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Falls and fall-related injuries in community-dwelling elderly persons in Hong Kong: a study on risk factors, functional decline, and health services utilisation after falls

Key Messages

1. The incidence of falls and the prevalence of those who have encountered a fall in the community-dwelling elderly in Hong Kong was 270 per 1000 person-years and 19.3%, respectively. Serious injuries and fractures occur in 7.2 and 5.9% of fallers, respectively.
2. Independent predictors for falls are advancing age, Parkinson's disease, previous history of falls, left knee extension power and gait speed. Independent predictors for recurrent falls are previous history of falls, self-perceived mobility problems, left knee extension power, total mobility score in the Tinetti Balance and Gait Test.
3. 'Fear of falling' is a common post-fall complication.
4. Fallers commonly experience decline in physical functions and the activity of daily living.
5. Fallers, particularly recurrent fallers, consume more health care services than non-fallers. The excess annual health care costs of fallers versus non-fallers amount to HK$552 million for all community-living elderly in Hong Kong.
6. Effective falls prevention programmes in Hong Kong might reduce falls and fall-related health service utilisation by up to 30%. The possible saving in public health care costs would be approximately HK$160 million annually.

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Introduction

According to overseas studies, one third of community-dwelling older adults will fall each year. Physical injuries (eg fractures) and adverse psychological effects (eg fear of falling) are common. Various intrinsic and extrinsic (environmental) risk factors for falls have been reported.[1] Fallers and particularly recurrent fallers are prone to increased hospitalisation, nursing home placement, and death.[2,3] In Hong Kong, local data on falls in the elderly are inadequate. A cross-sectional study reported that the prevalence rate of having at least one fall in the preceding 12 months was 18%.[4] However, recall bias and forgetting falls may underestimate the true prevalence.

A prospective population-based cohort study is needed in Hong Kong to examine the prevalence, incidence, and risk factors for falls in the elderly. To such patients and to health service authorities, fall-related consequences like injuries, adverse psychological effects, functional decline, mortality, and health services utilisation are of practical and economic importance.

The present study aimed to investigate the risk factors associated with falls and recurrent falls and study their impact in relation to functional decline, mortality, nursing home placement, and health services utilisation in a random sample of community-dwelling Hong Kong elderly.

Methods

A prospective cohort study (conducted from February 1998 to July 2000) with 1-year follow-up was performed in the community, using a multi-stage random sampling procedure. All recruited subjects were aged ≥65 years, could walk independently or with a walking aid, and lived at home. Being non-ambulatory, or unable or unwilling to provide informed consent or cooperate were grounds for exclusion. In the baseline assessment, face-to-face interviews were performed in the subjects' homes. Information on demographics, socio-economic conditions, known diseases, medications, and activities of daily living were obtained from the subjects and family members/caregivers. Direct clinical and functional assessments were then performed. Potential home environmental risk factors for falls were assessed by direct observation, using a structured format. Every subject was followed up for 1 year or until the loss to follow-up. The occurrence of falls, any injury after falls, the numbers of visits to clinics, accident and emergency departments and hospitalisations were monitored by a 2-monthly telephone follow-up as well as a second home visit at the end of 1 year. The Hospital Authority computerised system was used to confirm the health services utilisation data. For fallers, additional re-assessment of the outcomes (mortality, institutionalisation, and hospitalisation) was performed 1 year after the first fall.

Results

A total of 1517 population-based elderly subjects were recruited from March 1998

Table 1. Logistic regression analyses of clinical and functional predictors for one or more falls (n=1516)

Clinical or functional predictor	Relative risk	95% CI, relative risk	P value
Left knee extension power (kg-force)	0.88	0.79, 0.97	0.013
Gait speed (m/s)	0.25	0.12, 0.53	<0.001
Age (years)	1.03	1.01, 1.06	0.004
Parkinson's disease	3.58	1.03, 12.47	0.045
History of falls in past year±over 1 year	3.35	2.43, 4.63	<0.001

Table 2. Logistic regression analyses of clinical and functional predictors for recurrent falls (versus single fallers/non-fallers) [n=1516]

