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Impact of Balance and Dizziness Problems on Falls in Older Adults: The Longitudinal AGES-Reykjavik Study

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Keywords: dizziness | falls | imbalance | population-based longitudinal study | vertigo

ABSTRACT

Objective: To investigate the impact of balance and dizziness problems (BDP) and other risk factors on falls in a longitudinal, population-based cohort of older adults.

Methods: The Age, Gene/Environment Susceptibility-Reykjavik Study (AGES-RS I) 2002–2006 examined 5764 adults aged 66–98. Five years later, 3316 surviving subjects were reexamined in AGES-RS II. Participants were asked about BDP, falls, usual activities, and health conditions. BDP symptoms during the past 12 months included: vertigo (spinning/moving sensation); floating/spacey sensation; light-headedness (no moving sensation); near fainting (presyncope) or fainting (syncope); blurred vision with head movement (oscillopsia); and feeling off-balance/unsteady. Clinical assessments included hand grip and leg strength plus steps and time to walk 6 m.

Results: During the past 12 months in AGES-RS II, BDP prevalence was 40.1% (males 35.2%, females 43.7%) and the prevalence of falling was 23.0% (males 20.9%, females 24.8%). BDP increased steps and time to walk 6 m. BDP increased the risk of falls (adjusted prevalence ratio [PR] = 1.53; 95% confidence interval [CI]: 1.34–1.76 for AGES-RS I, PR = 1.77, 95% CI: 1.55–2.03 for AGES-RS II). The prevalence of ≥ 2 falls was 8.9% (15.6% with BDP vs. 4.4% without BDP). Among those who fell ≥ 2 times, 70.4% reported BDP in the past 12 months. Additional risk of falling was associated with fear/panic attacks, memory loss, hearing loss, and other health conditions.

Conclusion: BDP are common in older adults and associated with 50% to 80% increased risk of falling and even greater risk of falling ≥ 2 times. Quantitative estimates are provided for contributing factors that further increase the risk of falls.
Level of Evidence: 2 (prospective cohort study).

1 | Introduction

Despite prior studies of vertigo, other dizziness problems, and imbalance (disequilibrium/unsteadiness) with falling in community-dwelling older adults, investigations of large population-based samples followed up over a period of 5 years or longer are scarce. Earlier studies of community-dwelling prospective cohorts have found one-third of adults aged ≥ 65 and one-half of those aged ≥ 80 experience falls each year [1, 2]. Falls are the leading cause of nonfatal injury and a principal cause of accidental death among older adults [1–7]. Many associated factors have been implicated, including sociodemographic differences, mobility problems, sensory impairments, psychological problems, medical factors, and medication use [8]. Specific risk factors include muscle weakness, dizziness and vertigo, syncope, postural hypotension, prior history of falls, gait or balance deficits, use of assistive devices, visual deficits, arthritis, age ≥ 80, impaired Activities of Daily Living (ADLs), depression, and cognitive impairment [1, 9–12].

Approximately 50% of patients presenting at emergency departments with dizziness symptoms (i.e., dizziness, vertigo, and imbalance) as their principal complaint are diagnosed with vestibular (inner ear) disturbance [13]. Vestibular disorders are associated with vertigo, other dizziness symptoms, imbalance, problems with hearing, nausea, and other problems. However, some balance and dizziness problems (BDP) have a central nervous system origin or arise from other physiological systems unrelated to peripheral vestibular dysfunction. Regardless of the etiology, BDP are associated with falls [14–17] and can negatively impact quality of life [18, 19]. While all age groups are affected, including children and young adults [20–22], the association between BDP and falls is most consequential for older adults due to increased morbidity and mortality [4, 23–25].

This study aims to examine and quantify the association between falls and symptoms of BDP. We analyzed a unique data set from a longitudinal study of health, disease, and disability in a well-characterized cohort of older adults [26]. Our specific aims were to quantify the prevalence and associations between BDP and falls and to identify additional risk factors for falls among older adults.

2 | Materials and Methods

2.1 | Study Population

This longitudinal, population-based cohort study was established in 1967 in the Reykjavik, Iceland capital region. Participants were recruited from a population-based cohort of men and women born 1907–1935. The Icelandic Heart Association (IHA) initiated the Reykjavik Study ($n = 27{,}281$ in 1960; $n = 11{,}549$ alive in 2002) to identify preventive factors based on clinical assessments for cardiovascular disease evaluation from mid-life through old age. The National Institute on Aging (NIA) began collaborating in 2002 with IHA to expand the study design to assess healthy aging. The new Age, Gene/Environment Susceptibility-Reykjavik Study (AGES-RS) randomly selected 8030 participants, aged 66–96 years, from the earlier Reykjavik Study. Two study waves were carried out in 2002–2006 and again in 2007–2011. The first wave, AGES-RS I, examined 5764 (71.8%) of eligible individuals, and the second wave, AGES-RS II, re-examined 3411 (72.2%) of the survivors. Reasons for not participating in AGES-RS II were death ($n = 1039$), refusal ($n = 1198$), and unable to contact ($n = 116$) [27]. Complete information on BDP and falls in the past 12 months was obtained from 2844 participants in AGES-RS I and II. Information was collected from personal interviews, medical records, and clinical exams, including performance assessments.

2.2 | Ethical Considerations

In adherence to the Tenets of the Declaration of Helsinki, AGES-RS was approved by the Icelandic National Bioethics Committee (VSN: 00-063), the Icelandic Data Protection Authority, and the Institutional Review Board for the National Institute on Aging (NIA), National Institutes of Health, USA. All participants provided written informed consent.

2.3 | Main Outcomes

2.3.1 | Balance and Dizziness Problems (BDP)

Questions regarding BDP were asked using different wording in the two study periods. In the baseline AGES-RS I, the questions asked about vertigo, dizziness, and disequilibrium in the past 12 months. In AGES-RS II, questions regarding BDP in the past 12 months asked about: (i) vertigo (spinning/moving sensation), (ii) floating/spacey sensation, (iii) light-headedness (no moving sensation), (iv) near fainting (presyncope) or fainting (syncope), (v) blurred vision with head movement (oscillopsia), and (vi) feeling off-balance/unsteady. BDP was scored positive if yes to any of these. If yes to any BDP symptoms, participants were asked: "If multiple symptoms, which was most bothersome." Follow-up questions about the most bothersome symptom were then asked: (i) "How long bothered?" (ii) "How often bothered in the past 12 months?" and (iii) "How long each episode or symptom lasts?"

2.3.2 | Falls

In AGES-RS I and II, participants were asked: "During the past 12 months, have you fallen and landed on the floor or ground?"

If yes: "How many times have you fallen in the past 12 months?" In addition, participants in AGES-RS II were asked: "During the past 12 months, have you fallen at least one time?" If yes, then the follow-up question was: "Have you fallen during the past 5 years because of any of these: (i) vertigo, (ii) floating/spacey sensation, (iii) light-headedness, (iv) near fainting or fainting, (v) blurred vision with head movement, or (vi) feeling off-balance/unsteady?"

2.4 | Covariates

Potential risk factors associated with BDP and falls, including demographic and lifestyle characteristics and medical health history, were recorded at baseline clinic visits during detailed personal interviews prior to clinical examinations. Hours per week of moderate or vigorous physical activity in the past year were categorized as: never, rare or occasional (< 1 h/week), moderate (1 to < 3 h/week), or high (≥ 3 h/week). Depression was assessed using the 15-item Geriatric Depression Scale (GDS-15) and defined by scores ≥ 6 [28, 29]. Cognitive impairment was assigned after administering three cognitive domain tests (memory, processing speed, and executive function). Dementia was identified in a 3-step procedure involving the Mini-Mental State Examination, the Digit-Symbol Substitution Test, and a diagnostic battery of neuropsychological tests and evaluation by a neurologist; then a panel of experts reached a consensus diagnosis based on DSM-IV criteria [27, 30]. Height and weight were measured in the clinic to determine body mass index (BMI).

