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Proposal for a screening protocol for falls among old subjects attending the audio-vestibular clinic

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Abstract

Background Older adults suffer from falls. 30% of the elderly fall annually in United States of America (Otorhinolaryngol Head Neck Surg. 5:1-4 2020). Falls have also cost society and people heavily. *The aim* of this study is to identify fall risk factors in elderly visiting the audio-vestibular clinic and propose a screening strategy.

Methods The study included 500 elderly participants over 60 years old who visited the audio-vestibular clinic for hearing and/or vestibular evaluations. All participants in this study underwent a full audiological and neuro-otological history, general examination, otological examination, audiological evaluation, and office vestibular testing.

Results One hundred fifty-nine out of 500 (32%) of the study group had a history of vertigo, and 153 out of 500 (31%) had fallen at least once in the past two years. Dizziness and age were significantly associated. Dizziness was more common in people over 70 years old. Similar results were found for the fall history and age. Falls were more common in elderly participants with dizziness. 25% of participants with a history of falls had dizziness, compared to 14.5 percent of those without. Systemic diseases and falls were significantly associated. Falls and abnormal office vestibular test results were statistically significant. Multiple regression analysis showed that Diabetes Mellitus, hypertension, orthostatic hypotension, positional and positioning nystagmus, Romberg and Fukuda tests, and falls were all associated. Multiple risk factors cause older adult to fall. Dizziness increases the risk of falling, especially in the elderly. In our study, hypertension and diabetes were the two greatest independent fall risk factors. Office vestibular tests can detect elderly fallers.

Keywords Fall, Risk factors, The elderly

Background

Falling is the most common public health issue affecting older adults. In the 65 + age group, 30% of individuals fall at least once annually in united states of America [1]. For those above 85 years old, this incidence rises to 50% [2–4]. Almost half of these elderly adults fall frequently, and the risk increases by two or three times if there is cognitive impairment or a history of falls [5]. Falls have serious consequences for the elderly, as they contribute significantly to their mortality due to hospitalization, decreased mobility, restrictions in daily activities, and being dependent on family or society. They have a major impact on the elderly's quality of life and cause significant impairment [6]. The fear of falling again and the development of unsteadiness while standing or walking might confine the elderly to a small area of life where they stop engaging in many of their previous regular activities [7].

Falls also have significant negative financial effects on both the individual and society. According to reports, the UK's National Health Service (NHS) spends about 28 billion US dollars a year treating falls. The overall

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expense of fall-related injuries is expected to triple to $60 billion annually during the next few decades if effective preventative techniques are not implemented [3]. Around 20 billion dollars are thought to be spent on falls every year throughout the United States [4]. Falls are recognized worldwide as a serious health issue and are actively investigated because of the high rates of mortality and morbidity caused by falls, as well as the financial burden on people, falls are internationally recognized as a major health issue and studied extensively [8, 9].

It is challenging to pinpoint a single risk factor or reason for a fall. There are two categories of causes: intrinsic and extrinsic. Balance, cardiovascular, neurological, and musculoskeletal diseases; certain medicines; and visual, auditory, and/or cognitive disorders are among the intrinsic factors associated with falls, whereas environmental factors are extrinsic [7]. More than 30% of adults over the age of 60 years old report feeling vertigo and dizziness. Dizziness alone is a powerful predictor of falls [6]. Although the underlying causes of dizziness in the elderly can be varied, It may be related to musculoskeletal, cardiovascular, and central processing impairments; dysfunction of the vestibular, sensory, and visual systems; or a combination of more than one of these factors [2, 4]. Functional impairment of the vestibular system accounts for about 85% of dizziness in elderly adults [10]. As a result, vestibular system deficits, particularly those caused by physiologic aging (presbyvestibulopathy), are a significant cause of falls [4].

It is essential to predict and prevent falls among the elderly. Vestibular disorders and the natural ageing process of the vestibular system are two major contributing factors to falls, it is to be expected that many elderlies' adult (>60 years old) who visit audio-vestibular clinics for auditory and/or vestibular assessment have one or more fall-related risk factors. The current study's objectives are to determine the fall risk factors among elderly participants who visit the audio-vestibular clinic and to suggest a screening protocol capable of determining the risk for falls in these patients.

