Frequent Falls in the Elderly:

A Vestibular Physician's Deep Review of Multifactorial Fall Risk, Assessment, and Prevention

Vestibular Medicine for Vestibular Physicians

Systemic & Multisensory Balance Disorders — Module 4.6

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How to Use This Review

This literature review forms part of the Vestibular Medicine for Vestibular Physicians series published by the Australian Dizziness Clinics Education Hub. It is written for vestibular physicians, neuro-otologists, advanced ENT trainees, and vestibular physiotherapists working at the deep end of multisensory and systemic balance disorders, where a working command of mechanism, criteria, and atypical presentations is expected rather than optional.

The review is dense by design — intended as a 30–40 minute deep read or a desktop reference. It is supported by an A4 clinician cheat sheet, short-form clinician videos, audio episodes, and a patient information leaflet within the same Education Hub module.

Callout Box Guide

[] **Key Point:** Foundational concepts and summary statements that anchor the core clinical content of each section.

[] **Clinical Insight:** Clinically relevant observations for direct application in assessment and management.

[] **Clinical Pearl:** High-yield memorable clinical points — the take-home messages most likely to change practice.

[] **Important:** Red flags, atypical presentations, and critical safety points requiring escalation or imaging.

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I. Introduction and Epidemiology

Falls in older adults represent one of the most consequential public health problems facing contemporary medicine. Approximately one-third of community-dwelling adults aged 65 years and older fall at least once annually, rising to 40-50% in those over 80 years and to 50-60% in nursing home residents [1,2,3]. The World Health Organization estimates 684,000 fatal falls annually worldwide, with older adults bearing the greatest mortality burden [6]. Falls are the leading cause of injury-related death and hospital admission in this age group, accounting for 87% of all fractures in older people and representing the most common cause of traumatic brain injury [3,5].

Despite these figures, fewer than half of older adults who fall disclose this to their clinician, reflecting pervasive under-reporting and diagnostic neglect [2]. This creates a clinically important gap: falls that are not identified cannot be risk-stratified, and their modifiable contributors cannot be addressed. For the vestibular physician, the significance extends beyond epidemiology — vestibular dysfunction is a disproportionately common, frequently overlooked, and specifically treatable contributor to fall risk in this population [7,8].

Recurrent falls are defined as two or more falls within a 12-month period and signal substantially elevated risk for injurious falls and functional decline [1,4]. A single fall with injury or loss of consciousness warrants equivalent urgency. The concept of unexplained falls — falls without apparent mechanical cause after standard evaluation — is important in clinical practice because syncope, arrhythmia, and vestibular causes are overrepresented in this subgroup [8,9]. Correct classification of falls as recurrent, unexplained, or injury-related drives the depth and breadth of subsequent investigation.

Table 1. Epidemiology of falls in older adults — key measures by population group.

Population	Annual fall rate	Recurrent falls	Key consequence
Community-dwelling 65+	~30%	~15%	Hip fracture, head injury [2,3]
Community-dwelling 80+	~40%	~25%	Long lie, deconditioning [3]
Nursing home residents	50-60%	~40%	Fracture, mortality [5,6]
Post-stroke	~40-70%	~35%	Reinjury, loss of rehab gains [10]
Parkinson's disease	~60-70%	~45%	Hip fracture, fear of falling [11]

The economic burden is substantial. In Australia, fall-related hospitalisations cost an estimated AUD 2.5 billion annually, with hip fractures alone accounting for 40% of direct costs [1,12]. International data consistently show that each prevented hip fracture saves approximately USD 30,000-50,000 in acute and rehabilitation costs [12]. The evidence base for multifactorial fall prevention is robust: well-implemented programmes reduce fall rates by 20-35% and injurious fall rates by 25-40% in community settings [13,14].

Risk stratification is the practical entry point for the vestibular physician. Established risk factor categories include intrinsic factors (sensory, neurological, musculoskeletal, cardiovascular, cognitive, and medication-related) and extrinsic factors (environmental hazards, footwear, lighting). The Tinetti POMA score, Timed Up and Go (TUG), Short Physical Performance Battery (SPPB), and Dynamic Gait Index (DGI) are validated tools that translate multidomain impairment into a quantifiable fall risk estimate [15,16,17]. The vestibular physician's particular contribution lies in identifying and treating vestibular-sensory contributors that generalist assessments frequently miss.

[] **Key Point:** One-third of adults over 65 fall each year; 50% of nursing home residents fall annually. The vestibular physician must be equipped to identify vestibular-specific contributors within the multifactorial falls framework — these are both prevalent and specifically treatable.

II. Pathophysiology — Multifactorial Model of Falls

Falls result from a failure of postural control — the integrated system by which the central nervous system processes afferent sensory information, generates motor commands, and maintains the body's centre of mass within its base of support [7,16,18]. This system has substantial redundancy in young healthy adults,

but the cumulative effects of ageing and disease progressively erode reserve across all three major sensory channels: vestibular, visual, and somatosensory (proprioceptive). When the combined sensory deficit exceeds the individual's remaining reserve and adaptive capacity, a destabilising perturbation cannot be corrected and a fall results [7,18].

