

## Part 5 Falls Risk Factors



## 5. Falls Risk Factors

### 5.1 Risk Factor Classification

There are numerous ways to classify risk factors for falls and fall-related injuries which will often determine the intervention required during the life course. These classifications include the following issues.

#### 5.1.1 Intrinsic versus Extrinsic

Typically, risk factors have been grouped into two main categories:

- › intrinsic factors (within the individual) and include both demographic (e.g. age and gender) and health factors (e.g. medical conditions and medications)
- › extrinsic factors involve either the physical environment (e.g. obstacles and tripping hazards) or socio-economic environment (e.g. living alone and lack of support networks) <sup>[77, 78]</sup>.

Falls among older people under 75 years are more likely to be associated with extrinsic factors while intrinsic factors are more important among people aged 80 and over <sup>[78, 79]</sup>.

#### 5.1.2 Modifiable versus Non-modifiable

Modifiable risk factors are those that can be altered such as, for example, physical inactivity or impaired vision due to cataracts. Changing the risk factor potentially reduces the risk. Even untreatable risk factors that are not modifiable (e.g. age, past history of a fall) may be useful for identifying those at greater risk <sup>[80]</sup> who may benefit from interventions that may prevent general falls and falls injury.

#### 5.1.3 Single versus Multiple

Often it is not possible to identify a single specific cause for falling as falls are usually multifactorial in their origin <sup>[37]</sup>. The majority of falls result from interactions between long-term or short-term predisposing factors and short-term precipitating factors in a person's

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environment <sup>[38]</sup>. Risk of falling increases exponentially as the number of risk factors increases <sup>[38, 81, 82]</sup>. There is a continuum of falls risk that ranges from no risk to high risk. There can be a cumulative effective of mild levels of risk for a person with a small number of risk factors which may place them at a moderate level of risk overall.

### 5.1.4 Host, Agent or Environmental Factors

Haddon's injury matrix conceptualises injury in terms of interacting factors (host, agent, and environment) and phases (pre-event, event, post-event), when these factors are likely to cause injury <sup>[83]</sup>. The matrix can be used to design effective interventions to prevent or minimise injury at each of these phases <sup>[83]</sup>. For fall-related injuries, host factors correspond to intrinsic factors and environmental factors to extrinsic factors in the physical or social environment. Agent factors which play an important role in fall-related injuries include the height and direction of the fall, and the capacity of the body or landing surfaces to absorb energy.

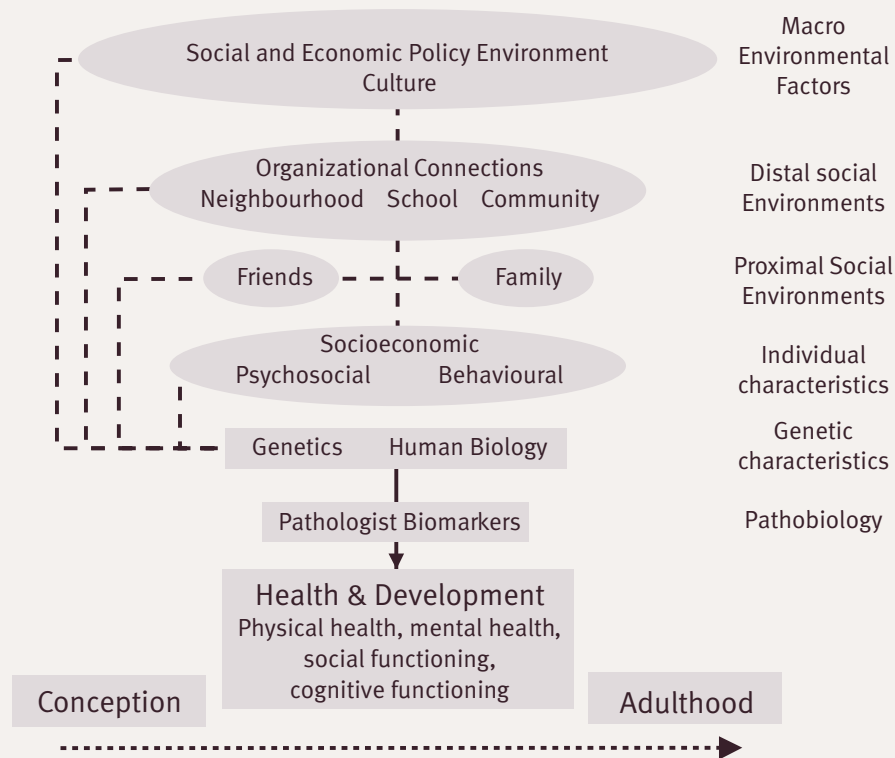
Refer to <http://www.health.qld.gov.au/stayonyourfeet> for the application of Haddon's injury matrix in preventing falls.