Methods

Five hundred elderly participants over the age of 60 years old who visited the audio-vestibular clinic for hearing and/or vestibular evaluation made up the research group. Elderly adults who had neurological disorders, cognitive disorders, or retrolabyrinthine lesions were excluded from the research. Participants ages varied from 60 to 83 years, with 318 male (63.8%) and 182 female (36.4%) with a mean age of 67.32 years old and SD of 5.4 years. There were 332 (66%) participants between the ages of 60–70 years old, 154 (31%) participants in age group 70–80 years old, and 14 (3%) participants above the age of 80 years old.

Participants were informed about the study's objectives and detailed procedures, and they provided written consent to participate in the research. The study was approved by the ethical research committee of Minia university with IRB 691/2023. All participants who took part in the present study were subjected to full audiological and neuro-otological history taking, general examination, otological examination, audiological evaluation, and office vestibular testing. General examination included calculating body mass index (BMI) (weight in kilograms divided by square of the height in meters) using the formula of BMI = weight in kg/height in m^2 [11] and taking blood pressure measurements. Blood pressure was assessed in supine and standing positions to detect possible postural hypotension. A reduction in systolic pressure of at least 20 mm Hg or a reduction in diastolic pressure of at least 10 mm Hg within 3 min of standing was referred to as postural hypotension. Participants stayed standing for at least one minute and in the supine position for at least two minutes before measuring standing blood pressure [5. Hearing was assessed using air and bone conduction audiometry, and middle ear function was assessed using tympanometry and acoustic reflex recording.

Participants were also subjected to office vestibular tests, including the search for spontaneous and post-head-shake nystagmus with visual fixation intact and fixation removed using Frenzel goggles. The assessment also included the clinical head impulse test. Oculomotor tests were performed, including gaze-evoked nystagmus, smooth pursuit, and saccade testing. Positioning test, the goal of a positioning test is to cause nystagmus, and patients need to know that this is the only way to properly identify and treat benign paroxysmal positional vertigo (BPPV). They need to know that any vertigo caused by the test is usually short-lived and that the tester will support them if they feel like they are going to fall off the table. They should also be told to keep their eyes open and look straight ahead. If they feel dizzy, they shouldn't sit up. Positional testing looks for nystagmus in different situations, usually starting with the person lying supine. Six head positions should be tested: head straight, right ear down, and left ear down in the supine position, and the same three head positions in the head hanging position. Head position should be changed gradually. In addition, the examiner must be patient enough to observe for positional nystagmus for a minimum of 10 s in a single head position. Positional testing should ideally be conducted without vision to prevent fixation. The examiner can test for suppression of positional nystagmus if nystagmus is present in any position [12].

Modified Romberg, Fukuda, and modified Clinical Test for Sensory Integration of Balance (modified CTSIB) tests were also done. Modified Romberg test in which the participants stand upright with the feet parallel and close together (to reduce the stance area) and the arms crossed with hands crossing on opposite shoulders. The participants were assessed with their eyes open and closed. A participant with a normal vestibular system can stand in this posture for 30 s without swaying. The test is considered abnormal if the participant moves his feet from their original standing position or moves their hands from their shoulders (an attempt to regain balance). Sway or fall during eye open or closed are definite abnormalities [13].

The Fukuda stepping test is done with arms extended at 90-degree angles in front of the body and eyes closed. The participants march in place for 50 steps. The angle and direction of the deviation were observed. A reference mark system such as a band of tape on the floor oriented along the sagittal plane was used at the start of the test. A rotation of more than 45 degrees in either direction was abnormal. The presence of sway or fall was a definite abnormal result [14]. In the modified CTSIB, the participants sway, and performance were evaluated under four conditions. Condition One is standing on a regular, firm surface with their eyes open. Condition two are the same stance on a regular, firm surface but with eyes closed. Condition three progresses to standing on a dynamic surface (foam) with eyes open. Finally, in condition four, the participant stands on foam with his eyes closed. The participant was allowed three trials on all four conditions, and an average of their performance on each condition was taken [15]. Normally, the participant stands quietly or with minimal sway without needing any support or assistance. Sway occurred when the participant was able to maintain his or her balance without assistance, but the degree of sway was greater than normal. A fall occurred because the participant could not complete or perform the condition without support or assistance [16].