Sensory problems of vision and hearing were determined based on self-report and exams. Vision was measured as presenting visual acuity, aided by current corrective lenses [31]. Vision impairment was classified by better eye visual acuity (VA) ≥ 20/50 (logMAR ≥ 0.4) [31, 32]. Report of vision problems included cataract surgery and diagnosis of glaucoma or macular degeneration. Participants were asked about their hearing: (i) "Have you been bothered by ringing in the ears (tinnitus) for ≥ 5 minutes in the past 12 months?" (ii) "Do you use a hearing aid?" and (iii) "How is your hearing (without a hearing aid), is it good, a little trouble, a lot of trouble, or deaf?" Pure tone, air-conduction hearing thresholds were obtained via an automated procedure using an Interacoustics AD229e microprocessor audiometer (Interacoustics A/S, DK-5610, Assens, Denmark) that employed the Hughson-Westlake method (up 5 dB, down 10 dB), which conformed to ISO 8253-1:1989/2010(en) [33]. Standard TDH-39P supra-aural audiometric headphones or E.A.R. tone 3A insert earphones (MEDI, Benicia, CA, USA) were used. Hearing thresholds at frequencies of 0.5, 1.0, 2.0, 3.0, 4.0, 6.0, and 8.0 kHz were measured in each ear using noise-insulated booths. The better ear (BE) "speech-frequency" pure tone average (PTA) of thresholds at 0.5, 1.0, 2.0, and 4.0 kHz was analyzed based on the World Health Organization (WHO) and Global Burden of Disease (GBD) classification: normal hearing (< 20 dB hearing level [HL]), mild impairment (≥ 20 to < 35 dB HL), moderate impairment (≥ 35 to < 50 dB HL), or more severe hearing impairment (≥ 50 dB HL) [34, 35]. Injuries resulting from falls were abstracted from medical records. Quadriceps strength and hand grip strength were determined by isometric dynamometry during the clinical exam. Time (seconds) and number of steps to walk six meters at standard (and fast) speed were measured two times and the average time and number of steps were analyzed.

2.5 | Statistical Analysis

Continuous variables are described using means and standard deviations (or standard errors of the mean), whereas categorical variables are described using frequency counts and percentages. Chi-square tests were performed to detect statistical significance for categorical variables. All significance tests were two-tailed and p values ≤ 0.05 were considered statistically significant; borderline significance values, p values > 0.05 to ≤ 0.10, are also provided. The generalized linear interactive modeling (GLIMMIX) procedure was used to calculate p values after adjusting for age and sex (Table 1). The Cochran-Armitage trend test was used to assess statistically significant differences in BDP prevalence by age and by number of falls in the past year (Table 2).

Functional mobility was determined by responses to questions and performance (6-m walk at standard or fast speed) in both AGES-RS I and II. These measures were analyzed as independent variables to predict BDP and falls. Logistic regression analysis was used to calculate prevalence ratios (PR) with 95% confidence intervals (CI) for associations with lifestyle, exercise, and health conditions. Other risk factors for falls—selected based on clinical relevance or after identifying significant associations—were examined for subjects with BDP in AGES-RS II. Analyses were conducted using SAS version 9.4 (SAS Institute, Cary, North Carolina).

3 | Results

The average age of the 5224 participants in AGES-RS I was 77.0 years. However, the mean age of the 2353 participants in AGES-RS I who did not participate in AGES-RS II was 79.6 years, whereas the mean age of the 2884 participants in AGES-RS I who participated in AGES-RS II 5 years later was 75.0 years. In AGES-RS II, the mean age of participants was 80.2 years. Attrition in this cohort of older adults was described in the Methods, namely, nearly half (n = 1039) of the non-participants died before AGES-RS II and a similar number (n = 1198) refused to participate largely due to advancing age.

3.1 | Prevalence of Balance and Dizziness Problems (BDP)

Among the 5700 participants in AGES-RS I, the prevalence of BDP was 45.5% (males 41.1%, females 48.8%; p < 0.001; Table 1). In AGES-RS II, the prevalence of BDP was 40.1% (males 35.2%, females 43.7%; p < 0.001; Table 1). The most prevalent individual symptoms reported in AGES-RS II were off-balance/unsteady 28.6%, vertigo 16.5%, and light-headedness 10.4% (Table 2). The prevalence of BDP increased significantly with age, which was attributable primarily to age-related increases in two symptoms: off-balance/unsteady and light-headedness.

TABLE 1 | Prevalence of balance and dizziness problems (BDP) and falls in past 12 months in AGES-RS I and II by characteristics.

		AGES-RS I						AGES-RS II					
		BDP[a]			Falls			BDP[a]			Falls		
Characteristic	**Level**	***n***	**%**	***p*[b]**	***n***	**%**	***p*[b]**	***n***	**%**	***p*[b]**	***n***	**%**	***p*[b]**
Total[c]		5224	45.5		5217	18.6		2884	40.1		3335	23.0	
Age, years, mean ± SD		77.0 (5.9)						80.2 (4.8)					
Age (years)	66–69	529	36.9	*Ref*	553	13.6	*Ref*	NA[d]			NA[d]		
	70–74	1553	37.7	NS	1620	16.9	0.04	321	35.8	*Ref*	397	21.9	*Ref*
	75–79	1491	47.7	< 0.001	1586	17.7	0.01	1069	35.7	NS	1211	22.2	NS
	80–84	1213	52.6	< 0.001	1344	21.3	< 0.001	913	42.2	0.03	1051	23.6	NS
	85+	438	56.2	< 0.001	591	23.9	< 0.001	478	47.4	< 0.001	676	25.0	NS
Sex	Male	2235	41.1	< 0.001	2413	15.2	< 0.001	1160	35.2	< 0.001	1360	20.9	0.005
	Female	2989	48.7	*Ref*	3280	21.1	*Ref*	1603	43.7	*Ref*	1881	24.8	*Ref*
Education	Primary	1191	47.9	*Ref*	1262	18.9	*Ref*	577	43.2	*(ref.)*	663	23.8	*Ref*
	Secondary	2551	46.4	NS	2648	17.6	NS	1448	39.8	NS	1649	23.2	NS
	College	791	41.5	0.05	815	18.8	NS	441	39.0	NS	523	22.4	NS
	University	571	39.7	0.04	596	16.1	NS	305	38.0	NS	386	22.5	NS
Marital status	Married or cohabiting	3050	42.0	0.07	3166	16.2	NS	1772	38.7	NS	2069	22.0	NS
	Single, widowed or divorced	2055	50.1	*Ref*	2156	20.5	*Ref*	999	42.8	*Ref*	1152	25.1	*Ref*
BMI, mean ± SD		27.0 (4.4)						26.8 (4.4)					
BMI	(< 18.5) Underweight	75	54.1	NS	85	17.7	NS	48	56.3	0.052	55	20.0	NS
	(18.5–24.9) Healthy	1625	46.1	*Ref*	1775	18.3	*Ref*	921	38.3	*Ref*	1087	21.4	*Ref*
	(25.0–29.9) Overweight	2287	43.7	NS	2475	17.8	NS	1158	39.4	NS	1345	22.8	NS
	(≥ 30) Obese	1171	47.4	NS	1268	20.1	0.10	608	43.6	0.006	694	27.0	0.007

(Continues)

TABLE 1 | (Continued)