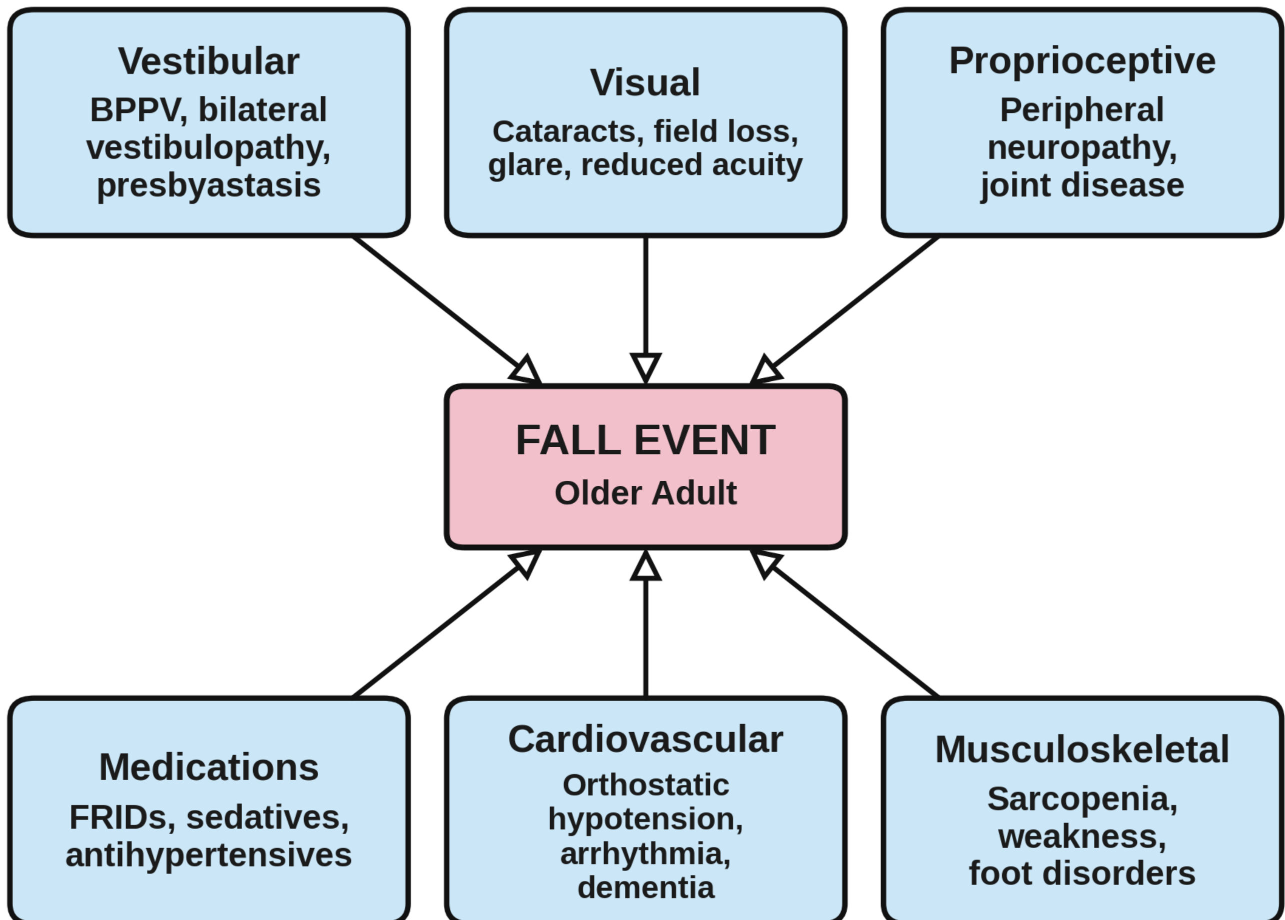

Figure 1. Multifactorial fall risk model — convergent failure across vestibular, visual, proprioceptive, musculoskeletal, cardiovascular, and pharmacological domains produces a fall when combined impairment exceeds the individual's compensatory reserve.

Source: Adapted from Lord et al. [7] and Tinetti & Kumar [18].

Vestibular Contributions to Falls

The vestibular system provides the primary reference frame for head and body position in space, drives the vestibulo-ocular reflex to stabilise gaze during movement, and contributes critically to vestibulo-spinal reflexes that maintain postural tone [7,19]. Age-related vestibular degeneration — presbyastasis — involves progressive loss of hair cells in the semicircular canals and otolithic maculae, reduced type I hair cell density, and declining endolymph production beginning in the fifth decade [20,21]. Histopathological studies demonstrate approximately 40% reduction in vestibular hair cell density by age 70 compared with young adults [20]. The resultant vestibular hypofunction manifests as increased postural sway, particularly on compliant surfaces and in conditions of reduced visual input — precisely the conditions of greatest fall risk [7,19,21].

BPPV is the single most common treatable vestibular cause of falls in older adults [22,23]. Pooled estimates from vestibular clinics demonstrate a two- to three-fold elevation in fall risk in untreated BPPV, with older patients (aged 70 and above) showing the greatest benefit from canalith repositioning

procedures in terms of subsequent fall reduction [22,23]. Bilateral vestibulopathy (BVP) — whether from ototoxic drug exposure, autoimmune disease, or idiopathic age-related degeneration — produces the most severe postural instability, characterised by total dependence on visual and somatosensory cues and catastrophic balance failure when these are compromised (Romberg positive, impaired tandem gait, oscillopsia during gait) [24,25].

Visual and Somatosensory Contributions

Age-related visual deterioration — reduced contrast sensitivity, impaired depth perception, cataract formation, and macular degeneration — substantially increases fall risk through degraded environmental perception and reduced ability to detect surface irregularities [7,26]. Cataract extraction produces a measurable reduction in fall rates (approximately 34% in women undergoing first-eye surgery) by restoring visual input quality [26]. Multifocal lens prescriptions paradoxically increase outdoor fall risk in active older adults by degrading depth perception in the inferior visual field during walking [26,27].

Proprioceptive impairment — most commonly from peripheral neuropathy (diabetic, nutritional, idiopathic) — removes the ground-contact feedback essential for fine balance correction [7,28]. Vibration sense loss at the ankles and reduced ankle dorsiflexion strength are the most clinically detectable markers of somatosensory fall risk [28]. When vestibular and proprioceptive deficits coexist — a common combination in older adults with multisensory disequilibrium — the individual is left solely dependent on vision for balance; any reduction in visual quality or lighting then produces near-total postural failure [7,18,28].

Cardiovascular and Pharmacological Mechanisms

Orthostatic hypotension (OH) — defined as a sustained reduction in systolic blood pressure of 20 mmHg or diastolic of 10 mmHg within three minutes of standing — is present in approximately 20-30% of community-dwelling older adults and in 50-60% of those in residential care [29,30]. It causes cerebral hypoperfusion, presyncope, and syncope, and is strongly associated with recurrent falls [29]. Causal mechanisms include autonomic degeneration (primary and secondary), hypovolaemia, antihypertensive medication, and deconditioning. Importantly, OH-related falls are frequently misclassified as mechanical trips because the prodrome is often not recalled [9,29].

Fall-Risk Increasing Drugs (FRIDs) represent the most immediately modifiable pharmacological contributor to falls [31,32]. Psychoactive medications — benzodiazepines, z-drugs, antidepressants (both TCAs and SSRIs), antipsychotics, and opioid analgesics — account for the largest attributable fraction of medication-related falls through sedation, impaired reaction time, reduced muscle tone, and orthostatic effects [31,32]. Polypharmacy (four or more regular medications) is an independent falls risk factor, reflecting drug interaction burden and cumulative anticholinergic load [32]. The AGS Beers Criteria and STOPP/START tool provide structured frameworks for identifying FRIDs that should be deprescribed or dose-reduced in older fallers [33].

Cognitive and Musculoskeletal Contributions

Cognitive impairment disrupts dual-task performance — the simultaneous execution of walking and a cognitive task — which is the most ecologically valid predictor of falls in community settings [34]. Dementia impairs frontal executive function that coordinates protective stepping responses; Parkinson's disease adds freezing of gait, shuffling, and impaired postural reflexes that cannot be overridden by voluntary correction [11,34]. Sarcopenia — age-related loss of skeletal muscle mass and strength, affecting 10-40% of adults over 65 — reduces the power required to execute protective stepping and catching reactions [7,35]. Reduced quadriceps strength is one of the strongest single predictors of falls in longitudinal cohort studies [7,35].

[] **Clinical Insight:** The key clinical concept in multifactorial falls is sensory redundancy failure — not any single impairment. A patient with mild vestibular hypofunction, mild peripheral neuropathy, and mild cataract may fall despite each deficit being individually mild. The vestibular physician must quantify sensory reserve, not just identify individual diagnoses.

III. Clinical Features and Red Flags

The clinical presentation of falls is heterogeneous, reflecting the diversity of underlying mechanisms. A detailed history of the fall circumstances — time of day, activity during fall, presence and nature of prodrome, recall of falling (distinguishing trip/slip from sudden collapse), witness accounts, and post-fall symptoms — is the single most diagnostically informative step [1,4,9]. Vestibular falls characteristically follow head movement (rolling in bed, turning, bending forward), are associated with vertigo or oscillopsia, and occur in the context of preceding dizziness complaints [22,23]. Syncopal falls are sudden, often without warning, and associated with amnesia for the event or a transient loss of consciousness that the patient does not recognise [9,29].

Symptom Patterns by Mechanism

BPPV-related falls are typically triggered by specific head positions — rolling in bed being the canonical provocation — and accompanied by brief (under one minute) rotational vertigo. The patient may describe 'stumbling when looking up' or 'nearly falling when bending to pick something up' [22,23]. Bilateral vestibulopathy produces a different pattern: falls on uneven surfaces, in low light, or when closing the eyes (Romberg-positive phenotype), without true vertigo but with a pervasive sense of disequilibrium [24,25]. The patient's gait is impaired specifically when visual cues are degraded — walking in the dark, on sand, or on wet grass [24].

