Accidental falls among community-dwelling people with chronic stroke in Hong Kong

ORIGINAL ARTICLE

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ABSTRACT

Purpose. To investigate the association between demographics, stroke-specific disabilities, fall-related self-efficacy, and fall history of people with chronic stroke living in the community in Hong Kong.

Methods. A convenience sample of 112 community-dwelling adults with chronic stroke and mild-to-moderate disabilities who had been discharged from hospital for >1 year was recruited. Assessment consisted of 2 sessions. The first session comprised the Activity-Specific Balance Confidence Scale–Cantonese, a questionnaire on visual-spatial ability, and a questionnaire to collect demographic data, fall history, and circumstances of the last fall. The second session assessed residual stroke impairments (including balance, mobility, muscle power, and ankle spasticity at the paretic side) and functional assessments using the Modified Ashworth Scale, the Berg Balance Scale, the timed up-and-go test, and the Chinese Frenchay Activities Index.

Results. Of the 95 participants analysed, 26 had one fall and 24 had more than one fall in the preceding year; the prevalence of falls was 52.6%. 18 of the fallers had injuries and 8 needed medical attention. Of the 74 falls in the previous year, 43 occurred indoors and 31 occurred outdoors. The common activities preceding the fall were walking (n=12), transitioning body posture (n=9), and going up or down stairs (n=6). Participants who had support from domestic helpers and better balance were less likely to fall. Participants who had visual acuity impairments and were living in public housing were more likely to have multiple falls. In contrast, those who were living with spousal support and had better balance were less likely to have multiple falls.

Conclusion. Fall is common in people with chronic stroke. Home-based or environmental interventions targeting modifiable risk factors should be considered in fall-prevention programmes.

Key words: Accidental falls; Community health services; Stroke

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INTRODUCTION

In Hong Kong, stroke is the fourth leading cause of death and the most common cause of severe disability, and occurs in 3.6 per 1000 persons per year.[1] Residual stroke impairments may increase the risk of falling.[2-4] The accidental fall rates among people with stroke vary from 23% to 73%, whereas multiple fall rates range from 12% to 47%.[3-6] People with stroke are at risk of falls (1.3-6.5 falls per person per year).[7] In people with a first stroke within the previous one year, the fall rate is 1.77 times that of matched controls.[8] The risk of falling for stroke survivors was twice that for community-dwelling controls.[9]

Only a few studies have examined the factors contributing to falls in people with stroke living in the community.[3,6,10-12] This cross-sectional study investigated the association between demographics, stroke-specific disabilities, fall-related self-efficacy, and fall history of people with chronic stroke living in the community in Hong Kong.

METHODS

This study was approved by the human ethics review committee of the Hong Kong Polytechnic University (Ref: HESAR20090723002). All participants gave their written informed consent. From August to December 2009, a convenience sample of 112 community-dwelling adults with chronic stroke who had been discharged from hospital for >1 year and were able to walk without assistance for 10 metres and scored ≥18 in the Chinese Mini-Mental State Examination (CMMSE)[13] was recruited from 2 community stroke self-help organisations in Hong Kong (**Figure**). Participants with poorer cognitive performance (CMMSE, <18) were considered to be less reliable in recalling and reporting their fall history, so they were excluded.[8]

Patients were also excluded if they had other neurological disease, unstable cardiovascular disease or other disease, hospital admission within the previous 1 month, and current active stroke rehabilitation (>2 times per week). This ensured that participants were medically stable, and their functional performances were similar.

Procedures

Assessment consisted of 2 sessions. Each session took around 30 minutes to complete. The first session comprised the Activity-Specific Balance Confidence Scale–Cantonese (ABC-C),[14] a questionnaire on visual-spatial ability, a questionnaire to collect demographic data (age, sex, education, stroke details, number of prescribed medications, type of services received, living situation, and walking aid use), fall history (the number of falls during the previous 12 months, time of day [day or night] of the fall, and duration [in months] since the last fall), and the circumstances of their last fall (location, reason, what they were doing, whether they were injured or needed medical attention). The second session assessed residual stroke impairments (including balance, mobility, muscle power, and ankle spasticity at the paretic side) and functional assessments using the Modified Ashworth Scale,[15] the Berg Balance Scale (BBS),[16] the timed up-and-go test (TUGT),[17] and the Chinese Frenchay Activities Index (C-FAI).[18] The assessors were blind to the participants' fall history.