		AGES-RS I						AGES-RS II					
		BDP[a]			Falls			BDP[a]			Falls		
Characteristic	**Level**	***n***	**%**	***p*[b]**	***n***	**%**	***p*[b]**	***n***	**%**	***p*[b]**	***n***	**%**	***p*[b]**
General health status	Excellent or very good	1903	33.7	*Ref*	1992	14.8	*Ref*	1089	26.4	*Ref*	1292	18.3	*Ref*
	Good	1607	38.2	0.05	1714	17.2	0.09	807	38.1	< 0.001	939	21.0	NS
	Fair	1432	62.8	< 0.001	1600	21.9	< 0.001	871	55.6	< 0.001	982	29.1	< 0.001
	Poor	274	79.2	< 0.001	381	31.0	< 0.001	99	72.0	< 0.001	122	44.8	< 0.001
Cognitively impaired[f]	No	4377	43.9	*Ref*	4566	17.3	*Ref*	2279	39.1	*Ref*	2668	22.3	*Ref*
	Mild	449	53.0	0.03	546	20.5	NS	293	45.7	NS	328	29.6	0.007
	Dementia dx.	286	54.2	0.07	387	23.3	0.03	167	43.7	NS	188	27.7	NS
Depression	GDS[e] ≥ 6	350	72.6	< 0.001	435	28.1	< 0.001	189	63.0	< 0.001	219	37.9	< 0.001
Alcohol	Never	1149	48.5	*Ref*	1207	19.7	*Ref*	NA[d]	—			—	
	Former	638	50.9	0.005	798	20.9	0.07	NA[d]	—			—	
	Current	3303	43.1	NS	3533	17.4	NS	NA[d]	—			—	
Smoking	Nonsmoker	2170	45.2	*Ref*	2463	19.9	*Ref*	1432	39.1	*Ref*	1672	22.8	*Ref*
	Former	2305	44.7	0.06	2414	17.5	NS	1106	41.0	0.02	1285	22.6	NS
	Current	633	47.8	0.003	681	16.6	NS	234	41.9	NS	276	27.5	0.05
Visual loss	VA[g] ≥ 20/50	737	50.3	NS	790	20.1	NS	667	42.0	NS	751	24.0	NS
Cataracts	Yes	676	49.9	0.005	713	18.5	NS	538	40.9	NS	618	24.4	0.09
Tinnitus	Yes	654	55.5	< 0.001	688	17.9	NS	651	46.8	< 0.001	700	25.9	0.01
Hearing loss (self-report)	Yes	2779	50.3	< 0.001	2924	19.5	0.006	1594	45.0	< 0.001	1730	24.7	0.02
Hearing aid user	Yes	993	52.3	0.003	1062	19.6	NS	715	44.8	0.03	776	23.2	NS
Hearing (better ear, pure-tone average)	< 20 dB HL[h]	1275	38.6	*Ref*	1317	14.7	*Ref*	457	40.8	*Ref*	535	20.7	*Ref*
	≥ 20 to < 35 dB HL	2080	45.0	0.01	2170	17.9	0.02	1120	37.9	NS	1249	23.8	0.05
	≥ 35 to < 50 dB HL	1180	49.2	0.002	1260	21.2	< 0.001	835	39.5	NS	962	23.5	NS
	≥ 50 dB HL	396	53.5	0.001	420	19.3	0.09	360	46.3	NS	406	23.4	NS

(Continues)

TABLE 1 | (Continued)

Characteristic	Level	AGES-RS I						AGES-RS II					
		BDP[a]			Falls			BDP[a]			Falls		
		n	%	*p*[b]	*n*	%	*p*[b]	*n*	%	*p*[b]	*n*	%	*p*[b]
Moderate-to-vigorous physical activity	< 1 h/week	3502	48.9	*Ref*	3680	18.7	*Ref*	1656	44.7	*Ref*	1994	25.5	*Ref*
	1–7 h/week	1284	37.9	< 0.001	1324	15.3	0.05	1011	35.6	< 0.001	1113	19.8	0.006
	> 7 h/week	279	32.3	< 0.001	285	18.2	NS	199	24.3	< 0.001	218	20.2	NS
Mobility disability (can't walk 500 m or climb 10 steps)	Not able	244	75.8	< 0.001	424	33.7	< 0.001	146	63.7	< 0.001	181	47.5	0.02
Devices used to get around (cane, walker, or wheelchair)	Yes	729	69.8	< 0.001	798	30.2	< 0.001	NA[d]			NA[d]		
Activities of daily living (no. of ADLs unable to do)	None	3764	37.9	*Ref*	3971	15.2	*Ref*	1967	31.2	*Ref*	2309	18.3	*Ref*
	1	739	58.6	< 0.001	818	20.2	0.003	388	54.9	< 0.001	436	29.6	< 0.001
	2	332	71.4	< 0.001	454	31.1	< 0.001	184	67.9	< 0.001	210	34.3	< 0.001
	≥ 3	270	80.0	< 0.001	312	38.1	< 0.001	208	73.6	< 0.001	235	48.5	< 0.001
Pain, aching, or stiffness in joints	Yes	3010	52.0	< 0.001	3168	21.0	< 0.001	1300	50.4	< 0.001	1501	28.2	< 0.001
Arthritis	Yes	1966	53.6	< 0.001	2157	20.9	0.03	886	45.9	< 0.001	1014	26.6	< 0.001
Chronic lung disease	Yes	540	57.0	< 0.001	601	21.5	0.07	215	49.6	0.002	242	28.9	0.01
Diabetes	Yes	450	51.3	0.007	507	20.9	NS	249	51.6	< 0.001	282	25.0	NS
Fear or panic attacks	Yes	465	54.8	< 0.001	483	17.6	NS	37	51.2	< 0.001	79	30.9	0.002
Hypertension	Yes	4223	46.5	NS	4616	18.7	NS	2564	41.0	0.008	2977	23.2	NS
Parkinson's diagnosis	Yes	52	71.2	< 0.001	68	35.3	0.001	37	82.1	< 0.001	41	44.2	0.005
Slurred speech, problem with talking < 24 h	Yes	246	66.3	< 0.001	264	26.9	< 0.001	160	59.6	< 0.001	175	36.4	< 0.001
Stroke	Yes	333	67.9	< 0.001	400	26.0	0.002	127	58.3	< 0.001	154	29.1	NS

[a]Balance and dizziness problems (BDP) were defined using different questions in AGES-RS I and II (see Section 2: Methods).
[b]*p* values were calculated while adjusting for age and sex by using the generalized linear interactive modeling (GLIM) procedure in SAS; *p* values > 0.05 and ≤ 0.10 are borderline significant; *p* values > 0.10 are shown as not significant (NS).
[c]In AGES-RS I (2002–2006), the number of subjects with information available was 5224 for BDP and 5217 for falls, or 90.6% and 90.5% of the 5764 individuals examined; in AGES-RS II the number of subjects available was 2884 for BDP and 3335 for falls.
[d]NA = "not applicable" or "did not ask" the question in AGES-RS II.
[e]GDS = Geriatric Depression Scale (GDS); GDS > 6 is used to define depression.
[f]Cognitive impairment (CI) was based on three cognitive assessments and was adjudicated by a panel of experts into categories: no CI, mild CI, and dementia diagnosis.
[g]VA = visual acuity; impairment is defined as the best presenting (with use of glasses or contact lenses) visual acuity (VA) ≥ 20/50 in the better eye; blind individuals, defined as VA ≥ 20/400, are not excluded.
[h]Hearing threshold classification is based on the pure-tone average (PTA) of four thresholds (0.5, 1.0, 2.0, and 4.0 kHz) in decibels (dB) hearing level (HL) for the better ear (BE).

TABLE 2 | Prevalence of balance and dizziness (BDP) symptoms by sex, age, and falls last 12 months, AGES-RS II.