Orthostatic falls occur within 30-180 seconds of standing, are preceded by lightheadedness or greying of vision, and are more frequent in the morning, post-meals, or after prolonged recumbency [29]. Falls in Parkinson's disease involve a distinctive pattern of retropulsion — backward falls triggered by a posterior perturbation — and freezing-related falls on carpet transitions or when turning [11]. Neuropathic falls are characterised by foot-drag, tripping on level surfaces, inability to correct for minor terrain changes, and pronounced worsening in darkness [28].

Red Flags Requiring Urgent Investigation

Several clinical features demand urgent investigation because they imply a high-risk aetiology that may be immediately life-threatening or rapidly progressive. The vestibular physician must recognise these red flags and act on them before attributing falls to a chronic multifactorial mechanism.

- Loss of consciousness during or immediately before the fall — implies cardiac arrhythmia, vasovagal syncope, or seizure; ECG and ambulatory monitoring are mandatory [9,29].
- Fall with new focal neurological deficit — dysarthria, hemiparesis, visual field loss, diplopia — implies stroke or TIA; urgent brain imaging and neurology referral [4].
- Fall with posterior cranial fossa symptoms — sudden severe occipital headache, double vision, ataxia, nausea disproportionate to vertigo — raises concern for posterior circulation stroke; MRI with DWI sequence within 24 hours [36].
- Prolonged long lie after fall — immobility for more than one hour; risk of rhabdomyolysis, pressure necrosis, dehydration, and aspiration pneumonia [4].
- Rapidly progressive balance deterioration without identifiable cause — warrants investigation for central pathology: cerebellar atrophy, normal pressure hydrocephalus, paraneoplastic cerebellar degeneration [36].
- Falls with autonomic features (pallor, diaphoresis, incontinence) — implies significant vasovagal or cardiovascular event rather than mechanical fall [9].

[] **Important:** Any fall associated with loss of consciousness, new neurological signs, or posterior fossa symptoms must be treated as a neurological or cardiac emergency until proven otherwise. Do not accept multifactorial falls as the working diagnosis when red flags are present.

IV. Diagnostic Approach — Structured Falls Assessment

The structured falls assessment is the cornerstone of evidence-based falls management. It integrates history, physical examination, and standardised performance measures to identify all modifiable risk domains and quantify overall fall risk. International guidelines — including the NICE 2013 falls guideline, the 2022 World Guidelines for Falls Prevention, and the AGS/BGS clinical practice guideline — are concordant in recommending a multidomain assessment for any older adult with recurrent falls or a single injurious fall [4,14,37].

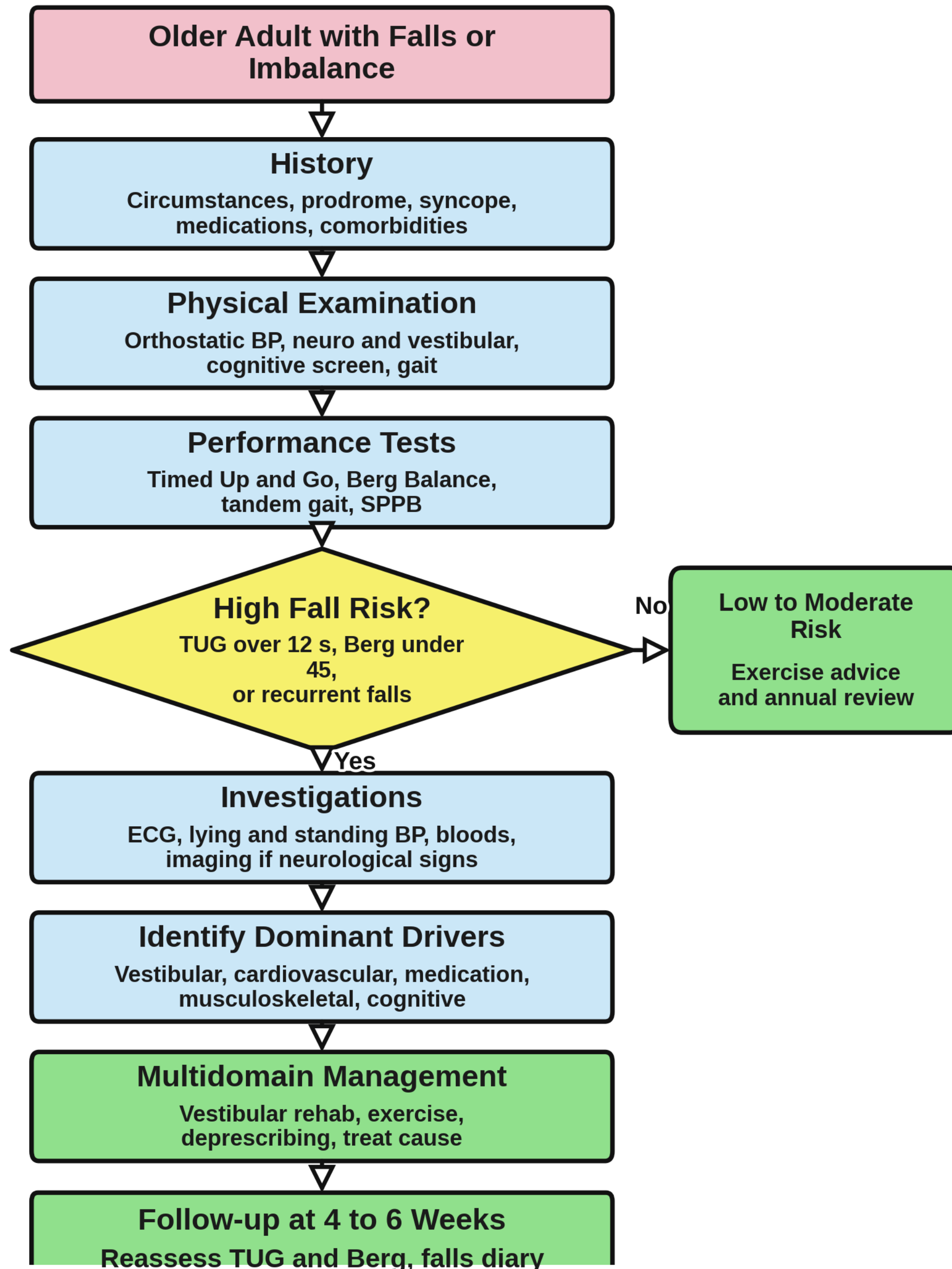

Figure 2. Structured falls assessment algorithm — from initial screen through history, physical examination, performance testing, risk stratification, investigations, and multidomain management.
Source: Adapted from NICE Falls in Older People [37], World Falls Guidelines [1], and Shumway-Cook et al. [16].

Standardised Performance Measures

Performance measures provide objective, reproducible quantification of fall risk beyond clinical impression. The Timed Up and Go (TUG) test — stand from a standard chair, walk 3 metres, turn, return, and sit — is the most widely used single measure; TUG greater than 12 seconds identifies high fall risk with 80% sensitivity and 56% specificity in community samples [15,16]. Addition of a dual-task condition (counting backwards during TUG) improves prediction by capturing executive-motor coupling deficits [34,15]. The Short Physical Performance Battery (SPPB) combines balance (four-stage stance tests), gait speed (4-metre walk), and chair-stands into a 0-12 score; SPPB 9 or below predicts hospitalisation, nursing home placement, and falls [17].