Clinical or functional predictor	Relative risk	95% CI, relative risk	P value
History of falls in past year±over 1 year	3.04	1.80, 5.14	<0.001
Self-perceived mobility problem	1.82	1.01, 3.30	0.047
Left knee extension power (kg-force)	0.75	0.63, 0.90	0.002
Total mobility score in Tinetti Balance and Gait Test	0.93	0.89, 0.97	0.002

to October 1999. The mean age (standard deviation [SD]) of the subjects was 73 (6) years; 49% were females. The ten most common diagnosed co-morbidities were: arthritis (61%), hypertension (33%), cataract (26%), peptic ulcers (15%), diabetes mellitus (12%), coronary heart disease (9%), hyperlipidaemia (7%), chronic obstructive airway disease (6%), stroke (6%), and asthma (3%). Dementia and depression were known to be present in 0.33% and 0.66% of the subjects, respectively; 38% of the subjects had a history of falls, 14% within the past year.

Prevalence and incidence of falls

Overall, 401 new falls occurred in 294 persons over the 12-month follow-up of the 1517 community living elderly subjects. The fall rate (number of falls per 100 persons) was 26%, giving an incidence of 270 falls per 1000 person-years. The incidence of fallers was 198 per 1000 person-years and was higher in females than males and increased with advancing age. The 1-year prevalence of falls (persons with at least one new fall) was 19% and for recurrent falls (ie ≥2 falls per year) was 5% (n=72). The mean number of falls per faller was 1.4 (SD, 0.79); 222 (76%) of these fallers (n=294) had only one fall over the 1-year follow-up, while 24% had recurrent falls.

Environmental risk factors of falls

Of all falls 47% occurred indoors and 53% outdoors. In univariate analyses, some of the baseline environmental risk factors showed significant association with falls at home. Having a narrow corridor (<3 feet wide) was a risk factor for both single fallers and recurrent fallers. The presence of obstacles in the bedroom was a risk factor for falls but not recurrent falls. The presence of a loose rug in the bathroom, toilet or kitchen was a risk factor for recurrent but not single falls. Absence of a staircase just outside the home was associated with a higher chance of recurrent but not single falls. At the time of the fall, environmental risk factors were reported by 57% of the fallers. They included: wet/slippery floors, uneven floors, curbs, and obstacles. Loose or slippery shoes were also possible factors for falls in 27% of patients.

Intrinsic risk factors of falls

Univariate analyses showed the following intrinsic risk factors for one or more falls: female gender, advanced age, low abbreviated mental test score, high number of co-morbidities and medications, arthritis, dementia, history of stroke, Parkinson's disease, hypertension, history of spinal fracture, increased number of falls in the past year, higher Geriatric Depression Scale Score, low Barthel Index, low Lawton's Instrumental Activities of Daily Living (IADL) score, use of walking aid, postural hypotension (systolic blood pressure drop ≥20 mm Hg), low right handgrip strength, low right and left knees' extension power, decreased body height, failure in feet-together stand, semi-tandem stand, tandem stand, tandem walk, 5-metre walking time or gait speed and the total mobility score in Tinetti Balance and Gait Test. Logistic regression analysis of both the clinical and functional predictors showed that age, Parkinson's disease, previous history of falls, left knee extension power, and gait speed were independent predictors for falls (Table 1).

In univariate analyses of intrinsic risk factors for recurrent falls (ie at least 2 falls), the significant risk factors were: female gender, advanced age, low abbreviated mental test score, high number of co-morbidities and drugs, arthritis, dementia, stroke, coronary heart disease, a previous history of falls, self-perceived mobility problem, fear of falling, low activities of daily living (Barthel Index and IADL scores), use of walking aid, postural hypotension, low right hand grip strength, low right and left knee extension power, failure to stand with feet together, failure in semi-tandem stand, failure in tandem stand, failure in tandem walk, slow gait speed, low balance score, gait score and total mobility score. Logistic regression analysis of both the clinical and functional predictors showed that a previous history of falls, self-perceived mobility problems, left knee extension power, as well as total mobility scores in the Tinetti Balance and Gait Test were independent predictors (Table 2).