Statistical analysis

IBM SPSS Statistics for Windows, version 20.0. Armonk, NY: IBM Corp, released 2011 was used for all results. The mean and standard deviation were used to show quantitative data, while the frequency distribution was used to present qualitative data. To evaluate proportions, the Chi-square test was used. When the number is less than 5, the fissure exact test is used. The combined impact of various independent variables on the target (dependent variable) was examined using multiple regression analysis. For all significant tests, a probability of less than 0.05 was used as a cutoff point, and all statistical tests were two-taild.

Results

The study included 500 elderly participants who attended the audio-vestibular clinic for hearing and/or vestibular evaluation. About one-third of the study group (159 out of 500; 32%) had a history of dizziness, and nearly one-third (153 out of 500; 31%) had a history of falls, at least once in the previous two years. Kolmogorov–Smirnov test revealed that data is normally distributed. The results of the chi-square test (Table 1) showed a statistically significant association between age and the presence of a history of dizziness. Participants over the age of 70 years

Table 1 History of dizziness and falls among different age groups of elderly participants

Age groups	No Previous history of dizziness. $N = 341$ N (%)	History of dizziness. $N = 159$ N (%)	Total	*P* value
60–70 years	300 (90.3%)	32 (9.7%)	**332**	< 0.0001*
70–80 years	36 (23.4%)	118 (76.6%)	**154**	
> 80 years	5(36%)	9 (64%)	**14**	
Total	**341 (68%)**	**159 (32%)**	**500**	
Age groups	**No Previous history of falls N = 347 N (%)**	**History of falls $N = 153$ N (%)**	**Total**	***P* value**
60–70 years	304 (91.6)	28 (8.4)	**332**	< 0.0001*
70–80 years	38 (24.7)	116 (75.3)	**154**	
> 80 years	5 (35.7)	9 (64.3)	**14**	
Total	**347 (69%)**	**153 (31%)**	**500**	

*Significant *P* value less than 0.05

Table 2 Association between history of dizziness and history of fall among elderly participants

	No previous history of falls $N = 347$ N (%)	History of falls $N = 153$ N (%)	Total	*p* value
History of dizziness				
Negative	127(79.8)	32 (20.2)	159	0.0014*
Positive	220 (64.5)	121 (35.5)	341	
Total	347	153	500	

*Significant *P* value less than 0.05

old reported much higher dizziness than participant under the age of 70 years old. Similar results were found regarding the history of falls, whereas participants older than 70 years old had a significantly greater history of falls than those younger than 70 years old (Table 1). Older participants with a history of dizziness experienced more falls than those without a history of dizziness (chi-square test; Table 2). Just 35% of participants with a history of falls had a history of dizziness, whereas only 20% of participants with a history of falls did not have a history of dizziness.

There was a history of diabetes mellitus (DM) in 184 (36.8%), a history of hypertension in 212 (42.4%), and a history of cardiovascular disease in 174 (34.8%) of the 500 older participants. A statistically significant association was found between the history of these systemic disorders and the history of falls using the Chi-square test (Table 3). There was a statistically significant association between the occurrence of orthostatic hypotension and a history of falls in only 3% of the study participants. However, there was no statistically significant association between sex and history of falls (Table 3). Most of the study group (91%) had an abnormal BMI. Like sex, no statistically significant association was found between an abnormal BMI and a history of falls (Table 3). As regards the hearing status of the participant subjects, 43 (8.6%) had normal hearing sensitivity; 457 (91.4%) had hearing loss; 370 (74%) of them had sensorineural hearing loss;

Table 3 Association between history of falls and presence of DM, hypertension, cardiovascular diseases, sex, BMI, and hearing assessment

	No previous history of falls ($n = 347$) N (%)	History of falls ($n = 153$) N (%)	*p* value
DM			
Negative	267 (84.5)	49 (15.5)	< 0.0001*
Positive	80 (43.5)	104 (56.5)	
Hypertension			
Negative	272 (94.4)	16 (5.5)	< 0.0001*
Positive	75 (35.4)	137 (64.6)	
Cardiovascular diseases			
Negative	277 (85)	49 (15)	< 0.0001*
Positive	70 (40.2)	104 (59.8)	
Sex			
Male	219 (68.9)	99 (31.3)	0.73
Female	128 (70.3)	54 (29.7)	
BMI			
Normal	32 (68.1)	15 (31.9)	0.84
Abnormal	315 (69.5)	138 (30.5)	
Hearing assessment			
Normal	29 (67.4)	14 (32.5)	0.95
Hearing loss	318 (66.9)	139 (30.4)	