Table 2. Standardised fall risk assessment tools — description, cut-offs, and clinical utility.

Tool	Description	High-risk cut-off	Clinical strength
TUG	Stand, walk 3 m, return, sit	More than 12 seconds	Quick; predicts injurious falls [15]
TUG dual-task	TUG while counting backwards	More than 15 seconds	Captures executive-motor coupling [34]
BBS (Berg Balance Scale)	14-item balance test, 0-56	Below 45/56	Comprehensive; rehab tracking [38]
DGI (Dynamic Gait Index)	8 gait tasks, 0-24	Below 19/24	Detects vestibular gait deficits [16]
FGA (Functional Gait Assessment)	10 gait tasks, 0-30	Below 22/30	More sensitive than DGI in elderly [16]
SPPB	Balance + gait + chair stand, 0-12	9 or below	Predicts nursing home placement [17]
Romberg / Tandem Romberg	Static balance eyes open/closed	Cannot maintain 10 sec	Identifies vestibulo-spinal deficit [7]

History and Physical Examination

A complete falls history documents the circumstances of each fall (activity, time, location), the presence and nature of any prodrome (vertigo, lightheadedness, palpitations, visual change), whether consciousness was lost (and whether the patient has insight into this), witness accounts, injury sustained, and the patient's ability to rise independently [1,4]. Medication history must include all prescribed and over-the-counter medications, recent changes, and cumulative anticholinergic load. Inquiry about fear of falling is essential — post-fall syndrome (fear of falling leading to activity restriction and deconditioning) is present in 40-73% of fallers and is itself a major falls risk factor [39].

Physical examination for falls is comprehensive. Orthostatic blood pressure measurement (lying to standing at one and three minutes) is mandatory in any older faller [29,37]. Vestibular examination includes the Dix-Hallpike for BPPV, the video Head Impulse Test (vHIT) or clinical HIT for horizontal semicircular canal gain, and the Romberg test with eyes closed on both firm and foam surfaces [19,22]. Neurological examination assesses proprioception (vibration sense and joint position at the ankles and toes), lower limb strength, cerebellar function (heel-shin), and cognitive screen (MoCA or MMSE) [4,34]. Cardiovascular examination includes rhythm assessment and auscultation for aortic stenosis. Vision is assessed with a near Snellen chart [26,27].

[] **Clinical Pearl:** The Romberg test on foam distinguishes vestibular from somatosensory contributions to falls: patients with peripheral neuropathy fall on both hard and foam surfaces with eyes closed; patients with isolated vestibular loss are most impaired on foam (somatosensory cues also degraded). This distinction guides rehabilitation targeting.

V. Investigations — When and What to Order

Investigations in the older faller are directed by history and examination findings rather than applied universally. The clinical question is: which investigations will identify a modifiable cause, change management, or provide prognostic information that justifies the cost, inconvenience, and potential risk

of the test [4,9,37]? Routine laboratory work, cardiac investigations, vestibular function testing, neuroimaging, and bone density assessment each have specific indications in the falls context.

Table 3. Investigation indications and diagnostic yield in older fallers.

Investigation	Indication	Key finding	Action if positive
Orthostatic BP (lying to standing at 1 and 3 min)	All fallers	Drop of 20/10 mmHg or symptoms	Review antihypertensives; trial midodrine [29]
12-lead ECG	Unexplained falls, LOC, palpitations	Arrhythmia, heart block, AF, long QT	Holter monitoring; cardiology referral [9]
Holter/event monitor	ECG normal but LOC or pre-syncope	Paroxysmal arrhythmia	Pacemaker; antiarrhythmic therapy [9]
FBC, electrolytes, renal function, glucose	All fallers	Anaemia, hyponatraemia, hyperglycaemia	Treat underlying cause [4]
Vitamin D (25-OH)	All recurrent fallers	Below 50 nmol/L	Supplementation 800-2000 IU/day [13]
Vitamin B12	Peripheral neuropathy, cognitive change	Below 200 pmol/L	Supplementation or IM hydroxocobalamin [28]
Cognition (MoCA)	Any cognitive concern	Below 26/30	Neuropsychology; dementia workup [34]
DEXA bone density	Recurrent fallers, osteoporosis risk	T-score below -2.5	Bisphosphonate; calcium + vitamin D [12]

Vestibular Function Testing

Dedicated vestibular function testing provides objective quantification of semicircular canal and otolith function that clinical examination alone cannot supply [19,24]. The video Head Impulse Test (vHIT) measures horizontal canal VOR gain; gain below 0.8 with a catch-up saccade identifies unilateral or bilateral hypofunction [24,25]. Vestibular Evoked Myogenic Potentials (VEMPs) assess saccular (cervical VEMPs) and utricular (ocular VEMPs) function, providing otolith-specific information that is particularly relevant to falls risk [19,25]. Computerised Dynamic Posturography (CDP) — specifically the Sensory Organisation Test (SOT) — quantifies the relative contribution of vestibular, visual, and somatosensory inputs to balance and allows condition-specific fall risk profiling [16,19].

Neuroimaging

Routine neuroimaging is not indicated in straightforward recurrent mechanical falls with a clear multifactorial explanation [4,37]. Brain MRI is warranted when: (a) new focal neurological signs are present; (b) clinical features suggest normal pressure hydrocephalus (magnetic gait, urinary incontinence, cognitive impairment triad); (c) rapidly progressive ataxia without a clear cause; or (d) posterior circulation symptoms accompany falls (suspected posterior stroke or cerebellar disease) [36]. CT brain is indicated acutely after a fall with head injury, LOC, or anticoagulant use to exclude subdural haematoma [4].

[] **Clinical Insight:** Orthostatic blood pressure measurement is the most frequently omitted investigation in older fallers. A standing BP drop of 20 mmHg systolic — even without symptoms — is clinically significant in the context of falls. Measure at one and three minutes; measure post-meal if postprandial OH is suspected.

VI. Differential Diagnosis — Identifying the Dominant Driver(s)

Falls in older adults rarely have a single cause. The clinical task is not to identify the cause of falls but to characterise the dominant driver(s) — those that, if addressed, will produce the greatest reduction in future fall risk — within the multifactorial landscape [1,4,7]. Three domains are most commonly under-identified in standard geriatric assessments: vestibular-sensory causes, cardiovascular causes (particularly OH and arrhythmia), and medication-related causes. The vestibular physician is specifically positioned to address the first of these and to systematically work through the others [7,8].

Table 4. Differential diagnosis of recurrent falls — distinguishing clinical features.