Mortality

Thirty-three subjects died during the 1-year follow-up

Table 3. Estimated fall-related excess health services use and health care cost for community-living elderly in Hong Kong per year

Parameters	Non-fallers (mean±SEM)	Fallers (mean±SEM)	Mean excess health service use in fallers vs non-fallers	Unit cost* (per visit or bed-day) [HK$]	Excess public health care cost related to falls in community-living elderly (n=137 404)† [HK$]
No. of general out-patient visits	2.32±0.09	3.12±0.19	0.8	200	21 984 640
No. of specialist visits	1.37±0.11	1.98±0.25	0.61	735	61 605 083
No. of accident and emergency visits	0.21±0.002	0.40±0.04	0.19	556	14 515 359
Total No. of bed-days in hospitals	2.39±0.37	3.40±0.54	1.01	3273	454 220 525
Total					552 325 607

* Cost based on Hospital Authority and public services internal cost data
† Estimated from (1) the numbers of elderly women and men (376 148 and 323 092 respectively) and (2) the prevalence rates of falls (22.7% and 16.1% in women and men respectively)

period. Overall mortality was 2.2%. Causes of death included cancer, stroke, coronary heart disease, hepatitis, pneumonia, brain tumour, etc. Four of the deaths were directly or indirectly fall-related. During the 1-year follow-up, mortality of the fallers (4.5%) was significantly higher than in the non-fallers (2.3%).

Injuries and fear of falling

75% of fallers sustained injuries. The majority (68%) of fallers had mild soft tissues injuries only (local pain, bruises, haematoma, abrasions and lacerations), whilst 7% (n=21) had serious injuries of which 17 were fall-related fractures (3 hip fractures, 2 spinal fractures, 4 Colles fractures and 8 rib or other fractures). Subdural haematomas occurred in five subjects. The proportion of 'fear of falling' increased significantly from 33 to 37% at 1 year; 70% of the fallers reported 'fear of falling' after the falls.

Functional decline in fallers

Fallers experienced a greater decrease in scores for the Barthel Index for basic activities of daily living, IADL, gait speed, and total mobility. Score declines occurred in both single and recurrent fallers. Recurrent fallers experienced the larger declines in all four functional measures. Subjects with 'fear of falling' had significantly poorer functional measure scores, including those for the 1-year: Barthel Index, Lawton IADL, gait speed, knee extension strength, balance, gait, and total mobility.

Nursing home placement in fallers

Twelve (0.8%) of the subjects had moved to live in old-age homes over the 1-year follow-up. The 1-year institutionalisation rate of the fallers (8%) was higher than in non-fallers (0.7%).

Health services utilisation

A total of 216 (15%) subjects had been hospitalised. Fallers had proportionally greater numbers of visits to doctors, general out-patient departments (GOPD), specialist clinics, and accident and emergency departments and proportionally greater numbers were admitted to hospital. Moreover, recurrent fallers were the greatest users of these services. There were no significant differences between fallers and non-fallers in terms of numbers of private doctor and rehabilitation visits and total bed-days in hospital. The excess public health care cost per year due to falls had been calculated for all community-living elderly in Hong Kong. Fallers would cost approximately HK$552 million more than non-fallers per year when comparing costs attributable to the number of GOPD visits, number of specialist clinic visits, number of accident and emergency visits, and the total number of bed-days in hospital (Table 3).

Discussion

Falls are common and serious in Hong Kong

This is the first prospective cohort study on falls in a random sample of community-dwelling elderly in Hong Kong. Community-dwelling (non-institutionalised) elderly people comprise about 93% of our elderly population. Falls are common and one out of five elderly has a fall every year. Injuries, fear of falling, decline in the activities of daily living, and increased health services utilisation are important undesirable consequences after such falls.

Public health impact of falls

The population of elderly (aged ≥65 years) in the year 2002 was close to 0.75 million. Thus, it was estimated that 0.14 million per year of community-dwelling Hong Kong elderly were expected to experience a fall. Based on the serious injury rate of 7% in fallers, approximately 9893 elderly persons would have serious injuries. In terms of the excess public health care cost, all elderly fallers in Hong Kong would consume approximately HK$552 million more than non-fallers every year (Table 3).

Predicting falls

Functional predictors stronger than clinical predictors for falls

Compared to clinical predictors, functional predictors predict both falls and recurrent falls in the elderly more accurately. Hence, direct assessment of the lower limb

muscle power and balance and gait functions (eg tandem stand and tandem walk tests, Tinetti Balance and Gait Test, gait speed) are very important assessment tools for this purpose.