### 5.1.5 Life Course Risk Factors

The life course approach recognises that many health conditions experienced in later life may arise either as an accumulation of risk or as exposure to risk factors at critical periods of life <sup>[84]</sup>. These can be socio-demographic, behavioural, biomedical, genetic, environmental, or other factors and these can act independently or in combination <sup>[84]</sup>. For example, behavioural factors such as smoking, excessive alcohol use, physical inactivity and poor diet in adolescents and young adults can affect peak bone mass and contribute to later development of osteoporosis and risk of fall-related fractures <sup>[85]</sup>. The chain of causes from socio-economic factors through environmental and community conditions to individual behaviour offers many different points

for intervention, as illustrated in the life course model of health determinants (Figure 5.2) [5, 86] .

**Figure 5-2: Life Course Model of Health Determinants**



Source: Lynch, 2000 [86]

## 5.2 Evidence-based Falls Risk Factors

A number of reviews have examined the evidence of risk factors for falls [35-37, 78, 87] and fall-related injuries [88]. Based on these reviews, factors associated with increased risk of falls and fall-related injuries in community-dwelling older people include the following factors.

### 5.2.1 Socio-demographic Factors

A previous fall is a strong single predictor for future falls. Falls are also generally considered to be a marker of frailty and decreased mobility [35]. Therefore with increasing age, an individual’s risk of falling also increases. Most overseas studies in community settings

have also shown women are at higher risk, as are those of Caucasian ethnicity compared with Afro-Americans, Hispanics or South Asians [78]. Additional risk factors for falling include living alone [78] and having poor social networks [87]. Furthermore living alone and/or having poor social networks may be associated with other fall risk factors such as poorer diet, difficulties in activities of daily living, lower levels of physical activity, and fewer resources in times of need [89].

### 5.2.2 Psychological Factors

Psychological factors such as fear of falling, depression, impaired cognition and risk taking behaviours are associated with increased falls risk [35, 78, 87]. Fear of falling, and avoidance of activities due to fear of falling, are strongly correlated with multiple falls [90]. The relationship between falls and fear of falling is cyclical – falls are an independent predictor of developing fear of falling and fear of falling is a predictor of subsequent falls [91]. The result is a spiralling risk of falls, fear of falling, and functional decline [91]. A range of social, psychological, and physical risk factors for disability are associated with persistence of fear of falling including living alone, cognitive impairment, depression, and impairments in balance and mobility [92]. Additional factors that are shared risks for depression and falls are self ratings of poor health, poor cognitive status, impaired activities of daily living, and slow walking speed [93]. Recent studies have shown that sleep disturbances [94, 95] and/or abnormal sleep patterns [96, 97] are risk factors for falls. There are suggestions that psychological disturbance, particularly depression, may be an intermediary factor in the association between poor sleep quality and falls [94]. Medications for treating psychological conditions such as sleep disturbance, anxiety and depression can increase the risk of falls, indicating that prescription of these medications should be monitored closely. Psychological risk factors may respond to non-pharmacological interventions, including cognitive and behavioural therapy [98, 99].

### 5.2.3 Impaired physical function

Limitations in the activities of daily living (ADL) have been shown to increase falls risk. Limitations can be caused by impaired balance/mobility/walking ability (gait) or muscle weakness resulting in physical functioning dropping below the threshold where activities of daily living can be carried out <sup>[78]</sup>. Any lower limb disability is a major risk factor for falls, for example, muscle weakness, orthopaedic abnormality or poor sensation <sup>[78]</sup>. Difficulty rising from a chair is also associated with increased risk <sup>[78]</sup>.

### 5.2.4 Sensory and neuromuscular impairments

Sensory or neuromuscular impairments that are risk factors for falls include deficits in vision, peripheral sensation, proprioception, vestibular function and reaction time. An individual will have increased risk of falling with vision deficits, including reduced visual acuity, contrast sensitivity and depth perception, and eye diseases such as macular degeneration and cataracts.