Cause / Diagnosis	Characteristic features	Key investigation	Distinguishing test
BPPV	Triggered by head position change; brief rotational vertigo; no hearing loss	Clinical — Dix-Hallpike	Positive Dix-Hallpike with canal-specific nystagmus [22]
Bilateral vestibulopathy (BVP)	Disequilibrium on uneven surfaces; falls in dark; oscillopsia; no vertigo	vHIT, bithermal calorics	Bilateral reduced VOR gain (vHIT below 0.6) [24,25]
Orthostatic hypotension	Falls within 1-3 min of standing; morning predominance; post-meal worsening	Orthostatic BP measurement	Systolic drop 20 mmHg or diastolic drop 10 mmHg on standing [29]
Carotid sinus hypersensitivity	Unexplained falls in older men; neck rotation trigger; no prodrome	ECG during carotid sinus massage	Asystole 3 seconds or BP drop 50 mmHg with massage [9]
Cardiac arrhythmia	Sudden LOC without prodrome; palpitations; no recall of fall	ECG, Holter monitor	Arrhythmia correlating with symptom [9]
Peripheral neuropathy	Foot-drag, trips on flat surfaces; worse in dark; ankle vibration sense lost	Nerve conduction studies	Reduced conduction velocity + sensory amplitude [28]
Parkinson's disease	Retropulsion falls; freezing of gait; bradykinesia; rigidity	Clinical diagnosis; DATSCAN if uncertain	Unified PD Rating Scale — motor subscale [11]
Normal pressure hydrocephalus	Triad: magnetic gait, urinary incontinence, dementia	Brain MRI	Periventricular white matter change; enlarged ventricles [36]
Medication-related falls	New falls after starting/increasing FRID; polypharmacy; daytime sedation	Medication reconciliation	Temporal correlation; improvement with deprescribing [31,32]

The vestibular physician's differential must specifically distinguish BPPV and presbyastasis (peripheral causes) from central causes of positional instability: cerebellar degeneration, multiple system atrophy, and posterior fossa lesions can all produce falls with dizziness and may initially present to vestibular services [36]. HINTS criteria (Head Impulse, Nystagmus pattern, Test of Skew) and the presence of direction-changing nystagmus should be systematically assessed in any patient with new-onset dizziness and falls [36].

[] **Clinical Pearl:** In unexplained falls — falls without a clear environmental trigger and with amnesia for the event — the differential is cardiovascular syncope, not vestibular. Orthostatic BP, ECG, and carotid sinus massage should precede vestibular investigations in this subgroup.

VII. Vestibular and Sensory Causes of Falls

Vestibular dysfunction is present in a higher proportion of older fallers than most clinicians recognise. A prospective study of community-dwelling adults over 60 with recurrent falls found vestibular impairment in 34% using clinical and laboratory criteria [8]. The vestibular physician must be systematic in identifying the following vestibular-specific fall phenotypes and applying their respective targeted treatments [7,8,19].

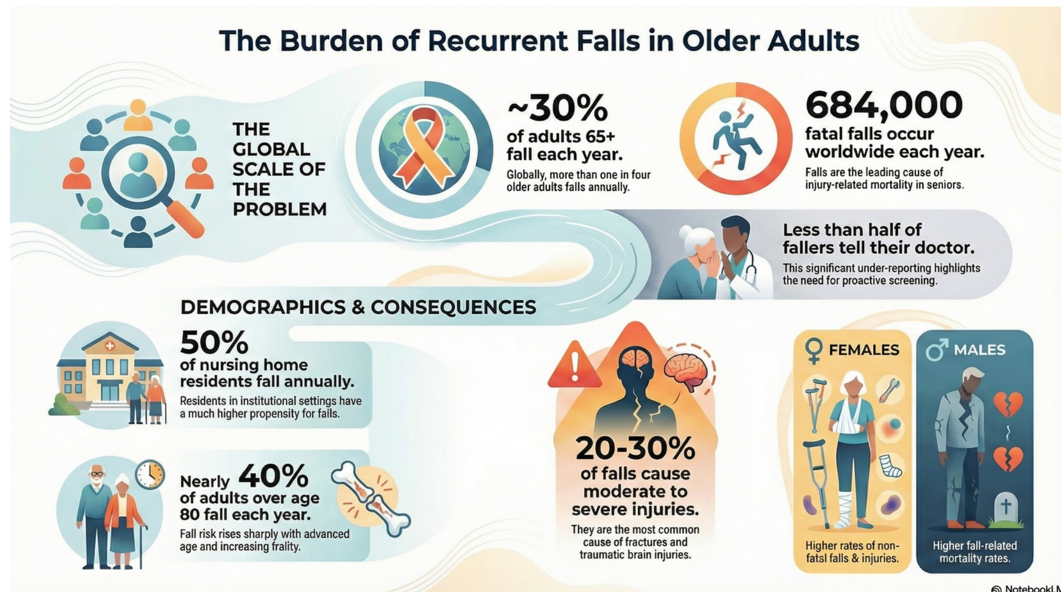

Figure 3. Burden of recurrent falls in older adults — epidemiological data including global fall rates, demographic patterns, injury consequences, and fatal fall mortality.

Source: Australian Dizziness Clinics educational infographic, adapted from WHO [6] and Hopewell et al. [13].

BPPV in the Falls Context

BPPV deserves particular emphasis because it is the most prevalent peripheral vestibular disorder and the most specifically treatable vestibular cause of falls [22,23]. The Barany Society criteria define definite posterior-canal BPPV by: (a) recurrent brief episodes of vertigo provoked by specific head movements; (b) Dix-Hallpike eliciting torsional-upbeating nystagmus with a latency of 1-5 seconds, duration under 60 seconds, and fatigability; and (c) absence of alternative explanation [22]. In the falls context, the diagnostic sensitivity of the Dix-Hallpike is reduced because older patients may not describe their falls as vertiginous — they describe them as 'suddenly losing balance' or 'the room going' [8,22,23].

Treatment of BPPV with the Epley manoeuvre (posterior canal) or the Gufoni/BBQ roll (horizontal canal) resolves the vertigo trigger and reduces falls. A randomised controlled trial by Bhattacharyya et al. (2017) confirmed guideline-level evidence that canalith repositioning reduces fall risk in older BPPV patients [23,40]. Repeat examination after treatment is essential — untreated residual BPPV or a canal conversion (from posterior to horizontal) will maintain fall risk despite apparent treatment [22,40].

Bilateral Vestibulopathy

BVP is defined by the Barany Society as bilaterally reduced or absent horizontal VOR gain (vHIT below 0.6 bilaterally or caloric responses below 6 degrees/second bithermal bilaterally), with the clinical syndrome of unsteady gait worsening in the dark and on uneven surfaces, and oscillopsia during head movement or walking [24,25]. Causes include ototoxicity (aminoglycosides, cisplatin), bilateral Meniere's disease, autoimmune inner ear disease, meningitis, and idiopathic age-related bilateral degeneration — the last being most prevalent in the falls context [24]. BVP patients are at extremely high fall risk because they lack the primary reference input for postural control and cannot compensate through habituation in the same way that unilateral vestibular loss patients can [24,25,41].

Management of BVP-related falls centres on vestibular physiotherapy targeting sensory substitution — training the patient to maximise proprioceptive and visual cues, and to adapt behavioural strategies (avoiding low-light conditions, using appropriate footwear on irregular terrain) [41]. Dynamic posturography-guided rehabilitation identifies the patient's specific sensory weighting profile and tailors exercises accordingly [16,19,41]. Environmental modification is critical: night lighting, non-slip surfaces,

and assistive devices for outdoor ambulation reduce the contexts in which the vestibular deficit is uncompensated [41].

Presbyastasis

Presbyastasis — or age-related vestibular loss — does not meet the criteria for BVP but represents a gradient of vestibular degeneration that accumulates across decades [20,21]. Patients report disequilibrium rather than vertigo, have mildly reduced postural stability on foam (Romberg positive), mildly impaired TUG on dual-task conditions, and normal or borderline vHIT gains [20,21]. Presbyastasis is clinically important because it reduces the safety margin against which other falls risk factors operate — a patient with presbyastasis and mild peripheral neuropathy has negligible sensory redundancy [7,21]. Vestibular rehabilitation targeting balance training, sensory re-weighting, and lower limb strengthening is the primary management [41].