			Vertigo, spinning/ moving	Floating/ spacey sensation	Lightheaded, no moving sensation	Presyncope/ syncope (fainting)	Blurred vision with head moving	Feeling off-balance/ unsteady	Any one or more DBP symptoms
			(*n* = 476)	(*n* = 90)	(*n* = 299)	(*n* = 223)	(*n* = 105)	(*n* = 824)	(*n* = 1150)
		n[a]	%	%	%	%	%	%	%
Total		2884	16.5	3.1	10.4	7.7	3.6	28.6	39.9
Sex	Male	1203	14.3	2.3	7.7	6.6	3.2	25.7	35.3
	Female	1681	18.1	3.7	12.4	8.6	4.0	30.6	43.3
p value (χ^2)			0.006	0.04	< 0.001	0.05	NS	0.004	< 0.001
Age	71–74	321	20.3	2.8	8.4	6.5	3.4	17.8	35.8
	75–79	1069	13.7	3.3	8.8	7.2	3.3	24.9	35.2
	80–84	913	16.7	3.4	12.8	8.4	4.3	31.2	42.2
	85+	581	19.5	2.6	10.5	8.3	3.4	37.2	47.2
p value (for trend)			0.10	NS	0.02	NS	NS	< 0.001	< 0.001
Falls (last 12 months)	0	2210	14.1	2.9	8.9	6.3	3.0	24.6	35.5
	1	403	20.6	3.5	12.2	7.4	3.2	30.8	44.4
	2–3	197	27.9	2.5	15.2	18.8	9.1	54.3	65.5
	≥ 4	56	37.5	12.5	37.5	26.8	10.7	78.6	87.5
p value (for trend)			< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

[a]Numbers differ slightly from Table 1 due to a few missing values.

TABLE 3 | Prevalence of a single balance or dizziness problem (BDP) symptom[a] and with two or more BDP symptoms[b] among participants with any BDP ($n = 1150$), AGES-RS II.

	Vertigo, spinning/ moving	Floating/ spacey sensation	Lightheaded, no moving sensation	Presyncope/ syncope (fainting)	Blurred vision with head moving	Feeling off-balance/ unsteady
	($n = 476$)	($n = 90$)	($n = 299$)	($n = 223$)	($n = 105$)	($n = 824$)
	%	%	%	%	%	%
Vertigo, spinning/ moving sensation	**12.7**[a]	5.5[b]	11.5[b]	8.5[b]	4.8[b]	23.8[b]
Floating/spacey sensation		**0.7**[a]	3.7[b]	3.1[b]	1.6[b]	5.6[b]
Lightheaded, no moving sensation			**3.7**[a]	7.3[b]	4.1[b]	18.5[b]
Presyncope/syncope (fainting)				**3.7**[a]	3.0[b]	13.2[b]
Blurred vision with head moving					**1.2**[a]	6.6[b]
Feeling off-balance/ unsteady						**33.0**[a]
Total	**41.4**[c]	**7.8**[c]	**26.0**[c]	**19.4**[c]	**9.1**[c]	**71.7**[c]

[a]Among subjects having at least one BDP, the percentage of participants with a single symptom (bolded; diagonal cells); for example, 33.0% with BDP reported feeling off-balance/unsteady and no other symptoms, while 12.7% with BDP reported vertigo and no other symptoms.
[b]Among subjects having at least one BDP, the percentage of participants with two or more symptoms (not bolded; off-diagonal cells); for example, 23.8% reported feeling off-balance/unsteady and vertigo (and possibly other BDP), while 11.5% reported both vertigo and light-headedness without a sense of motion (and possibly other BDP).
[c]The total row shows the prevalence (%; bolded) of each specific BDP symptom (includes as only symptom and also with any other BDP) any in the past 12 months, for example, 41.4% reported vertigo plus any other BDP symptom along with vertigo.

Among participants with one or more BDP symptoms, the relative frequency in descending order was: off-balance/unsteady 71.7%, vertigo 41.4%, light-headedness 26.0%, presyncope/syncope (fainting) 19.4%, blurred vision with head movement (oscillopsia) 9.1%, and a floating/spacey sensation 7.8% (Table 3). Among participants with BDP, vertigo only was 12.7%, and the combination of both vertigo and off-balance/unsteady was 23.8% (Table 3). Light-headedness only was 3.7%, whereas light-headedness in combination with vertigo was 11.5%. Only one BDP symptom was reported by 55.0%, two symptoms by 25.3%, three symptoms by 12.4%, and four or more symptoms by 7.3% (Table S1).

When asked which BDP was most bothersome, the most frequently reported were feeling off-balance/unsteady and vertigo. During BDP episodes, the most common conditions connected to or occurring around the same time were: headaches, including migraine 21.8%, nausea or vomiting 20.8%, and problems with vision 9.8% (Table S2).

3.2 | Prevalence of Falls and BDP

The prevalence of falls in AGES-RS II was 23.0% (males 20.9%, females 24.8%; Table 1). The overall prevalence of two or more falls was 8.9% (15.6% among those with BDP compared to 4.4% among those without BDP). Among those who fell in the past 12 months, 61.4% fell once, 30.0% fell two or three times, and 8.5% fell ≥4 times (Table 2). Among those who fell ≥2 times, 70.4% reported BDP. More frequent falls were associated with a higher prevalence of BDP (Figure 1). Those who fell ≥4 times in the past 12 months had BDP prevalences of 83.3% and 87.5% in AGES-RS I and II, respectively.

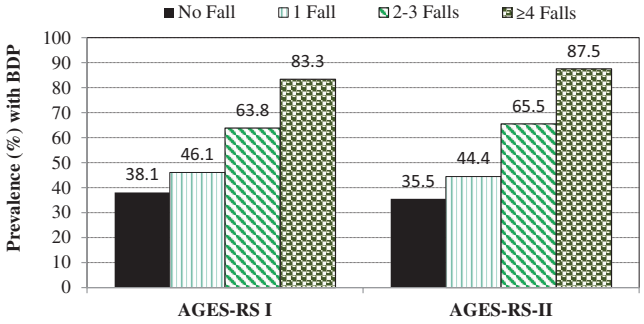

FIGURE 1 | Prevalence of balance and dizziness problems (BDP) by frequency of falls in the last 12 months.

Report of any BDP in the past 12 months greatly increased the prevalence of falls (Figure 2A). The prevalence of falls across age groups for participants with BDP was nearly double that compared to participants without BDP. Males who did not experience BDP had the lowest prevalence of falls across all age groups.

The prevalence of falls by specific BDP symptoms increased about 80% on average compared to participants without the specific symptom. In Figure 2B, the first bar for each BDP