Self-perceived levels of confidence in maintaining balance in 16 daily functional activities was assessed using the ABC-C on a scale of 0% (no confidence at all) to 100% (completely confident).[19] The scale has good internal consistency (Cronbach's α=0.97) and test-retest reliability (intraclass correlation coefficient=0.99) among individuals with stroke in Hong Kong.[14]

The BBS is a 14-item quantitative assessment of

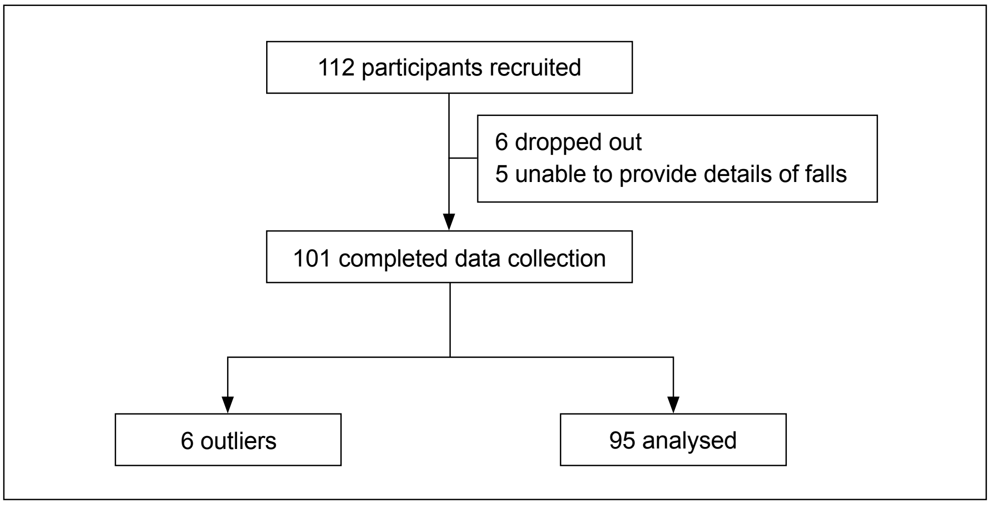

Figure. Flow chart of participant recruitment

balance in older adults on a 5-point ordinal scale of 0 to 4.[16] The maximum score is 56; higher scores indicate higher levels of function. Scores of <45 indicate significant balance difficulty.[20] The interrater and intrarater reliabilities of the BBS in a sample of stroke patients were 0.98 and 0.99, respectively.[21] The BBS is a reliable tool to predict falls in stroke patients.[8,10,22]

The C-FAI measures the instrumental activities of daily living in patients recovering from stroke on a 4-point ordinal scale.[18] The index emphasises frequency rather than quality of activities in order to reduce elements of subjectivity,[23] and is associated with the Barthel Index (r=0.6).[18] The score ranges from 15 to 60.

The TUGT evaluates functional mobility in frail elderly persons.[17] A duration of >13.5 seconds to complete the test indicates significant deficits in functional mobility.[24] The intra-class correlation coefficient was >0.95 in a stroke population. The TUGT has been used to differentiate subjects with a history of falls among people with chronic stroke.[10]

Visual-spatial ability was assessed using the Star Cancellation subtest of the Behavioural Inattention Test (BIT-star).[25] The maximum score is 54. Scores of <44 indicate unilateral spatial neglect. The BIT-star correlates with the Clock Drawing Test (r=0.34) and the Functional Assessment Battery (r=0.47).[26] Binocular vision was assessed using the Snellen chart. Participants were allowed to wear their customary eyeglasses. Ability to read the smallest row accurately indicated best visual acuity. Participants were classified into groups according to visual acuity of <20/20 or ≥20/20.

Sample size calculation

In a sample of community-dwelling chronic stroke patients, the mean±standard deviation (SD) times for the TUGT for non-fallers and fallers were 37.6±18.3 and 46.9±12.3 seconds, respectively.[27] A sample size of 46 participants per group was required for 80% power (β=0.20) with an α of 0.05 and a group difference of 9.2 seconds in the TUGT. A total of 101 participants were necessary, assuming a 10% dropout rate.

Descriptive statistics was generated for all variables. Participants were categorised into fallers or non-fallers. Missing values were replaced by samples mean. Outliers may skew lines of best fit in the wrong direction and were excluded from the analysis. Outliers were determined by exploratory data analysis in the stem-and-leaf plots by deleting the individual data points. There were 6 outliers in age (n=1), the TUGT (n=3), the ABC-C (n=1), and the C-FAI (n=1). Chi squared test was used to compare the group differences for the ordinal and categorical variables. Independent t-test was used to determine mean differences between fallers and non-fallers for continuous variables. Binary logistic regression (forward conditional method) was used to determine predictors of falls in the preceding 12 months. All significant variables were analysed in a logistic regression to determine whether the other non-significant variables might improve prediction. All tests were 2-sided. A p value of <0.05 was considered statistically significant.