Orthostatic Hypotension as a Vestibular Mimic

OH warrants specific attention in the vestibular physician's differential because patients with OH frequently present to vestibular services describing dizziness and unsteadiness [29,42]. The OH symptom complex — lightheadedness, greying of vision, swimmy head sensation on standing — can be indistinguishable from vestibular imbalance on history alone. Orthostatic BP measurement is therefore mandatory before attributing any older faller's dizziness to a vestibular cause [29,42]. When both OH and vestibular dysfunction coexist — a common combination in older Parkinson's patients — both must be independently addressed [11,29].

Table 5. Vestibular and sensory causes of falls — specific management strategies.

Cause	Diagnosis	Specific treatment	Expected outcome
BPPV (posterior canal)	Positive Dix-Hallpike; torsional-upbeating nystagmus	Epley manoeuvre; repeat if required	80-95% single-session resolution; falls reduced [22,23,40]
BPPV (horizontal canal)	Supine roll test; geotropic/apogeotropic nystagmus	Gufoni manoeuvre or BBQ roll	70-85% resolution; repeat in 48 hours [22]
Bilateral vestibulopathy	Bilateral vHIT below 0.6; caloric suppression	VPT: sensory substitution; environmental modification	Improved balance scores; fall rate reduction [41]
Presbyastasis	Mild bilateral reduction; foam Romberg positive	Balance training; lower limb strengthening; sensory challenge	Reduced TUG; improved SPPB [21,41]
Peripheral neuropathy	Vibration loss at ankles; NCS slowed	Vitamin B12 if deficient; balance training; appropriate footwear	Modest improvement in sensory ataxia; fall reduction [28]

[] **Clinical Pearl:** Screen all older fallers for BPPV with the Dix-Hallpike — even when vertigo is not the presenting complaint. Older patients with BPPV often present with balance problems or unsteadiness rather than typical rotational vertigo, and the Dix-Hallpike will be missed unless it is performed as a reflex component of the falls examination.

VIII. Multidomain Management

Effective falls management requires simultaneous intervention across all identified risk domains rather than a single targeted therapy. The evidence base for multifactorial intervention programmes is strong: a Cochrane review of 62 trials (Hopewell et al., 2018) confirmed that multifactorial programmes reduce fall rates by 23% (rate ratio 0.77, 95% CI 0.67-0.87) in community-dwelling older adults and reduce injurious falls by a similar magnitude [13]. The key is programme individualisation — assessing each domain and tailoring intervention intensity to the patient's specific risk profile [1,13,14].

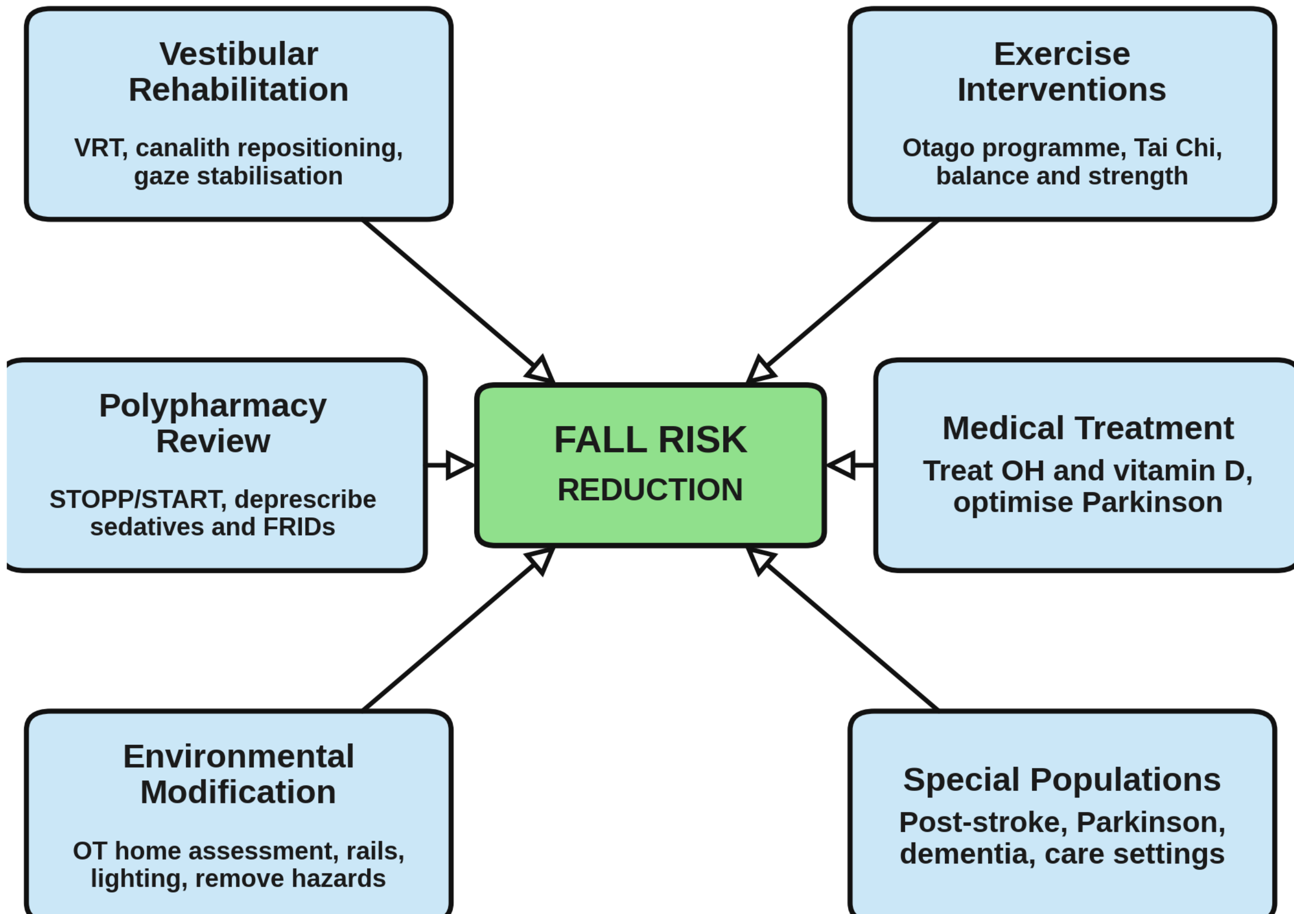

Figure 4. Multidomain intervention framework for falls prevention — six simultaneous domains converge on fall risk reduction: vestibular rehabilitation, exercise, polypharmacy review, environmental modification, targeted medical treatment, and special population considerations.

Source: Adapted from Gillespie et al. [14], Hopewell et al. [13], and Lord et al. [7].

Vestibular Rehabilitation

Vestibular physiotherapy (VPT) is the most evidence-based intervention for vestibular causes of falls. For BPPV, canalith repositioning (Epley or variant manoeuvres) is curative in 80-95% of posterior-canal cases at a single session [22,23,40]. For vestibular hypofunction (unilateral or bilateral), structured VPT programmes incorporating gaze stabilisation exercises, habituation exercises, and balance re-training reduce fall rates by 30-50% compared with no treatment in randomised controlled trials [41,43]. The Whitney 2000 intervention framework, widely adopted in VPT practice, stratified rehabilitation exercises to the Dizziness Handicap Inventory score and demonstrated significant falls reduction in a community vestibular cohort [43]. VPT also addresses presbyastasis through sensory re-weighting exercises on compliant surfaces and in reduced-vision conditions [41].