*Significant *P* value less than 0.05

Table 4 Results of office vestibular tests in elderly of the 500 older participants

Office vestibular tests	Number (%)
Gaze evoked nystagmus	
Present	14 (2.8%)
Absent	486 (97.2%)
Saccade test	
Normal	465 (93%)
Abnormal	35 (7%)
Smooth pursuit test	
Normal	460 (92%)
Abnormal	40 (8%)
Spontaneous nystagmus	
Present	13 (2.6%)
Absent	487 (97.4%)
post head shake test	
Normal	475 (95%)
Abnormal	25 (5%)
Head impulse test	
Normal	484 (96.8%)
Abnormal	16 (3.2%)
Positioning test	
Normal	448 (89.6%)
Abnormal	52 (10.4)
Positional test	
Normal	457 (91.4%)
Abnormal	34 (8.6%)
Fukuda test	
Negative	424 (84.8%)
Positive	76 (15.2%)
modified CTSIB	
Negative	414 (82.8%)
Positive	86 (17.2%)
Romberg test	
Negative	485 (97%)
Positive	15 (3%)

Table 5 Qui Square test showing the association between the abnormal results of office vestibular tests and history of falls

	No previous history of falls (*n* = 347) N (%)	History of falls (*n* = 153) N (%)	*p* value
Gaze evoked Nystagmus			< 0.0001*
Absent	346 (71.2)	140 (28.8)	
Present	1 (7.1)	13 (92.9)	
Pursuit tracking			< 0.0001*
Normal	341(74.1)	119 (25.9)	
Abnormal	6 (15)	34 (85)	
Saccadic			< 0.0001*
Normal	335 (72)	130 (28)	
Abnormal	12 (34.3)	23 (65.7)	
Spontaneous Nystagmus			< 0.0001*
Absent	345 (70.8)	142 (29.2)	
Present	2 (15.4)	11 (84.6)	
Post head shaking test			< 0.0001*
Absent	341 (71.8)	134 (28.2)	
Present	6 (24)	19 (76)	
Head impulse test			< 0.0001*
absent	344 (71.1)	140 (28.9)	
present	3 (18.7)	13 (81.3)	
Positional nystagmus			< 0.0001*
Absent	337 (73.7)	120 (26.3)	
Present	10 (23.3)	33 (76.7)	
Positioning nystagmus			0.01*
Absent	319 (71.2)	129 (28.8)	
Present	28 (53.8)	24 (46.2)	
Fukuda test			< 0.0001*
Normal	324 (76.4)	100 (23.6)	
Abnormal	23 (30.3)	53 (69.7)	
Modified CTSIB			< 0.0001*
Normal	315 (76.1)	99 (23.9)	
Abnormal	32 (37.2)	54 (62.8)	
Romberg test			< 0.0001*
Normal	345 (71.1)	140 (28.9)	
Abnormal	2 (13.3)	13 (86.7)	

*Significant *P* value less than 0.05

30 (6%) had conductive hearing loss; and 57 (11.4%) had mixed hearing loss. Like sex and BMI, no statistically significant association was found between hearing status and falling (Table 3).

Table 4 shows the number and percentage of normal and abnormal results of office vestibular tests in the study group. The findings of the office vestibular tests in elderly participants with a history of falls are shown in Table 5 along with their statistical significance using the qui square test. There was a significant association between abnormal office vestibular test results and a history of falls. Multiple regression analyses were performed on the several parameters that demonstrated statistically significant associations with falls. Table 6 provides the unadjusted and multivariable-adjusted odds ratios (95% confidence interval CI) for these fall risk factors. After adjusting, the association between falls and each of the following: a history of cardiovascular disease, abnormal occulomotor tests, the presence of spontaneous nystagmus, an abnormal head impulse test, an abnormal post-head shake test, and an abnormal modified CTSIB test lost its significance. However, there is still a significant association between falling and each of the following factors: DM, hypertension, orthostatic hypotension, positional nystagmus, an abnormal Romberg test, and an abnormal Fukuda.

Discussion

Falls in older adults are costly to manage because they are a significant cause of morbidity and mortality. After the age of 60, the frequency and prevalence of falls, as well as the severity of the complications they cause, continue to increase [17]. Unintentional injuries are the fifth leading cause of death for individuals over the age of 65 in countries with a high income, following heart disease, cancer, stroke, and lung diseases [18]. They are responsible for 10% of emergency hospital visits and 6% of hospital admissions [19]. Even if there are no major injuries, the psychological effects of a fall on an elderly person can be severe, as they can cause dependency and self-protective immobility [20].