RESULTS

Of the 95 participants analysed, 26 had one fall and 24 had more than one fall in the preceding year; the prevalence of falls was 52.6%. 18 of the fallers had injuries and 8 needed medical attention (**Table 1**).

Of the 74 falls in the previous year, 43 occurred indoors and 31 occurred outdoors. Regarding the last falls (n=50), 33 occurred in daytime and 17 at night; 28 occurred indoors (mainly at the bedside and in the living room and toilet) and 22 occurred outdoors (mainly on paths/walkways, stairs, and at bus and train stops). The common activities preceding the fall were walking (n=12), transitioning body posture (e.g. from sitting to standing position) [n=9], and going up or down stairs (n=6).

The most common self-perceived reason for falling was personal factors, followed by environmental factors and health-related factors (**Table 2**).

Regarding visual-spatial ability, 6 participants scored <44 in the BIT-star. The mean±SD scores for fallers and non-fallers were similar (52.0±4.2 vs. 51.7±5.2). 60 participants had below-normal visual acuity. There were no significant differences between fallers and non-fallers for BIT-star and visual acuity assessments.

Table 1
Demographics of the participants*

Parameter	All (n=95)	Faller (n=50)	Non-faller (n=45)	p Value
Age (years)	61.2±10.2 (41-89)	60.9±10.1	61.4±10.3	0.80
Sex				
Male	57 (60)	30	27	1.0
Female	38 (40)	20	18	1.0
Education (years)	8.3±4.5 (0-19)	8.2±4.1	8.3±5.0	0.90
Chinese Mini-Mental State Examination	26.8±2.8 (19-30)	26.9±2.7	26.7±2.8	0.74
Taking >3 medications (yes/no)	42 (44)	21	21	0.65
Comorbidities				
Hypertension	59	32	27	0.688
Diabetes mellitus	28	16	12	0.569
Heart disease	16	6	10	0.184
Visual problems	14	11	3	0.035
Musculoskeletal and joint conditions	15	8	7	0.95
Other	25	11	14	0.314
Walking aids (yes/no)	68 (72)	41	27	0.018
Straight cane	43 (63)	26 (63)	17 (63)	
Umbrella stick	2 (3)	2 (5)	0 (0)	
Quad cane	7 (10)	5 (12)	2 (7)	
Walking frame	1 (1.5)	0 (0)	1 (4)	
Hiking stick	12 (18)	7 (17)	5 (19)	
Stick chair	1 (1.5)	1 (2)	0 (0)	
Wheelchair	2 (3)	0 (0)	2 (7)	
Post-stroke period (months)	71.4±43.3 (12-209)	75.9±44.0	66.3±42.5	0.28
Affected side				
Left	49 (52)	25	24	0.75
Right	46 (48)	25	21	0.75
Type of stroke				
Ischaemic	52 (55)	28	24	0.79
Haemorrhagic	25 (26)	14	11	0.69
Unknown	18 (19)	8	10	0.44
Housing				
Public	35 (37)	19	16	0.81
Home Ownership Scheme	32 (34)	18	14	0.62
Private	19 (20)	10	9	1.0
Village	9 (9)	3	6	0.22
Living situation				
Alone	13 (14)	9	4	0.20
Family	82 (86)	41	41	0.20
Spouse support	67 (71)	31	36	0.06
Maid support	14 (15)	4	10	0.051
Carer (maid and spouse) support	70 (74)	35	46	0.07
Total No. of carers	2.0±1.3 (0-5)	2.1±1.3	2.0±1.3	0.75
Daytime alone	24 (25)	16	8	0.11
Fear of fall	57	35	22	0.036
Stroke-specific measurements				
Berg Balance Scale	47.4±6.2 (30-56)	45.2±5.6	49.8±6.0	<0.001
Timed up-and-go test	16.8±6.4 (8-35)	18.8±7.0	14.7±4.9	0.001
Activity-Specific Balance Confidence Scale–Cantonese	64.2±18.4 (18-98)	61.1±18.5	67.5±18.0	0.09
Chinese Frenchay Activities Index	22.5±7.7 (7-38)	22.2±7.0	22.8±8.4	0.70
Star Cancellation subtest of the Behavioural Inattention Test	51.9±4.7 (28-54)	52.0±4.2	51.7±5.2	0.71
Visual acuity of >20/20	60 (63)	33 (55)	27 (45)	0.55
Increased muscle tone measured by Modified Ashworth Scale	38 (40)	24 (63)	14 (37)	0.093
Manual muscle testing of <grade 3	22 (23)	15 (68)	7 (32)	0.093

* Data are presented as mean±SD (range) or No. (%)

