazard models accounting for relevant demographics and clinical variables found the presence of symptomatic dizziness, and specifically difficulty with balance or falls, to be associated with increased risk of all-cause mortality. Conversely, experiencing symptomatic dizziness without difficulty with balance, falls, or positional dizziness was not associated with increased risk of mortality.

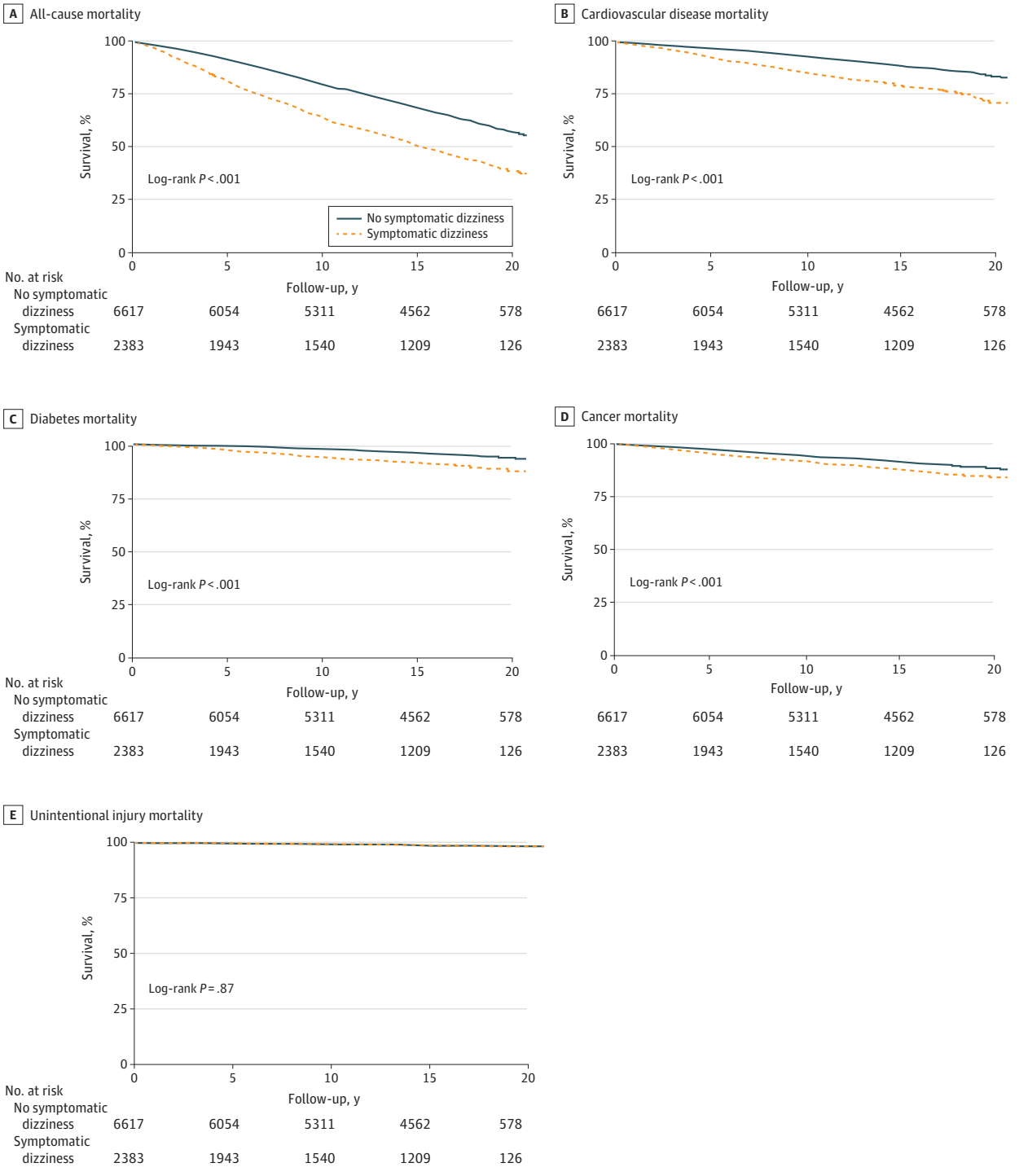
Several previous studies have explored the association between dizziness and mortality.[17-19] A study based on the NHANES cohort of US adults 40 years and older found that balance dysfunction, measured by the modified Romberg test of standing balance on a firm and compliant support surface, was associated with increased risks of all-cause, cardiovascular disease–specific and cancer-specific mortality at 12 years of follow-up.[17] A study based on the National Health and Interview Survey, which examined a sample of US adults, found that symptomatic dizziness was associated with increased all-cause mortality risk at 5 years of follow-up.[19] Another study examining a cohort of patients with a history of cancer diagnosis found balance dysfunction, measured through the modified Romberg test, to be associated with increased all-cause mortality among patients with cancer.[18] Several other studies have also found associations between balance dysfunction measured through a 1-legged stance test and mortality.[28,29]