The high rate of falls among the elderly impairs their quality of life. Potential outcomes include long-term hospitalization, restrictions on physical activity due to injuries or fear of falling, changes in balance and postural control, social isolation, anxiety, and depression [21]. Post-fall syndrome, also known as fear of falling, is a form of post-traumatic stress disorder characterized by extreme anxiety when moving around and affects most elderly people [22]. In the elderly, recurrent falls are prevalent [23]. According to the 2011 "Global Report on Falls Prevention in Older Age" published by the World Health Organization, 35% of people aged 65 and older fall annually, while 42% of people aged 70 and older fall annually. The high frequency of falls increases the morbidity and mortality associated with them, necessitating measures to reduce their occurrence [24].

Table 6 Multiple regression analysis of factors associated with fall in elderly participants

Independent variables	Univariate analysis		Multivariate analysis	
	Crude OR (95% CI)	*P* value	Adjusted OR (95% CI)	*P* value
Age	1.33 (1.26 –1.41)	0.0001*	0.89 (0.78- 1.02)	0.1
DM	1.41 (0.93—0.22)	0.0001*	0.41 (0.19 -0.85)	0.02*
Hypertension	0.03 (0.02 – 0.06)	0.0001*	0.11(0.003–0.034)	0.0001*
cardiovascular diseases	0.12 (0.07 – 0.18)	0.0001*	0.75(0.34– 1.64)	0.48
Orthostatic hypotension	0.14 (0.04—0.43)	0.0001*	0.01 (0.001- 0.49)	0.0001*
Gaze Nystagmus	0.03 (0.004–0.24)	0.0001*	0.63 (0.05–8.03)	0.72
Pursuit tracking	0.06 (0.03–0.15)	0.0001*	0.28 (0.06–1.15)	0.07
Saccadic	0.2 (0.09–0.41)	0.0001*	0.98 (0.31–3.1)	0.98
Spontaneous Nystagmus	0.07 (0.02–0.34)	0. 001*	0.54 (0.09–3.2)	0.5
Head impulse test	0.09 (0.02- 0.33)	0.0001*	0.61 (0.11–3.3)	0.56
Post head shaking test	0.12 (0.04- 0.31)	0.0001*	1.31 (0.16–10.6)	0.79
Positioning nystagmus	0.47 (0.2–0.84)	0.01*	0.31 (0.12–0.8)	0.01*
Positional nystagmus	0.12 (0.05–0.22)	0.0001*	0.15 (0.02–0.85)	0.03*
Fukuda test	0.13 (0.07 – 0.23)	0.0001*	0.37 (0.15 – 0.9)	0.03*
Romberg test	0.06 (0.14 – 0.28)	0.0001*	0.034(0.003–0.42)	0.008*
Modified CTSIB	0.18 (0.11 – 0.31)	0.0001*	1.05 (0.47 – 2.37)	0.89

*Significant *P* value less than 0.05

This study examined 500 elderly participants attend audio-vestibular unit at Minia university hospital. 153 of 500 participants fell in the past two years. Over-70 s had a much higher fall rate than under-70 s. In contrast to our result, Chen et al. [25] found that 20.65% of elderly rural and urban Chinese fell. Their age varied from 60–83 ears old in urban area and 60–88 in rural area. Geetha et al. [26] found 27.6% falls in 250 elderly participants in a rural Indian study, which was fewer than our 31%. Like us, falls grew with age. Our results, which are consistent with those of Tinetti et al. [27], found that 30% of community-dwelling 65-year-olds fell annually. Ali et al. [28] found that 29% of elderly Suez Governorate health center visitors fell. Age predicted the fall history. Kamel et al. [29] found that age was significantly related to falls, with 15% of adults over 70 years old reporting at least one fall in the previous year compared to 5.2% of the same age group who did not fall. El Sayed et al. [30] found that 70 years old fell more often (p 0.001).