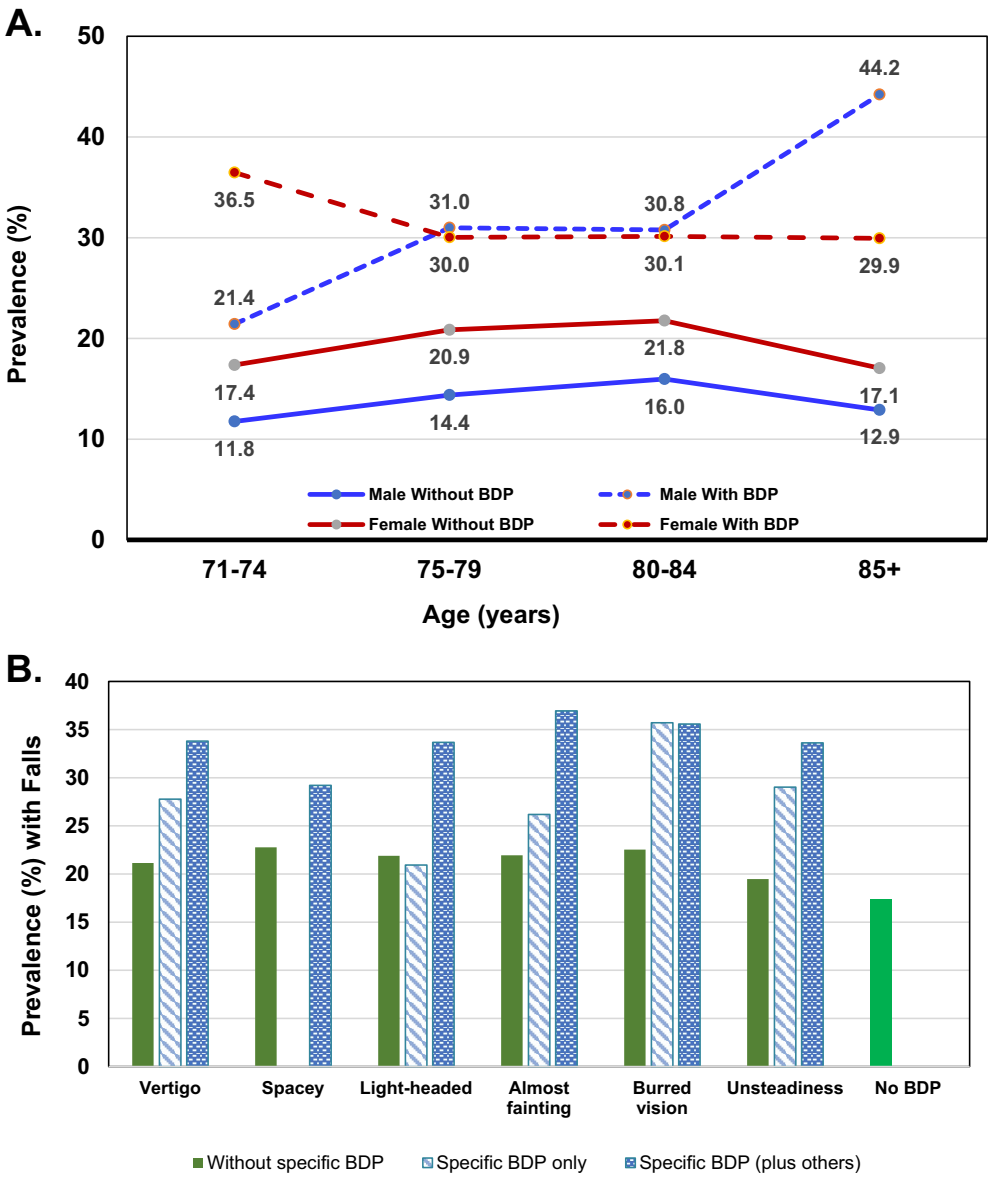

FIGURE 2 | Prevalence of falls in AGES-RS II in the last 12 months with or without balance and dizziness problems (BDP). (A) Prevalence of falls by sex, age, and with or without BDP. (B) Prevalence of falls by specific BDP symptoms, solid bars refer to the percentage of falls occurring without the specific BDP symptom, compared to the adjacent striped bar that shows the prevalence of falls occurring when only the specific BDP symptom was reported, followed by the stippled bars when the specific BDP symptom and any other BDP symptoms were reported.

symptom indicates the prevalence of falls in the past 12 months associated with the specific symptom (including any additional BDP). The second bar for each BDP symptom indicates the prevalence of falls when only the specific BDP symptom was reported. The third bar for each specific BDP symptom indicates the prevalence of falls if the specific BDP symptom was not reported (other BDP may have been reported). The last bar (far right) shows the prevalence of falls when no BDP symptoms were reported.

When only the BDP floating/spacey sensation was reported in the past 12 months, there were no falls (shown as 0% in Figure 2B). Also, light-headedness alone did not increase the prevalence of falls, although when combined with other BDP symptoms, there was an increase. If only a single BDP symptom was reported, the highest prevalence of falls occurred for blurred vision when moving head, followed in descending magnitude by relatively higher prevalences of off-balance/unsteady and vertigo. The combination of almost fainting (presyncope) or fainting together with other BDP symptoms led to the highest prevalence (36.9%) of falls in the past 12 months.

Logistic regression estimates of prevalence ratios for associations of BDP and falling were calculated separately for AGES-RS I and II, then for the two time periods combined, to compare sex- and age-adjusted prevalence ratios and 95% CI (Table 4). The prevalence of falls in the past 12 months was 31.4% among those with BDP and 17.4% among those without BDP. BDP in the past 12 months was associated with significantly increased rates of falling in the past 12 months in both AGES-RS I and II. Respondents who did not report BDP in the past 12 months during AGES-RS II, but who had reported BDP earlier in

TABLE 4 | Prevalence ratios (PR) for balance and dizziness problems (BDP) and falls in past 12 months, AGES-RS I compared to AGES-RS II.

		AGES-RS I			AGES-RS II		
		Fell		Prevalence ratios[b]	Fell		Prevalence ratios[b]
	BPD	*n*[a]	%	PR (95% CI)	*n*[a]	%	PR (95% CI)
AGES-RS I	No	1627	14.3	*Ref*	1615	18.8	*Ref*
	Yes	1101	22.2	1.5 (1.2–1.7)**	1095	29.3	1.5 (1.3–1.6)**
	Total	2728	17.5	—	2710	23.1	—
AGES-RS II	No	1638	15.8	*Ref*	1628	17.4	*Ref*
	Yes	1090	19.9	1.2 (1.02–1.4)*	1082	31.6	1.8 (1.6–2.1)**
	Total	2728	17.5	—	2710	23.1	—
AGES-RS I and II	No	1208	14.3	*Ref*	1199	15.3	*Ref*
	Yes, RS I	430	20.0	1.3 (1.03–1.6)**	429	23.1	1.5 (1.2–1.8)**
	Yes, RS II	419	14.1	1.0 (0.8–1.3)	416	28.9	1.9 (1.6–2.3)**
	Yes, RS I and II	671	23.5	1.5 (1.3–1.9)**	666	33.3	2.1 (1.8–2.5)**
	Total	2728	17.5	—	2710	23.1	—

Note: * Statistical significance, $p < 0.05$; ** Statistical significance, $p < 0.01$.
[a]Numbers (*n*) differ slightly from earlier tables due to some missing values.
[b]Prevalence ratios are adjusted for age and sex.

AGES-RS I, also had a significantly increased risk of falling in the past 12 months in AGES-RS II.

Among those with BDP in AGES-RS II, 51.1% reported falling at least once during the past 5 years (Table S3). Among those who fell during the past 5 years, 40.4% reported having experienced BDP symptoms in the past 12 months. The most common BDP symptoms reported were: off-balance/unsteady 28.3%, vertigo 15.1%, and almost fainting (presyncope) and fainting 10.9%. No difference was found in the reported prevalence of broken or fractured bones during the past 5 years for those with or without BDP in AGES-RS II.

3.3 | Performance Measures

In the 6-m walk, males took fewer steps but were faster than females at standard and fast speeds (Figures 3 and S1). Compared to those without BDP, individuals with BDP were slower and took more steps at standard speed but not at fast speed. The average number of steps, with and without BDP, at standard and fast speeds is shown in Figure 3. Graphs illustrating the average time to walk 6 m, with and without BDP, at standard and fast speeds are also provided (Figure S1). The average number of steps and time to complete the 6-m walk at standard speed was statistically higher among those with BDP who had fallen in the past 12 months. The average number of steps and time to complete the 6-m walk were lower among individuals who experienced falls but not BDP in the past 12 months.

No differences in maximum grip or leg (quadriceps) strength were found for individuals with or without BDP for either sex; however, females had lower maximum grip strength than males (Figure S2).

3.4 | Physical Activities, BDP, and Falls

The prevalences of BDP and falls by selected physical activities are shown in Table 5. BDP prevalence was higher among those who participated less often in outside activities; for example, if during winter and summer months, they did not walk for exercise, spent less time walking, did not swim for exercise, spent more time napping during the day, and spent fewer than 5 h sleeping at night. BDP prevalence was higher for individuals who spent 9 h or more sleeping at night during the summer and lower among those who swam more than five times a week during the winter or participated in more than 7 h per week in both light and moderate or vigorous physical activities.

The last two columns show the prevalence of falls in the past 12 months by usual activities and whether they did or did not report BDP in the past 12 months. After adjusting the prevalences for age and sex, those with BDP experienced more falls; however, if their usual activities reduced BDP prevalence, there were fewer significant associations with activities. The positive benefit in terms of the reduction of falls for some activities was primarily associated with the reduction in BDP prevalence, not the activities.