Falls risk is also increased with deficits in peripheral sensation (e.g. peripheral neuropathy), which reduce the ability to sense touch or vibration at the lower limbs which result in instability. Therefore individuals with medical conditions that exhibit these symptoms (e.g. diabetes) will be at increased risk of falls. Adequate visual, somatosensory and vestibular acuity contribute to the detection of postural disturbances and environmental hazards, while adequate strength and reaction time permit appropriate corrections to postural imbalance <sup>[35]</sup>. There is evidence emerging that there are strong links between vestibular function and falls: when individuals present with a potential vestibular condition there should be further investigation and management.

### 5.2.5 Medical conditions

Many falls occur as the result of acute and chronic medical conditions <sup>[35]</sup>. Many medical conditions have been associated with increased falls and injury risk and those with multiple chronic illnesses experience higher fall rates than their healthy counterparts <sup>[100]</sup>. Medical risk factors include stroke, incontinence, acute illness, Parkinson's disease, dementia, arthritis, diabetes, orthostatic hypotension, foot problems and osteoporosis. Many medical conditions increase the risk of falling by impacting directly on physiological mechanisms that affect maintenance of upright posture <sup>[35]</sup>. (Conditions which affect sensory input (such as diabetes) have been discussed in Section 5.2.4.) Problems with balance can also be experienced due to diseases which impair central processing of sensory information and motor responses, such as stroke, dementia, Parkinson's disease and orthostatic hypotension. Following central processing, anything which affects a person's ability to respond to the sensory input can contribute to the risk of falling, such as disease or disability of the spinal cord, nerves, bones, muscles and joints. Such conditions include arthritis of weight-bearing joints (because of structural deformity, decreased range of motion and pain), foot problems, and muscle disuse following fracture, injury or prolonged immobility.

### 5.2.6 Medication

The evidence base for appropriate prescribing in older people is strong and as more evidence emerges as to pharmacological interventions for more and more diseases, so the number increases of drugs available for prescription. Polypharmacy could therefore be considered a redundant term and the focus should be on appropriate or evidence-based prescribing. Older people should have access to the best pharmacological agents available and a rational discussion with the patient is often required to weigh up the risks and benefits of different medications and numbers of drugs prescribed <sup>[35]</sup>. However, studies have found that use of more than four medications increases falls risk significantly <sup>[78]</sup>. While multiple drug use may be partly a proxy



measure for poor health <sup>[35]</sup>, there is evidence that the use of multiple medications may lead to falls as a result of adverse reactions to one or more of the medications, detrimental drug interactions, or incorrect use. Even taking into account underlying disease, it is known that medications that are central acting like psychotropic medications (antipsychotics), benzodiazepines (sedatives and hypnotics), antidepressants and antihypertensives are independent predictors for falls <sup>[35, 101]</sup>. Additionally, both the ageing and the disease process affect an older person's ability to deal with, and respond to, drugs, indicating that greater care is needed in considering dosage and potential interactions between medications for older people.

## 5.2.7 Lifestyle factors

### 5.2.7.1 Alcohol Consumption

The magnitude of risk posed by alcohol use for falls or fall injuries among older adults remains uncertain. Studies seeking to measure the association between alcohol use and falls may suffer from response and selection biases, in that heavy alcohol consumers may under-report intake or decline participation altogether <sup>[35, 102]</sup>. However there is sufficient evidence to suggest that light alcohol intake may decrease the risk of falling, while a history of problem drinking increases fall risk <sup>[103]</sup>. Long-term, high-level consumption contributes to multiple medical conditions such as osteoporosis, reduced peripheral sensation and brain atrophy, which are associated with falls <sup>[35]</sup>. Results from meta-analysis indicate that alcohol intake above two units per day is associated with a significantly increased risk of osteoporotic fracture, especially hip fracture <sup>[104]</sup>. Although alcohol abuse has been implicated as a significant factor in geriatric trauma <sup>[105]</sup>, few studies have directly measured alcohol levels in older people presenting to an Emergency Department (ED) following a fall <sup>[106-108]</sup>. Kurzhailer et al (2005) reported positive blood alcohol concentrations in 22 percent of fallers presenting to ED and concluded that alcohol plays an important role in patients up to 70 years of age in fall-related injuries <sup>[106]</sup>.

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An Australian study reported that alcohol misuse may have been a direct cause of the fall in more than 10 percent of ED presentations in older people [39].