Like falls, nearly one-third of the study group (159 out of 500; 32%) had a history of dizziness, and we found a statistically significant association between age and dizziness. as dizziness was more common in participants over 70 years old. Older participants with dizziness fell more than those without. (Chi-square test; Table 2). 35% of those who fell experienced dizziness, while 20% did not. Elsayed et al. [30] found 16.3% of elderly had dizziness, which is lower than our finding. This study of 289 elderly participants found that 62.5% of fallers had dizziness and 37.5% did not. Dizziness was the only symptom found in multivariate analysis to independently predict falling. It can cause disequilibrium, and older people often can't quickly regain their balance; their physical fitness and skills can't prevent falling. Dizziness and the risk of falling were found to have similar significant associations in studies conducted in Sweden [31] and Greece [32].

Concerning health problems related to fall incidents in older participants, our results revealed that 184 (36.8%) of 500 older participants had a history of diabetes, 212 (42.4%) had a history of hypertension, and 174 (34.8%) had a history of cardiovascular disease. The chi-square test showed a significant association between falls and systemic disorders. Diabetes and fall risk mechanisms are unclear. Older adults with diabetes may suffer from peripheral neuropathy, retinopathy, vestibular dysfunction, cognitive impairment, and lower-limb musculoskeletal or neuromuscular lesions which showed an association with increasing risk of fall. Intensive glycemic control associated with hypoglycemia may be another possible reason for falls [33].

El Sayed et al. [30] found that older participants had higher rates of ischemic heart disease, hypertension, dyslipidemia, stroke, and diabetes. The total number of participants was 289. Their study found 87 (30.1%) had DM, 140 (48.4%) had hypertension, and 48 (16.6%) had ischemia of the heart. DM, hypertension, ischemia of the heart, and fall history were significantly associated. According to Mohammed et al. [34], faller had the most chronic diseases, including diabetes, hypertension, and arthritis. Diabetes, hypertension, and cardiac illness were 74.2%, 71.1%, and 43%, respectively. Duration, complications, gender, and age may explain the frequency differences in these chronic diseases across studies. They also discovered an association between diabetes, hypertension, ischemic heart, and a history of falls.

Falls and abnormal office vestibular tests were statistically significant in this study. Murray et al. [35] found that 75% of elderly participants discharged from the emergency department after a fall had vestibular and balance impairments. John et al. [36] also found that multiple causes cause elderly falls, including sensory deficits (visual, vestibular, and somatosensory), toxic factors (medications, alcohol), neurodegenerative processes (cortical, extrapyramidal motor, and cerebellar), and anxiety. Taha et al. [37] found that 66.6% of elderly people had vestibular and balance impairments with or without other balance issues. (As vision impairment, osteoarthritis). They discovered abnormal vestibular function tests in 60% of the Videonystagmography (VNG), 55% of the Vestibular Evoked Myogenic Potential (VEMP), and 70% of the Computerized Dynamic Posturography (CDP).

In our study, multiple regression of statistically important fall variables was done. DM, hypertension, orthostatic hypotension, positional and positioning nystagmus, abnormal Romberg and Fukuda tests, and falls were statistically significant. El Sayed et al. [30] found that hypertension and diabetes mellitus independently predicted elderly falls, and stroke has a big effect because it impairs physical and mental skills in elderly patients. According to Yamashita et al. [38] in Japan, hypertension independently predicts elderly falls. DM increases fall and injury risks due to neuropathy. Diabetics may fall due to reduced reactive balance to disequilibrium, according to Rosenblatt et al. [39] in the US. Corsinovi et al. [40] found that diabetes was the strongest risk factor for falling in an Italian university hospital's acute geriatric unit. Ali et al. [28] discovered a significant relationship between fall history and age, muscle weakness, depression, ischemic heart disease, visual impairment, fear of falling, postural hypotension, and polypharmacy.