Exercise Interventions

Exercise is the single most effective non-pharmacological intervention for community fall prevention [13,14,44]. The Otago Exercise Programme — a home-based programme of lower limb strengthening and progressive balance exercises developed and validated in New Zealand — achieves a 35% reduction in falls (rate ratio 0.68) and a 30% reduction in injurious falls in community-dwelling older adults, with efficacy maintained in those aged 80 and above [44]. Tai Chi specifically reduces fall risk by approximately 25% (multiple meta-analyses; most recently Lam et al.) through improvements in dynamic balance, lower

limb strength, and dual-task performance [44,45]. NICE 2013 recommends strength and balance training as the first-line exercise intervention for all community fallers [37].

Table 6. Exercise interventions for falls prevention — evidence and recommendation level.

Programme	Components	Evidence (fall rate reduction)	Recommended population
Otago Exercise Programme	Lower limb strengthening + progressive balance; home-based	RR 0.68 (35% reduction); RCT level 1 [44]	Community-dwelling 65+; highest benefit in 80+
Tai Chi (group or individual)	Dynamic balance; coordination; weight shifting	~25% fall reduction; multiple RCTs [44,45]	Community-dwelling; motivated; good cognition
VPT-based balance training	Gaze stabilisation; sensory challenge; surface variation	30-50% reduction in vestibular fallers [41,43]	Vestibular hypofunction; BVP; presbyastasis
SPPB-guided physiotherapy	Graded to SPPB score; includes gait training	Improves SPPB by 0.8-1.5 points [17]	Frail older adults; post-hospitalisation
Hospital-based group exercise	Resistance + balance; supervised; social	18% fall reduction (RCT [14])	Residential care; nursing home residents
Dual-task training	Motor + cognitive task combined; obstacle courses	Reduces dual-task cost by 20% [34]	Mild cognitive impairment; Parkinson's

Polypharmacy Review and Deprescribing

Medication review is one of the highest-yield single interventions in falls management because FRIDs are prevalent, identifiable, and modifiable [31,32]. The STOPP (Screening Tool of Older Persons' Prescriptions) criteria identify inappropriate medications in older adults with particular attention to falls risk, including benzodiazepines, anticholinergic drugs, antipsychotics, and antihypertensives in the context of postural hypotension [33]. A single pragmatic randomised trial (Campbell et al.) demonstrated a 66% reduction in falls with withdrawal of psychotropic medications — the largest single-intervention falls reduction reported in the literature [32]. Deprescribing is not always possible, but even dose reduction (halving benzodiazepine dose, for example) produces measurable falls benefit [31,32].

Common categories of FRIDs that the vestibular physician should specifically flag: vestibulotoxic drugs (aminoglycosides, furosemide, quinine, cisplatin — all capable of causing or worsening bilateral vestibulopathy); ototoxic chemotherapy agents; antiepileptic drugs (particularly carbamazepine and phenytoin, which impair cerebellar function at subtherapeutic as well as toxic levels); and diuretics causing hypovolaemia and exacerbating OH [31,32,42]. The vestibular physician reviewing a patient with bilateral hypofunction must always obtain a comprehensive drug history before attributing the hypofunction to idiopathic age-related disease [24,25].

Environmental Modification

Home environment assessment by an occupational therapist (OT) identifies hazards — loose rugs, poor lighting, absence of grab bars, low toilet and chair heights — that precipitate falls in older adults with impaired balance [13,37]. A Cochrane review demonstrated that home assessment by an OT reduces falls by approximately 21% in those at high risk (OR 0.79, 95% CI 0.64-0.97) [13]. Key interventions include: installation of grab bars in bathrooms, improved stair lighting, removal of trip hazards, non-slip surfaces in bathrooms, appropriate bed and chair heights, and provision of non-slip footwear [4,37]. Pathway lighting (motion-sensor activated) significantly reduces nocturnal falls, which are disproportionately common in older adults taking diuretics or sedatives [37].

Vitamin D Supplementation

Vitamin D deficiency (25-OH-D below 50 nmol/L) is prevalent in Australian older adults, particularly those with limited sun exposure, residential care residents, and patients with dark skin [3,13]. Vitamin D deficiency impairs muscle function, reduces proprioceptive sensitivity, and decreases bone mineralisation, all contributing to fall risk [13]. Supplementation with 800-2000 IU cholecalciferol daily reduces falls in vitamin D-deficient older adults (RR 0.83 in a large meta-analysis [13]); benefit in those with normal levels is less certain but supplementation is low-risk. Co-prescription of calcium (500-1200 mg/day) is standard when dietary intake is low [13].

> [] **Clinical Insight:** Exercise prescription for falls must be dose-adequate: the Otago Programme requires a minimum of three sessions weekly for 12 weeks to achieve the 35% fall rate reduction demonstrated in trials. Brief advice to exercise more is not equivalent to a structured, supervised programme and does not carry the evidence base.

IX. Special Populations

Several clinical subgroups require adaptation of the standard falls assessment and management framework to their specific physiological and clinical context. The vestibular physician is likely to encounter these subgroups within a falls service and must be equipped to modify the standard approach accordingly [1,4,11].

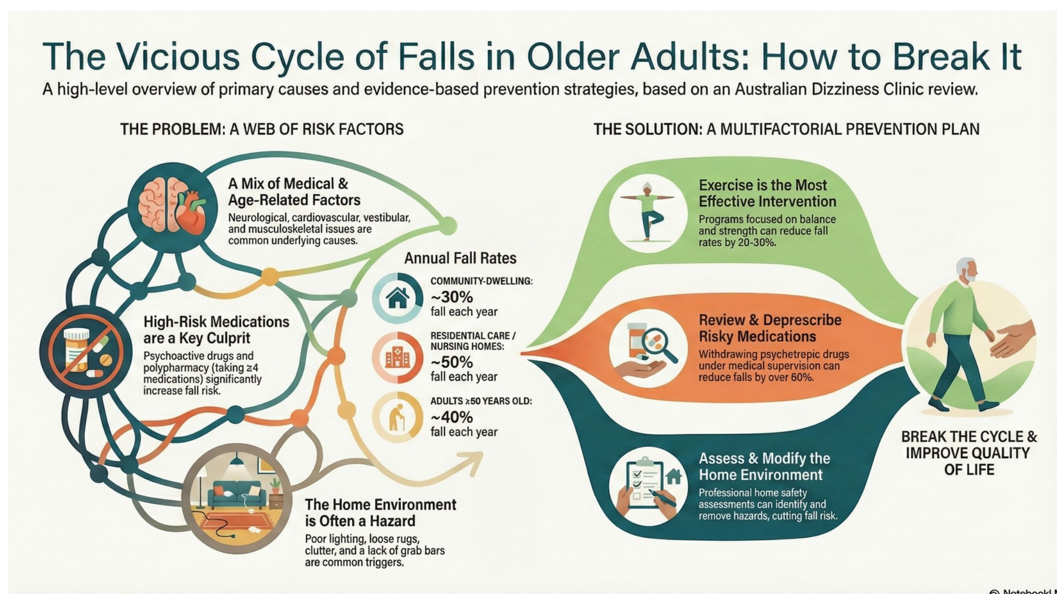

Figure 5. The vicious cycle of falls in older adults — risk factor web, annual fall rates by population group, and the principal prevention targets at each node.