Prediction of the risk of falling

In the community-dwelling elderly, the risk of falling can be conceived as a three-stage concept. Presence of clinical factors (eg stroke, Parkinson's disease, postural hypotension, history of previous falls, self-perceived mobility problem) leads to either weakness of the lower limb, balance and/or gait impairment. Presence of such features should alert health care professionals to the need for heightened fall prevention. Direct assessment of the lower limb power and performance in balance and gait tests should then be undertaken. In the present study, these performance-based functional assessments were potent predictors of falls and recurrent falls. Similarly, we have previously reported that lower limb power and tandem walk test performance were independent risk predictors for falls in the hospital.[5]

Interaction between intrinsic and environmental risk factors

The presence of intrinsic or environmental risk factors by themselves may not be enough to lead to falls. In some elderly, an interaction of intrinsic and environmental factors appears responsible. In our study, 15% of the fallers had both subjective weakness of the leg and encountered environmental hazards at the time of falling.

Healthy and fit elderly without disease and balance/gait impairment can usually compensate mild to moderate environmental hazards to avoid falling. Elderly with lower limb weakness and/or balance/gait impairments, are less likely to compensate successfully for such environmental hazards.

Falls prevention

An effective falls prevention programme should include the following components:

1. A protocol to screen and identify elderly persons at risk of falling (ie previous history of falls and self-perceived mobility problems);
2. An environmental safety checklist and intervention measures;
3. A clinical risk factor checklist and measures to remove/reduce such risks;
4. A functional risk factor checklist and measures (eg strength and balance exercises, Tai Chi) to reduce/improve such risks;
5. Osteoporosis detection, management and treatment;
6. Protective measures (eg head helmets, hip protectors) against fall-related serious injuries.

Screening assessment targeted at high-risk elderly

Elderly persons with a previous history of falls and self-perceived mobility problems can be identified by a simple screening questionnaire. In the latter, lower limb weakness and/or balance or gait dysfunction can be regarded as having a high risk of falls. Simultaneous interventions to reverse, reduce, or improve relevant clinical and functional factors should be instituted.

Primary and secondary falls prevention by a multiple risk factors intervention approach

Environmental risk factors were present in over 50% of our fallers, while over 50% of falls occurred outdoors. The government has to encourage the construction, building, and architecture sectors to incorporate fall-safe features in all relevant outdoor or public environments.

For the indoor environment, the elderly themselves must be motivated to improve home safety profiles to minimise falls. Public health education programmes on how to minimise home environmental risk factors like wet/slippery floors, uneven floors curbs, and obstacles have to be launched.

Lack of exercise and consequent deconditioning is common with advancing age. Programmes to improve physical fitness of the elderly should be encouraged. Exercise classes are good ways to achieve this; the 'active for life' slogan should be advocated.

Training to improve lower limb strength, balance, and gait

Special training programmes aimed at improving the strength/balance and gait functions of the elderly are likely to prevent falls, particularly for those with reversible lower limb weakness and/or balance and gait impairment. Resistance exercise, balance training and Tai Chi are examples of such programmes, that should be investigated for their efficacy as a means of fall prevention in the Hong Kong elderly.

Impact of successful falls prevention programmes

Tinetti et al[6] demonstrated a 31% reduction of falls in their study of a multiple risk factors reduction programme, proving that this is an effective approach and can be even more effective if targeted at high-risk elderly. Close et al[7] noted a 61% reduction in falls with a joint geriatrician-occupational therapist intervention for elderly visiting emergency departments for falls. Fall prevention guidelines recommend that prevention be targeted to high-risk elderly.[8,9] Assuming a 30% reduction in falls and fall-related health services utilisation and a corresponding reduction in the health care costs, there would be a saving of about HK$160 million per year in Hong Kong.

Limitations

We compared our sample's sex-age structure with the Hong Kong elderly population in 2001. Our subjects had a fairly similar sex and age distribution with only mild over-representation of the males and under-representation of the very old population (aged ≥85 years). Another limitation was related to the fair response rate of the elderly. We

presume subjects in our study were healthier than the general elderly, so our findings are probably an underestimate of the incidence and impact of fall-related injuries, mortality and health services utilisation. Also there may be limitations to applying the present findings to elderly person in nursing homes or hospital settings.

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