3.5 | Additional Risk Factors Associated With Falls

Several health conditions were associated with increased risk of falls (Table 6). The prevalence of falls among those with BDP, after adjusting for age and sex, was significantly higher for individuals who: (i) were patients in the hospital for one or more nights during the past 5 years, (ii) visited a doctor because of an illness or an injury in the past 12 months, (iii) had chronic lung disease, (iv) had hip or joint pain, aching, or stiffness on most days in the past month, (v) experienced slurred

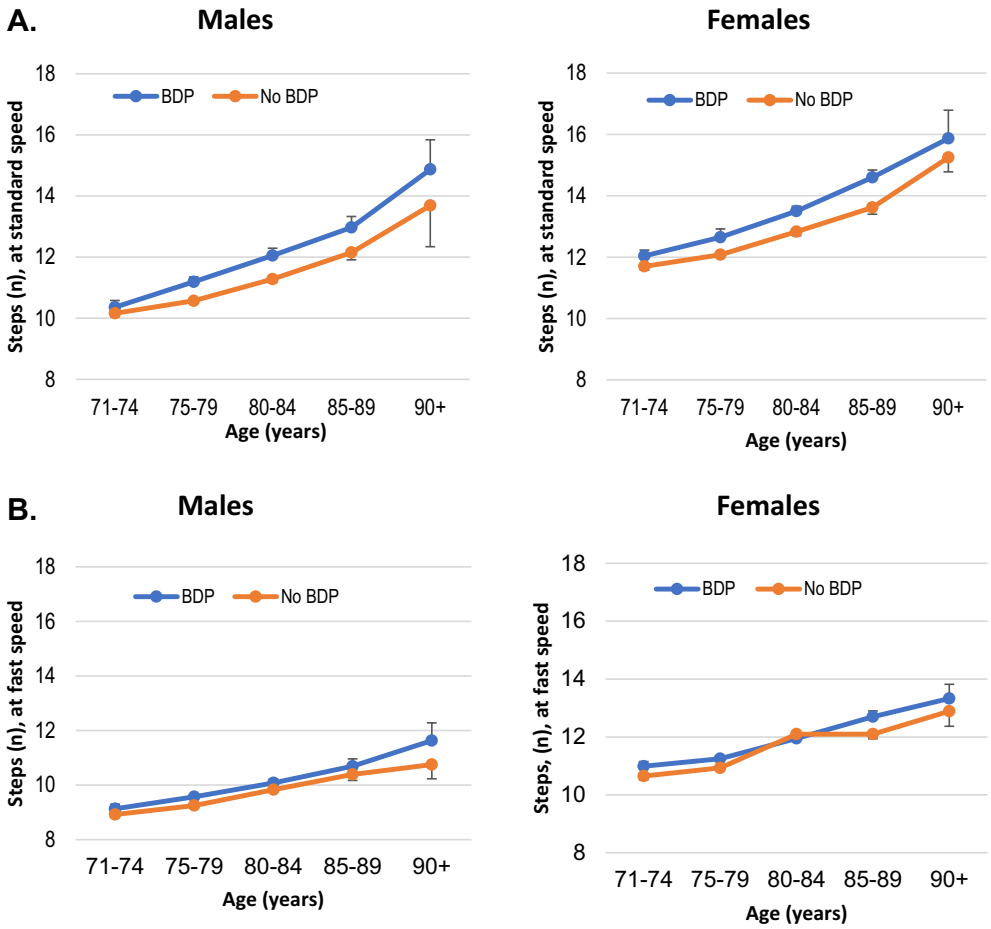

FIGURE 3 | Performance measures by sex, balance, and dizziness problems (BDP), and age in AGES-RS II; error bars represent the standard error of the mean (SEM) for each age group. (A) Standard speed, average number of steps to walk six meters; sex differences (males took fewer steps than females), increased number of steps with age, and increased number of steps for those with BDP versus no BDP, were significant ($p < 0.001$). (B) Fast speed, average number of steps to walk six meters; the sex differences and increasing trend with age were significant ($p < 0.001$), but BDP versus no BDP comparisons were not statistically significant.

speech lasting less than 24 h, (vi) had Parkinson's disease, (vii) reported attacks of fear or panic, (viii) reported worse memory compared to a year earlier, (ix) lost five kilograms or more of weight any time over the past 12 months, (x) were overweight, and (xi) reported a lot of trouble hearing.

4 | Discussion

Many sensory functions (e.g., vision, hearing, balance/vestibular, and olfaction/smell) decline markedly with age; however, within individuals, independent mechanisms appear to be involved in the decline of different sensory functions [36]. Age-related decline in the balance/vestibular system, as with other senses, has been studied extensively [37–41]. Prior epidemiological investigations have found that dizziness and vertigo prevalence increase with age [42, 43]. In the present study, we sought to quantify associations between symptoms of balance and dizziness problems, aging, and risk of falls.

The prevalence of falls in the past 12 months was 14.1% among individuals without BDP in AGES-RS I and 22.1% among those with BDP (50% relative increase). For individuals who reported no BDP in the past 12 months during both study time periods, the prevalence of falls increased only slightly from 14.3% in AGES-RS I to 15.4% in AGES-RS II. Hence, individuals without BDP had nearly the same prevalence of falls in both AGES-RS I and II, even though they were 5 years older on average. However, individuals who reported BDP in both time periods had a prevalence of falls in the past 12 months that increased from 23.6% in AGES-RS I to 33.4% in AGES-RS II. Also, the 5-year fall prevalence occurring in the time span for AGES-RS I and II was 51.1% (Table S3).

In AGES-RS II, BDP was associated with an increased number of steps and slower times for the 6-m walk at standard speed. In addition, individuals who reported both BDP and falls in the past 12 months took a greater number of steps and had slower times than those with BDP who had not fallen in the past 12 months. Yet, when encouraged to walk 6-m at fast speed, a recent history of BDP was no longer a significant factor. We surmise that community-dwelling older adults with BDP normally take precautions when walking at standard speed; yet, if requested and supervised in a clinic, they can perform as well as those within their age group who did not have BDP in the past 12 months.

Dizziness has been identified as a major risk factor for falls across all ages [8, 11–13, 16, 44]. Kerber reported patients with

TABLE 5 | Prevalence of balance and dizziness (BDP) and falls during past 12 months by usual activities, AGES-RS II.