### 5.2.7.2 Tobacco Use

Studies of tobacco use and fall-related injuries have consistently reported that osteoporotic fractures, particularly hip fractures, are a major adverse effect of smoking due to substantial cumulative excess bone loss [109, 110]. Current smoking is associated with a significantly increased risk of hip fracture compared to non-smoking. The risk decreases for former smokers, depending on the years since cessation. Smoking is one of the major preventable risk factors for chronic disease [84].

### 5.2.7.3 Physical Inactivity

Sedentary behaviour is a risk factor for falls [78]. Individuals who are inactive fall more than those who are moderately active [78]. Paradoxically, there is a suggestion in the literature that too much activity increases risk [87, 111], presumably because engagement in frequent physical activity, including household activities, increases exposure to opportunities to fall [111, 112]. The protective effect of physical activity on the risk of fall-related injuries, such as hip fracture, is strong for current physical activity and also with leisure activities from childhood to late adult age [113]. Accumulating evidence suggests that physical activity helps to maintain mobility, muscle strength, reaction time, balance, and bone mineral density, thereby reducing the risk of falls and osteoporotic fractures [114].

### 5.2.7.4 Under Nutrition

While there is no universally accepted definition of clinical under-nutrition in older persons [115], unintentional weight loss (defined as loss of more than four percent of body weight [115]) and low body mass index (BMI) contribute to frailty [116]. Frailty results from a ‘vicious

loop' which includes sarcopenia (loss of muscle mass and strength), neuromuscular impairment, falls and fractures, immobilisation, malnutrition and impaired protein synthesis <sup>[117]</sup>. Limited evidence supports the hypothesis that malnutrition increases the propensity to fall <sup>[118]</sup>, although the relationship is indirect. The body's ability to maintain balance and postural stability is achieved by a complex interaction between the visual, vestibular, proprioceptive, and neuromuscular systems, all of which can be affected by nutritional deficiencies <sup>[118]</sup>.

The association between nutritional status and fall-related injuries (particularly hip fractures) has been more widely investigated. Studies have shown that a significant risk factor for hip fracture is low BMI <sup>[119]</sup>. The mechanism for this relationship may be because of muscle weakness associated with nutritional deficiencies of protein or vitamin D <sup>[119]</sup>. The nutritional needs for optimizing bone health can be met by a diet that is high in fruits and vegetables (five or more servings per day), adequate in protein but moderate in animal protein, and with adequate calcium and vitamin D intakes through diet or supplements <sup>[120]</sup>. Adequate nutrition is also required to supply the energy levels required to undertake physical activity, including normal daily activities, and to optimise physical gains from an exercise programs <sup>[36]</sup>. It is important to evaluate potentially reversible causes of poor nutritional intake <sup>[115]</sup>, including oral health and dentition problems, lack of ability to purchase and store food, inability to prepare meals, poor appetite, poor diet and difficulties swallowing.

## 5.2.8 Environmental factors

### 5.2.8.1 Home Hazards

A high proportion of falls in community-dwelling older adults occur at home and environmental hazards are frequently implicated as the cause <sup>[121]</sup>. However, there is scant evidence to suggest that the houses of older fallers are any more hazardous than non-fallers <sup>[35]</sup>. It seems that the relationship between an older person's functional capacity

and their environment together can place an individual at risk of falls. Therefore reducing hazards in the home is likely to be most effective in those with a falls history and limited mobility.

### 5.2.8.2 Hazards in Public Places

Although fallers report that outdoor hazards (particularly broken or uneven surfaces) are frequent causes of falls, the issue of environmental risk factors in public places has not been well documented in the literature <sup>[35]</sup>. Nonetheless, there is evidence that presence of obstacles increases risk of tripping as it involves a complex interaction between a person's visual perception of the obstacle and the implementation of avoidance strategies such as increasing toe clearance, taking a wider step over the obstacle involving hip, knee and ankle flexion, and increasing step time requiring a longer time spent on one leg <sup>[122]</sup>. Factors that affect the mechanisms involved in obstacle avoidance strategies can increase the risk of tripping. In healthy older people this includes visual impairment. In people with chronic medical conditions such as stroke these include reduced toe clearance, reduced step length and closer limb placement to the obstacle after clearance <sup>[123]</sup> and an altered centre of mass which can increase instability <sup>[124]</sup>.