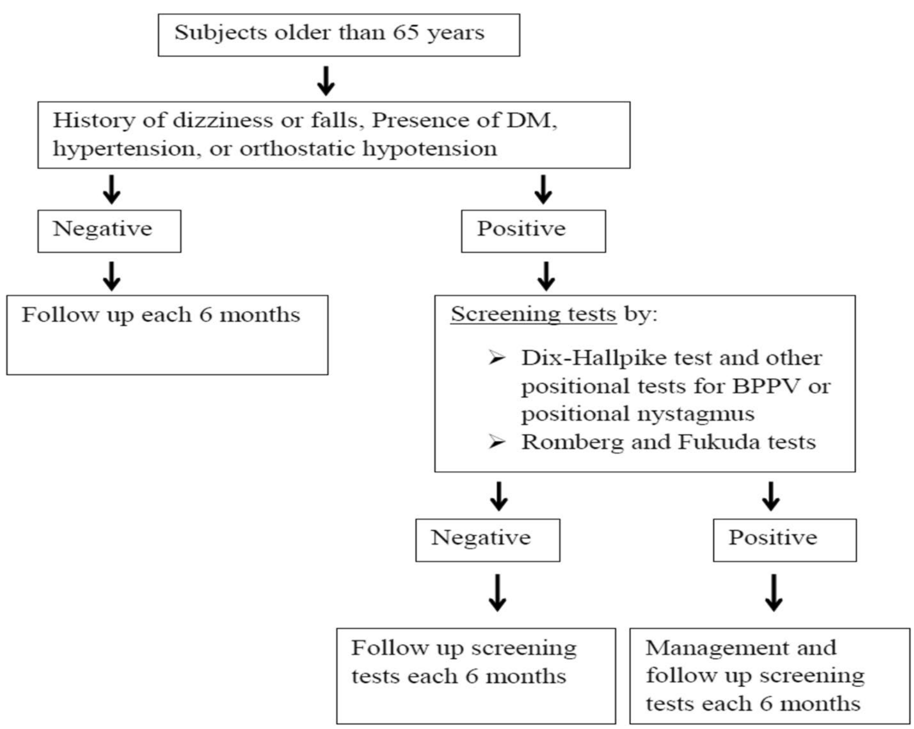

Fig. 1 Suggested screening chart for falls among elderly subjects attending the audio-vestibular clinic

Agrawal et al. [13] also suggested using the modified Romberg test of standing balance on hard and compliant support surfaces to screen for vestibular dysfunction and fall risk. The objective modified Romberg test showed that balance dysfunction increased considerably with age. Hansson and Magnusson [41] found that vestibular asymmetry in dizzy elderly people predicted falls. Thus, such patients need fall prevention programs. Furthermore, simple bedside tests for vestibular asymmetry could be used to screen for at least one risk factor for falls in the elderly. Fukuda test was included in the current study to screen for possible vestibule-spinal dysfunction which could predispose the elder subjects to falls. Although Bonanni and Newton [42] and Honaker et al. [43] found Fukuda test not reliable screening test for peripheral vestibular asymmetry in chronic dizzy patients, they suggested that the test can be used in combination with other vestibular tests. In the current study, Fukuda test was chosen as one of the simple, non-instrumental, and low cost office test to screen for vestibule-spinal dysfunction. It was incorporated with other office vestibular tests as Romberg and modified CTSIB test to screen for balance deficit and with the search for spontaneous and positional nystagmus and head impulse test to screen for vestibule-ocular deficit. Furthermore, all participants in the current study were chosen randomly (with and without dizziness and with and without previous history of falls). Multiple regression analysis demonstrated statistical significance of the Fukuda test as predictor for falls in elderly subjects. On the other hand, the multiple regression analysis excluded other tests as modified CTSIB from the predictors for falls. All the previous mentioned information about Fukuda test justifies its inclusion in the proposed screening protocol for fall in elderly subjects.

Limitations of the study

The collection of retrospective data on a person's history of falls, which may be subject to recall bias, is a major limitation of this study, and some elderly subjects may under-report the number of fall events, possibly leading to a lower prevalence rate reported in this study.

Conclusion

The predictors for falls in elderly subjects revealed by the current study include current history of dizziness, previous history of fall(s), presence of diabetes mellitus, hypertension, or orthostatic hypotension, presence of BPPV, presence of positional nystagmus, and abnormal test results in Romberg or Fukuda tests. The following chart is a suggested protocol for screening for falls in elderly subjects (Fig. 1).

Abbreviations

NHS	National Health Service
BMI	Body mass index
BPPV	Benign paroxysmal positional vertigo
CTSIB	Modified Clinical Test for Sensory Integration of Balance (modified
DM	Diabetes mellitus
VNG	Videonystagmography
VEMP	Vestibular Evoked Myogenic Potential
CDP	Computerized Dynamic Posturography

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Authors' contribution

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Dr. DF, Professor HS, and Dr AK. The first draft of the manuscript was written by Dr. DF and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Participants have been informed about the study aim and detailed procedures. Informed consent was obtained from all individual participants included in the study. The study was approved by the ethical research committee of Minia university (reference number 691/2023).

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interest.

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