			BDP		Falls: Without BDP		Falls: With BDP	
Usual activities	**Frequency**	***n* (%)**	**(%)**	***p*[a]**	**(%)**	***p*[a]**	**(%)**	***p*[a]**
Total		2884 (100.0)	41.8		17.3		32.4	
Out-of-home activities (going to movies, social events, etc.)	Not at all	884 (30.8)	44.2	*Ref*	18.3	*Ref*	33.3	*Ref*
	< once/month	1439 (50.2)	41.0	NS	16.0	0.09	31.1	NS
	≥ once/month	490 (17.1)	36.0	0.05	18.5	NS	27.3	NS
	≥ once/week	53 (1.9)	27.4	0.09	23.7	NS	15.0	NS
Walked for exercise (typical winter week)	No	1208 (42.2)	44.7	*Ref*	18.5	*Ref*	36.7	*Ref*
	Yes	1658 (57.9)	39.6	0.02	15.9	NS	28.2	0.003
Average daily walking time (during winter months)	< 30 min	409 (24.7)	48.1	*Ref*	15.5	*Ref*	23.6	*Ref*
	30–60 min	1105 (66.6)	36.8	< 0.001	16.3	NS	31.2	0.06
	> 60 min	145 (8.7)	39.2	0.03	26.0	NS	28.1	NS
Swam for exercise (typical winter week)	No	2231 (77.8)	43.6	*Ref*	18.0	*Ref*	32.1	*Ref*
	Yes	635 (22.2)	34.6	< 0.001	14.8	0.05	33.1	NS
Hours spent sleeping at night (during winter months)	< 5 h	50 (1.7)	51.7	*Ref*	11.4	*Ref*	42.5	*Ref*
	5–6 h	660 (23.0)	44.6	NS	21.4	NS	28.6	0.03
	7–8 h	1861 (64.9)	40.2	0.04	16.0	NS	32.5	0.09
	≥ 9 h	295 (10.3)	46.7	NS	15.0	NS	38.2	NS
Hours spent napping during day (during winter months)	None	1641 (57.3)	39.0	*Ref*	16.4	*Ref*	31.3	*Ref*
	< 1 h	955 (33.3)	43.1	< 0.001	18.1	NS	31.2	NS
	1–2 h	258 (9.0)	57.2	< 0.001	20.8	NS	35.8	NS
	≥ 3 h	12 (0.4)	56.6	0.03	16.5	NS	86.2	0.10
Walked for exercise (typical summer week)	No	792 (27.6)	44.8	*Ref*	18.3	*Ref*	35.1	*Ref*
	Yes	2074 (73.4)	41.0	0.06	16.4	NS	31.4	NS
Average daily walking time (during summer months)	< 30 min	455 (21.9)	45.8	*Ref*	13.3	*Ref*	28.7	*Ref*
	30–60 min	1380 (66.5)	40.0	0.01	17.2	NS	32.6	NS
	> 60 min	241 (11.6)	37.7	NS	18.8	0.05	36.7	NS
Swam for exercise (typical summer week)	No	2188 (76.3)	43.8	*Ref*	18.4	*Ref*	31.8	*Ref*
	Yes	678 (23.7)	33.8	< 0.001	14.4	0.007	35.6	NS
Hours spent sleeping at night (during summer months)	< 5 h	59 (2.1)	50.2	*Ref*	16.1	*Ref*	44.9	*Ref*
	5–6 h	786 (27.4)	43.9	NS	19.3	NS	29.2	0.01
	7–8 h	1774 (61.9)	39.6	0.08	16.5	NS	32.4	0.04
	≥ 9 h	247 (8.6)	51.1	NS	13.1	NS	36.6	0.10
Hours spent napping during day (during summer months)	None	1784 (62.3)	39.1	*Ref*	16.9	*Ref*	32.0	*Ref*
	< 1 h	857 (29.9)	43.7	0.001	18.1	NS	31.7	NS
	1–2 h	214 (7.5)	57.6	< 0.001	17.5	NS	33.0	NS
	≥ 3 h	11 (63.6)	56.0	0.07	16.5	NS	88.5	0.05

(Continues)

TABLE 5 | (Continued)

Usual activities	Frequency	*n* (%)	BDP (%)	BDP *p*[a]	Falls: Without BDP (%)	Falls: Without BDP *p*[a]	Falls: With BDP (%)	Falls: With BDP *p*[a]
Participated in light physical activities (past 12 months)	Never	314 (11.0)	37.6	*Ref*	21.0	*Ref*	26.9	*Ref*
	Rarely	269 (9.4)	46.6	0.01	16.1	NS	33.4	NS
	< 1 h/week	159 (5.6)	52.3	0.03	11.4	0.06	39.2	NS
	1–3 h/week	1165 (40.7)	47.1	0.003	15.2	0.09	33.6	NS
	4–7 h/week	632 (22.1)	32.7	NS	20.1	NS	28.4	NS
	> 7 h/week	327 (11.4)	34.1	NS	18.1	0.07	28.1	NS
Participated in moderate or vigorous physical activities (past 12 months)	Never	1369 (47.8)	46.7	*Ref*	18.3	*Ref*	34.7	*Ref*
	Rarely	170 (5.9)	43.3	NS	19.6	NS	35.1	NS
	< 1 h/week	117 (4.1)	29.6	0.006	14.0	NS	27.4	NS
	1–3 h/week	638 (22.3)	37.5	0.003	13.8	NS	27.4	0.08
	4–7 h/week	373 (13.0)	35.8	< 0.001	17.6	NS	23.8	0.02
	> 7 h/week	199 (6.9)	21.8	< 0.001	18.1	NS	17.8	NS

[a]*p* values were calculated while adjusting for age and sex by using the generalized the linear interactive modeling (GLIM) procedure in SAS; *p* values > 0.05 to ≤ 0.10 are borderline significant; *p* values > 0.10 are listed as not significant (NS).

disequilibrium were four times more likely to fall than control subjects over a 5-year period [45]. After adjusting for age and sex, we found a 50% increased risk of falls associated with BDP in AGES-RS I and, when participants were 5 years older, an 80% increased risk in AGES-RS II. Most earlier studies of the association of BDP and falls have been conducted on smaller clinical samples of individuals or with cross-sectional questionnaire studies. The present study adds to existing knowledge due to the relatively large sample size and because results are based on a longitudinal study of a population-based cohort of older adults (aged 66 or more years), which collected interviews, medical records, and clinical exam measures.

Among AGES-RS II participants with BDP, after adjusting for age and sex, risk factors independently associated with falls were hospitalizations during the previous 5 years, doctor's visits in the past 12 months, chronic lung disease, hip or joint pain, episodes of slurred speech in the past 5 years, Parkinson's disease, attacks of fear or panic, losing memory, being overweight, and having a lot of trouble hearing.

We found overweight (but not obese) individuals in AGES-RS II with BDP had a higher prevalence of falls. A study by Corna et al. found the prevalence of dizziness and falls in an inpatient obese population was higher than that in a general matched population, although dizziness and falls were not associated with the degree of obesity [46]. A study based on a nationally representative U.S. health interview survey found that obesity and dizziness were associated with a higher rate of falls but were not significantly associated with fall-related injury [47]. Engagement in physical activities was associated with a decreased prevalence of BDP and falls in AGES-RS II. Rietdyk et al. showed the co-occurrence of multiple fall-risk factors was common in a national sample of U.S. older adults [48]. The present study also demonstrated a protective effect of physical activity on fall risk.

There is evidence that multifactorial interventions and exercise are effective in reducing the number of falls among older adults [49, 50]. Vestibular, balance, and strength training could prevent or postpone many falls [51, 52].

4.1 | Strengths and Limitations

A major strength of this study is that interview and exam data were collected prospectively from a large population-based cohort of older individuals, followed longitudinally since 1967 with a continued high participation rate. One limitation is that the population is Western European and some of the results may not be generalizable to other populations.

4.2 | Implications for Otolaryngology Practice

This study's findings have important implications for the clinical practice of otolaryngology, particularly concerning the evaluation and management of patients experiencing balance and dizziness symptoms. These implications can be summarized in three key areas:

4.3 | Symptom Patterns Warranting ENT Referral

Among AGES-RS II adults over 70 years old, about 4 in 10 reported BDP during the last 12 months, with about half (2 in 10) having BDP with unsteadiness/disequilibrium as the most bothersome BDP symptom and about a quarter (1 in 10) having BDP with vertigo as the most bothersome symptom. Not all such patients have a vestibular problem for which ENT referral is indicated. Patients whose main symptom is unsteadiness (general feeling of instability) should first be evaluated by

TABLE 6 | Prevalence of falls in past 12 months by selected characteristics and prevalence risk ratios (PR) of falling when balance and dizziness problems (BDP) present in past 12 months, AGES-RS II.