### 5.2.8.3 Footwear

A number of features of shoe design have been implicated as having an impact on balance <sup>[35]</sup>. However, there is inconclusive evidence to suggest that certain types of footwear increase the risk of falling. In one study <sup>[125]</sup>, wearing shoes with high heels and small contact area increased the risk of a fall in everyday settings and activities, while in another <sup>[126]</sup>, footwear characteristics were not significantly associated with falls either inside or outside the home. However, risk of falling indoors has been found to be associated with going barefoot or wearing socks or slippers <sup>[126-128]</sup>. (See also Section 7.4.6)

#### 5.2.8.4 Assistive Devices

Use of assistive devices may have a positive or negative impact on the physical abilities or safety of older people. Some studies suggest that the use of devices may increase the risk of falling, while others suggest that assistive devices can increase an older adult's confidence, reduce fear of falling, and improve independence <sup>[129]</sup>. However, there is limited research on their potential contribution to falls <sup>[35, 129]</sup>. (See also Section 7.4.5.)

Mobility Aids such as walking aids are associated with increased risk of falls <sup>[87, 130]</sup>, although it may be that use of a mobility aid is simply an indicator of balance impairment and functional decline <sup>[130]</sup>. Such assistive devices can improve balance and mobility for older adults. However, if incorrectly prescribed or used, they can interfere with one's ability to maintain balance in certain situations, and the strength and metabolic demands can be excessive <sup>[130]</sup>, thereby increasing the risk of falling.

Multifocal glasses may predispose older people to falls because they impair depth perception and edge-contrast sensitivity at critical distances for detecting obstacles in the environment <sup>[131]</sup>.

### 5.3 Summary of Falls Risk Factors

A summary of falls risk factors for community-dwelling older people, the level of evidence and their potential to be modified is shown in Table 5.1.

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**Table 5-1: Falls Risk Factor Summary**

Risk factors	Level of evidence	Modifiable ✓ = Yes X = No
<b>Socio-demographic factors</b>		
Advanced age	***	X
Female	**	X
Ethnicity	**	X
Living alone	**	possibly
Poor social networks/ social isolation	*	possibly
<b>Psychological factors</b>		
Fear of falling	***	✓
Depression	**	✓
Poor self-rated health	*	✓
Impaired cognition	***	possibly
Sleep disturbance	*	✓
Risk taking behaviours	*	✓
<b>Physical functional capacity</b>		
Limitations in activity for daily living or mobility	***	✓
Impaired balance	**	✓
Impaired gait	***	✓
<b>Sensory and neuromuscular factors</b>		
Reduced vestibular function	*	Possibly (by habituation)
Visual impairments	***	Possibly
Reduced peripheral sensation	***	X
Reduced muscle strength	***	✓
Poor reaction time	***	✓
<b>Medical factors</b>		
History of falls	***	X
Stroke	***	Indirectly (potential functional improvement through rehabilitation)

Risk factors	Level of evidence	Modifiable ✓ = Yes ✗ = No
Parkinson's disease	***	Indirectly
Number of chronic conditions	***	✗
Abnormal neurological signs	***	✗
Incontinence	**	Possibly
Acute illness	**	✓
Arthritis	**	Indirectly (symptoms can be managed)
Foot problems	**	✓
Dizziness	*	✓
<b>Medication use</b>		
Use of multiple medications	***	✓
Benzodiazepine use	***	✓
Antidepressant use	***	✓
Anti-psychotic use	***	✓
<b>Lifestyle factors</b>		
Alcohol consumption	*	✓
Inactivity	***	✓
Malnutrition	*	✓
<b>Environmental factors</b>		
Home hazards	–	✓
External hazards	–	✓
Poor footwear	*	✓
Inappropriate spectacles	*	✓
Inappropriate walking aids	**	✓
– Little or no evidence of an association		
* Weak evidence of an association (occasionally but not usually found)		
** Moderate evidence of association (usually but not always found)		
*** Strong evidence of association (consistently found in well-conducted, prospective studies)		
<i>Source: adapted with permission from Lord et al, 2007<sup>[35]</sup></i>		

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### Good Practice Points

- › The three star, modifiable risk factors need to be addressed as a matter of priority. These include fear of falling, limitations in activity for daily living or mobility, impaired balance and gait, visual impairment, reduced muscle strength, poor reaction time, and use of multiple medications specifically benzodiazepine, antidepressant, anti-psychotic medications (psychoactive medications).
- › Since falls are usually caused by complex interactions of a number of risk factors, risk reduction strategies should target multiple factors.
- › For individuals this will usually involve assessment of falls risk followed by interventions which target risk factors.
- › Whole of community prevention of falls strategies should address multiple risk factors prevalent in the population.