While prior studies have examined the association between objective balance test findings and mortality, we used symptomatic dizziness and its manifestations to elucidate their associations with mortality. Several prior studies have used the modified Romberg, a validated test for balance measuring proprioceptive ability.[30-32] Other tests, such as the single-leg stance, have been used in understanding the association with mortality.[33-35] In this study, self-report of symptomatic dizziness and its manifestations were used to understand the association between dizziness and mortality. Posing questions about symptomatic dizziness elicits patients' personal experiences and is relatable to the questions clinicians ask in medical settings. As such, these findings, in addition to the prior studies focusing on objective balance test measures, provide a global examination of the association between dizziness and mortality. While a previous study found an association between the report of dizziness and the 5-year mortality rate,[19] the present study builds on this by further investigating the associations with various manifestations of symptomatic dizziness over a longer duration of follow-up.

While the association between symptomatic dizziness and cardiovascular disease–related mortality in this study is in line with findings from previous studies using objective balance tests, we also found an association between symptomatic dizziness and diabetes-specific mortality not previously reported.[17] Several potential mechanisms linking dizziness with cardiovascular disease and diabetes have been suggested. Patients experiencing symptomatic dizziness often limit physical activity due to a fear of falling, which may contribute to the development of cardiovascular disease and diabetes.[36-38] Conversely, hypertension has been proposed to cause dizziness because it may reduce blood supply to the vestibular labyrinth, leading to vestibular symptoms.[39-41] Severe cases of uncontrolled hypertension may affect both cerebral and labyrinthine vasculature, causing central and peripheral vestibular symptoms. Diabetes has also been proposed to cause dizziness through microangiopathy-induced ischemic changes in vestibular organs and peripheral neuropathy, leading to vestibular symptoms and sense of imbalance.[42-44] Additionally, diabetes is an established risk factor for cardiovascular disease, doubling the risks of developing coronary heart disease and stroke and creating an additional vestibulotoxic pathway.[45,46] While each of these potential mechanisms may link dizziness with cardiovascular disease– and diabetes-specific mortality, these conditions may induce dizziness via other means not directly contributing to mortality, such as presyncope, peripheral neuropathy, retinal eye disease, and altered peripheral vestibular function. This study's findings, in conjunction with these multiple potential mechanisms, collectively suggest that symptomatic dizziness may serve as an indicator and contributor to advanced cardiovascular disease and diabetes, both of which are highly associated with mortality.[37,47]

Problems with dizziness without report of difficulties with balance or falls and positional dizziness were not associated with increased risks of mortality in this analysis. Symptomatic dizziness itself without balance or fall issues may be a less consistent indicator of medical comorbidities associated with an increased risk of mortality. Follow-up questions and physical examination specifying the presence of balance or fall problems are critical for patients presenting with symptomatic dizziness. For patients with symptomatic dizziness, it is important to consider the onset, duration, frequency, characteristics, and spontaneity of the symptoms; the degree

Figure 2. Kaplan-Meier Survival Estimates for All-Cause and Cause-Specific Mortality by Symptomatic Dizziness



of imbalance experienced; and presence or absence of neurologic symptoms.[48,49] When there is a concern for difficulty with imbalance or falls, related interventions should be considered as appropriate, including but not limited to vestibular physical therapy and fall prevention programs.[50-52] While these interventions have been developed to assist patients with dizziness and prevent fall-related injuries, their effect on dizziness-related mortality is less known. As such, there remains a need for future studies to understand the effect of these treatments on reduction of all-cause and cause-specific mortality.