		All older adults		All with BDP in past 12 months		
		Falls		Falls		
Characteristics	**Response**	***n***	**%**	***n***	**%**	**Adjusted PR (95% CI)[a]**
Total		2866	23.0	1142	31.4	—
Hospital stays (one or more nights past 5 years)	Yes	1429	27.6	662	36.7	1.54 (1.26–1.87)
Doctor's visit (past 12 months)	Yes	2421	24.2	992	32.9	1.59 (1.12–2.27)
Chronic lung diseases	Yes	574	27.7	286	35.3	1.23 (1.02–1.49)
Pain, aching, or stiffness on most days in your left or right hip (past month)	Yes	607	30.6	324	35.2	1.22 (1.01–1.47)
Pain, aching or stiffness in any of your joints on most days	Yes	1300	27.4	655	35.4	1.42 (1.18–1.72)
Slurred speech or problems talking for brief periods (past 5 years)	Yes	160	36.3	102	48.0	1.61 (1.28–2.04)
Parkinson's disease diagnosis (past 5 years)	Yes	37	43.2	30	46.7	1.57 (1.01–2.43)
Fear or panic attacks (past 5 years)	Yes	68	38.2	45	48.9	1.55 (1.11–2.16)
Memory has gotten worse compared to 12 months ago	Yes	463	30.5	274	38.0	1.27 (1.06–1.55)
Lost 5 kg or more (past 12 months)	Yes	361	30.5	177	39.0	1.30 (1.05–1.61)
General state of health	Excellent or very good	1089	18.2	285	27.2	*Ref*
	Good	807	20.6	304	25.0	0.92 (0.70–1.22)
	Fair or poor	970	30.3	553	36.7	1.34 (1.07–1.69)
Body mass index	< 18.5 (underweight)	27	22.2	16	31.2	1.22 (0.97–1.53)
	18.5–24.9 (normal)	784	19.3	290	27.2	*Ref*
	25.0–29.9 (overweight)	1258	23.9	492	33.1	1.31 (1.02–1.68)
	≥ 30.0 (obese)	670	26.6	297	35.0	1.09 (0.51–2.33)
Hearing ability or difficulty (without a hearing aid)	Good	1277	20.6	435	28.7	*Ref*
	A little trouble	1197	25.3	517	32.5	1.11 (0.90–1.35)
	A lot of trouble	377	22.8	184	33.2	1.06 (0.80–1.40)
	Deaf	8	50.0	4	75.0	2.80 (1.53–5.15)

[a]Prevalence ratios (PR) and 95% confidence intervals (CI) were calculated using generalized linear interactive models (GLIM) while adjusting for age and sex.

a general practitioner for orthostatic hypotension, medication side effects, and other non-vestibular causes, which may lead to a referral for cardiologic consultation. Patients whose main symptom is disequilibrium (unsteadiness accompanied by spatial disorientation) may benefit from referral to a neurologist, especially when other symptoms and history suggest vestibular migraine. Patients who present with brief episodic vertigo triggered by head reorientation relative to the direction of gravity should first be assessed for benign paroxysmal positional vertigo, which affects about 1 in 3 older adults, can be effectively treated with canalith repositioning maneuvers, and merits referral to a vestibular rehabilitation therapist [53, 54]. Direct referral to an otolaryngologist should be considered for patients who report spontaneous episodic vertigo in combination with hearing loss, tinnitus or ear fullness; experience vertigo triggered by loud sounds or straining; exhibit facial weakness or other signs of facial cranial nerve dysfunction; have otorrhea; or have other symptoms, signs, or history suggesting cholesteatoma or other temporal bone disease [55].

4.4 | Informing Patient Selection for Objective Vestibular Testing

Certain symptom profiles, such as rotational vertigo, unsteadiness in the dark, or symptoms worsened by head movements,

are more predictive of abnormal vestibular function. These findings can be used to stratify patients and guide the use of resource-intensive objective vestibular testing (e.g., videonystagmography, vHIT, or vestibular-evoked myogenic potentials). Prioritizing patients with high-probability symptom patterns can improve diagnostic yield and efficiency in vestibular assessment [56, 57].

4.5 | Suggested Intervention Pathways by Risk Category

While not explicitly a "risk stratification" system in the sense of low/intermediate/high risk for overall vestibular dysfunction, the International Classification of Vestibular Disorders (ICVD) developed by the Bárány Society aims to provide evidence-based consensus and standardization regarding definitions for vestibular symptoms (e.g., vertigo and dizziness) and common vestibular disorders. These definitions often include criteria for symptom duration, intensity (severity), and frequency of episodes, which are crucial for differential diagnosis and indirectly for assessing the impact on a patient's life and potential for complications [58]. Dizziness is one of the most common chief complaints in both the ambulatory care setting and the emergency department. The third Guideline for Reasonable and Appropriate Care in the Emergency Department (GRACE-3) from the Society for Academic Emergency Medicine is on the topic "adult patients with acute dizziness and vertigo in the emergency department." Guidelines can inform management decisions for many patients [59].

Falls are highly associated with balance and dizziness symptoms. Most older adults included in the analysis fell into the low- or high-risk categories, with a minority in the intermediate-risk category. The world guidelines for falls prevention and management's risk stratification algorithm can be utilized clinically, even in a sample of patients on a frailty intervention pathway that was designed before the publication of the guidelines [60, 61]. Using the risk stratification algorithm, most of the included patients fell into either the high- or low-risk groups, as has been shown in non-clinical populations [62].

5 | Conclusions

Increasing lifespan and an aging population pose new health and socio-economic challenges. We found that older adults who report dizziness problems or feeling off-balance/unsteady are at greatly increased risk of falling. We showed that BDP increases fall risk by 50% to 80% and more than triples the risk of multiple falls. This highlights the clinical urgency of treating symptoms effectively, as well as underlining the importance of follow-up visits, even after acute symptoms resolve. The population studied (aged 66–98) overlaps heavily with the demographic most vulnerable to vestibular dysfunction, imbalance, and falls. Many patients with BDP are older adults, and this study strengthens the need for integrating fall risk screening into evaluations. The study identified hearing loss, memory loss, and fear/panic attacks as co-risk factors. Hearing loss is a condition that often coexists with vestibular pathology. This study supports an open treatment approach, considering auditory, cognitive, and psychological factors. Health care providers can use the findings to explain the consequences of untreated BDP that further justify referrals for vestibular rehabilitation, audiology, or fall prevention programs, that is, to advocate for proactive management in addition to symptom relief.

We showed the prevalence of BDP symptoms during the past 12 months increased with age from approximately 37% for those aged 66–74 years to 50% for those aged ≥ 85 years. The principal BDP symptom associated with this older age-related increase in prevalence was the off-balance/unsteady sensation. The prevalence of falls also increased with age; however, based on this cohort of Icelandic older adults, the increase in falls with age occurred primarily among individuals who reported BDP. For the individuals with BDP, other conditions associated with increased prevalence of falls were recent medical care and hospitalizations, having experienced slurred speech and problems talking for brief periods during the past 5 years, fear or panic attacks, and the report of a lot of trouble hearing. Since the prevention of falls is a major health concern, earlier detection and diagnosis of BDP problems—because of their value in predicting 1- and 5-year risk of falls—will become increasingly important for older adults, healthcare providers, and society.

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Conflicts of Interest

C.C.D.S. holds equity interest in Labyrinth Devices LLC. The terms of this arrangement are managed in accordance with the Johns Hopkins School of Medicine policies. All other authors declare they have no conflicts of interest.

Data Availability Statement

Data from this study are available through collaboration under a data usage agreement with the Icelandic Heart Association (IHA) and an Institutional Review Board (IRB) approval in accordance with the informed consent agreement. For submission of data access requests, interested researchers may contact: AGES_data_request@hjarta.is.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Figure S1:** lio270266-sup-0001-FigureS1.pdf. **Figure S2:** lio270266-sup-0002-FigureS2.pdf. **Table S1:** Number of different symptoms reported by participants with balancend dizziness problems (BDP) in the past 12 months, AGES-RS II. **Table S2:** Prevalence of falls in the past five years by balance and dizziness problems (BDP) in past 12 months, AGES-RS II. **Table S3:** Prevalence of conditions in AGES-RS II connected to or occurring around the same time as the only or most bothersome balance and dizziness BDP symptom in the last 12 months.