Source: Australian Dizziness Clinics educational infographic, adapted from Lord et al. [7] and Tinetti & Kumar [18].

Nursing Home Residents

Nursing home residents have the highest fall rate of any care setting (50-60% annually) and the highest rate of injurious falls, driven by the concentration of multiple severe fall risk factors [5,6]. The management framework must accommodate cognitive impairment that limits the patient's ability to participate in self-directed exercise, reduced mobility requiring supervised rather than home-based exercise, and institutional environmental factors [1,5]. Evidence-based interventions specifically effective in residential care include: individualised physiotherapy programmes, supervised group exercise sessions (18% fall reduction, RCT level [14]), review of antipsychotic and sedative prescribing, provision of hip protectors in falls-prone residents, and staff education in falls response protocols [1,5].

Post-Stroke Patients

Stroke survivors fall at two to four times the rate of age-matched community controls, with fall risk highest in the first six months post-event [10]. Contributing factors are heterogeneous: hemiparesis, foot drop, visuospatial neglect, hemianopia, spasticity, post-stroke depression, and medication burden all interact [10]. Vestibular dysfunction is additionally prevalent after posterior circulation stroke, adding a vestibular-specific contribution to the already elevated fall risk [36]. Task-specific gait and balance training in the post-stroke period achieves the best functional outcomes; constraint-induced movement therapy and dual-task training are supported by randomised evidence [10,16].

Parkinson's Disease

Falls in Parkinson's disease are multifactorial, involving motor deterioration (freezing, retropulsion, rigidity), autonomic dysfunction (OH), and cognitive impairment [11]. Retropulsion — backward falls triggered by minor posterior perturbations — is a particularly lethal fall pattern in PD and requires specific training in protective stepping responses [11]. The LSVT BIG programme (Lee Silverman Voice Treatment, adapted for motor function) improves movement amplitude and reduces falls in PD at the RCT level [11]. Optimisation of dopaminergic therapy reduces freezing and improves gait, but must be balanced against OH from dopamine agonists; carbidopa-levodopa is generally preferred over dopamine agonists in older PD patients specifically because of its lower orthostatic effect [11].

Post-Fall Syndrome

Post-fall syndrome — the development of fear of falling, activity restriction, deconditioning, and social withdrawal following an index fall — is present in 40-73% of fallers and is itself a major risk factor for subsequent falls [39]. The psychological and physical components of the syndrome mutually reinforce: fear reduces activity, deconditioning worsens balance, worse balance increases fall likelihood, which amplifies fear [39]. Cognitive-behavioural therapy (CBT) combined with graded exercise has the best evidence base for reducing fear of falling [39]. The Falls Efficacy Scale-International (FES-I) is the recommended patient-reported outcome measure, with scores above 22/64 indicating clinically significant fear of falling [39]. Vestibular rehabilitation that improves objective balance performance also reduces fear of falling as a secondary benefit [41,43].

[] **Clinical Insight:** Post-fall syndrome is under-diagnosed and under-treated. Screen for it explicitly using the FES-I or by asking directly: 'Are you avoiding activities because you are worried about falling?' Activity restriction from fear is a stronger predictor of future falls than performance measures in some cohorts.

X. Guidelines, Evidence Base, and Future Directions

The evidence base for falls prevention and management is among the most mature in geriatric medicine. Multiple systematic reviews and meta-analyses — most authoritatively the Cochrane review by Hopewell et al. (2018) [13], the AGS/BGS 2010 guideline [4], and the 2022 World Guidelines for Falls Prevention [1] — provide converging recommendations. Key evidence-based recommendations are graded in the NICE 2013 guideline [37] and summarised here.

Guideline Recommendations

- Multifactorial falls risk assessment should be offered to all older people who present to a healthcare professional with a fall, report recurrent falls in the past year, or demonstrate abnormal gait or balance [37].
- Strength and balance training is recommended as the first-line intervention for community fallers and should be offered as a structured programme rather than generic exercise advice [37,44].
- Home hazard assessment and modification by an OT reduces falls in high-risk older adults and should be offered to all those identified as at high risk [13,37].
- Medication review with targeted reduction of FRIDs should be part of every multifactorial falls assessment; withdrawal of psychotropic medications has the strongest single-drug evidence base [32,33,37].

Vitamin D supplementation (800-2000 IU daily) is recommended for older adults with confirmed deficiency; evidence for prevention in those with normal levels is insufficient to make a universal recommendation [13,37].

Cardiac assessment including orthostatic BP, ECG, and carotid sinus assessment should be performed in all older fallers with unexplained falls or LOC [4,9,37].

Vestibular assessment with Dix-Hallpike and clinical HIT/vHIT should be incorporated into the standard falls assessment in any older faller with dizziness or balance complaints [22,37].

Controversies and Evidence Gaps

Despite the strength of the exercise evidence, adherence to structured exercise programmes remains the Achilles heel of falls prevention in real-world settings — typically 50-60% of participants in clinical trials, likely lower in routine practice [44]. The implementation gap — the discrepancy between guideline recommendation and delivered care — is the primary barrier to population-level falls reduction [1]. Digital health technologies, including remotely monitored exergaming, wearable balance sensors, and smartphone-based Otago programme apps, show early promise for addressing adherence but require validation in adequately powered RCTs [46,47].

The benefit of vitamin D in falls prevention remains contested. A 2022 meta-analysis by Trajanoska et al. found no significant falls reduction with supplementation in community-dwelling adults with adequate levels; the protective effect appears confined to those with established deficiency [13]. High-dose supplementation (60,000 IU monthly or above) has shown paradoxical increases in fall risk, possibly through mechanisms related to differential VDR expression in muscle [48].

Hip protectors demonstrate inconsistent efficacy across trials, with strong evidence in per-protocol nursing home analyses but loss of significance in intention-to-treat analyses due to adherence failures [5]. The optimal design of hip protector devices and delivery systems to improve adherence is an active area of investigation [5]. Anti-slip footwear devices in icy conditions have pilot-level evidence for reducing outdoor falls in winter — relevant in Australian alpine regions and cold climates [2].

Future Directions

The most promising near-term advances in falls management are: (a) wearable sensor-based real-time fall detection systems that enable immediate response and precise biomechanical characterisation of fall risk [46,47]; (b) personalised medicine approaches to exercise prescription that match programme design to the patient's specific sensory deficit profile (vestibular, proprioceptive, visual) rather than using a one-programme-fits-all approach [41,47]; (c) systematic integration of vestibular assessment into geriatric falls services — currently vestibular testing is available in fewer than 20% of dedicated falls clinics in Australia [8]; and (d) pharmacological approaches to presbyastasis — preliminary work suggests that vestibular hair cell regeneration may be achievable with Wnt/Notch pathway modulators, though clinical application remains a decade away [21,49].

From a public health perspective, population-level falls prevention — mass-participation community exercise programmes, home hazard awareness campaigns, and medication review initiatives embedded in primary care — has the greatest potential for burden reduction. The WHO Decade of Healthy Ageing (2021-2030) identifies falls prevention as a core component of intrinsic capacity maintenance, providing an international policy framework for scaling evidence-based interventions [6,50].

[] **Key Point:** No single intervention prevents falls as effectively as a well-implemented multifactorial programme. The vestibular physician's unique contribution is systematic identification of vestibular-specific fall contributors — BPPV, bilateral vestibulopathy, presbyastasis, vestibulotoxic medications — and applying targeted treatments that reduce falls in addition to the standard multidomain interventions.

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