Limitations

This study has limitations. While using self-reported dizzy symptoms provides a practical understanding of patients' ex-

Table 2. Multivariable Cox Proportional Hazard Models Examining the Association of Symptomatic Dizziness With All-Cause and Cause-Specific Mortality[a]

Variable	Hazard ratio (95% CI)				
	Any symptomatic dizziness	Problems with dizziness	Problems with balance	Problems with falling	Positional dizziness
All-cause mortality	1.29 (1.18-1.41)	1.16 (1.06-1.28)	1.27 (1.17-1.39)	1.52 (1.33-1.73)	0.98 (0.82-1.19)
Cause-specific mortality					
Cardiovascular disease	1.32 (1.12-1.55)	1.24 (1.05-1.49)	1.41 (1.20-1.66)	1.49 (1.15-1.94)	1.13 (0.78-1.65)
Diabetes	1.66 (1.23-2.25)	1.17 (0.84-1.64)	1.74 (1.26-2.39)	2.01 (1.26-3.18)	1.10 (0.62-1.98)
Cancer	1.21 (0.99-1.47)	1.09 (0.89-1.34)	1.08 (0.86-1.34)	1.14 (0.83-1.58)	0.94 (0.67-1.32)
Unintentional injuries (accidents)	0.98 (0.51-1.88)	0.95 (0.43-2.10)	0.61 (0.24-1.55)	1.10 (0.40-3.03)	0.37 (0.06-2.64)

[a] All multivariable models were adjusted for age, sex, race and ethnicity, educational level, income, insurance status, body mass index category, smoking status, history of hypertension, and history of stroke. History of diabetes and history of cardiovascular disease were used for all models except their own cause-specific mortality.

periences with dizziness and its influence on their daily lives, it is susceptible to individual respondent interpretation, reporting, and recall bias. Additionally, the report of symptomatic dizziness was obtained at the time of NHANES participation. Given the cross-sectional nature of the cohort, the date of dizziness onset and any change in status of symptomatic dizziness were unavailable, and this could introduce bias into the analysis. For cause-specific mortalities such as unintentional injury, the lack of associations may have been influenced by the relatively small number of events and the heterogeneity of the causes, some of which may not be associated with dizziness, such as unintentional motor vehicle–related injury, firearms, and drowning, in addition to falls. Next, the results are based on observational data, and as such we are unable to determine causal relationships. Furthermore, the questions used to assess symptomatic dizziness lack certain characterization of dizziness that is clinically meaningful, such as room-spinning sensation or lightheadedness. However, we consider the breadth of definition used in this study to be an improvement over that of previous studies, especially considering the differential associations with mortality we uncovered when individually assessing the influence of reported problems with balance, falls, and positional dizziness. Although we were able to adjust for a plethora of major confounders and mediators, including demographic variables and medical comorbidities, residual confounding effects due to other factors unmeasured in this study cannot be excluded. For example, some variables such as objective measurements of cognition and physical activity were excluded, as they were only available for a fraction of the cohort (<30%). Studying the effect these variables may have on mortality represents a beneficial area of future work. Other future work could investigate interventions to decrease dizziness and assess its effect on mortality.

Conclusions

In this cohort study, symptomatic dizziness was associated with increased risk of all-cause mortality as well as mortality secondary to cardiovascular disease and diabetes in middle-aged and older US adults. Specifically, reporting problems with balance and falls were associated with mortality, while positional dizziness was not associated with mortality. As the US population continues to age, patients presenting with symptomatic dizziness will continue to increase in prevalence. Identifying interventions that effectively manage dizziness and their effect on mortality represent important areas of future work.

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Author Contributions: Dr Choi had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Concept and design: Lin, Straughan, Adams, Choi.
Acquisition, analysis, or interpretation of data: All authors.
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