Table 2
Fall details and circumstances

Fall details	No. (%) of participants
Faller (n=50)	
Single faller	26 (52)
Multiple faller	24 (48)
Falls in previous year (n=74)	
Indoors	43 (58)
Outdoors	31 (42)
Last falls (n=50)	
Indoors (n=28)	
Bedside	10 (20)
Kitchen	2 (4)
Toilet/bathroom	7 (14)
Living room	9 (18)
Outdoors (n=22)	
Path/road	6 (12)
Park	3 (6)
Train station/bus stop	3 (6)
Shopping mall	2 (4)
Stairs	5 (10)
Other	2 (4)
Fall time	
Daytime (0600-1800)	33 (66)
Night time (1800-0600)	17 (34)
Fall injury	18 (36)
Medical attention after fall	8 (44)
Self-perceived reasons for fall*	
Personal factor	34 (63)
Health-related factor	5 (9)
Environmental factor	11 (20)
Other	4 (7)

* Participants can choose more than one answer

24 fallers and 14 non-fallers had increased ankle spasticity at the paretic side, and 15 fallers and 7 non-fallers had knee extension strength below grade 3 in Manual Muscle Testing. There were no significant differences between fallers and non-fallers for increased spasticity (χ^2=2.815, p=0.093) and reduced muscle power (χ^2=2.777, p=0.096) over the paretic side.

The mean±SD scores of C-FAI were 22.2±7.0 and 22.8±8.4 for fallers and non-fallers, respectively, indicating low functioning in instrumental activities of daily living.

More fallers than non-fallers had visual problems (χ^2=4.432, p=0.035), required the use of walking aids (χ^2=5.635, p=0.018), and had fears of falling (χ^2=4.398, p=0.036) [**Table 1**]. Fallers performed more poorly than non-fallers in the BBS (p<0.001) and the TUGT (p=0.001).

Binary logistic regression (forward conditional method) is shown in **Table 3**. Participants who had support from domestic helpers (odds ratio

Table 3
Logistic regression on the predictors of fall among fallers

	B	SE	Wald test	*df*	Significance	Odds ratio (95% CI)
At least 1 fall						
Living with maid	-2.43	0.92	7.00	1	0.008	0.09 (0.02-0.53)
Berg Balance Scale	-0.187	0.05	14.84	1	0.000	0.83 (0.76-0.91)
At least 2 falls						
Public housing	1.90	0.66	8.42	1	0.004	6.67 (1.85-24.0)
Living with spouse	-1.46	0.63	5.36	1	0.021	0.23 (0.07-0.80)
Visual acuity of >20/20	1.90	0.76	6.31	1	0.012	6.71 (1.52-29.73)
Berg Balance Scale	-0.145	0.05	8.40	1	0.004	0.87 (0.78-0.95)

[OR]=0.088, 95% confidence interval [CI]=0.015-0.529) and better balance (OR=0.830, 95% CI=0.755-0.912) were less likely to fall. Participants who had visual acuity impairments (OR=6.672, 95% CI=1.852-24.038) and were living in public housing (OR=6.672, 95% CI=1.852-24.038) were more likely to have multiple falls. In contrast, participants who were living with spousal support (OR=0.233, 95% CI=0.068-0.800) and had better balance (OR=0.865, 95% CI=0.784-0.954) were less likely to have multiple falls.

DISCUSSION

In this study, falls were common among community-dwelling people with mild-to-moderate stroke. Most of the falls occurred indoors, which is opposite to falls in healthy older persons.[28] Walking and transition of posture were common causes of falls. Poor balance, low visual acuity, and poor housing and living situations were predictors of falls.

The prevalence of falls in chronic stroke patients in the Hong Kong community was similar to that in overseas studies.[3-6] Regarding indoor falls, bedside falls and transitions in body posture (e.g. from sitting to standing position) respectively accounted for 20% and 18% of the total falls. Transitions in body posture required both lower-extremity power and balance capacity, which might be impaired in stroke patients. Lower BBS scores or poor balance performance was related to falls[8]; a BBS score of <49 was associated with more than one fall for stroke patients.[8] In this sample, the BBS score was only 45.2 among fallers and 49.8 among non-fallers (mean difference, 4.6). Although there was a significant difference between fallers and non-fallers in terms of the TUGT, the TUGT was not as effective as the BBS in identifying fall risk in the stroke population. This was consistent with the findings of 2 other studies.[8,10]

In Hong Kong, public housing means small rented flats in high-rise buildings provided for people with low incomes. Crowded living environments and inappropriate seating or interior design might explain the relatively high percentage of falls indoors or during transitions in body posture. 20% of indoor falls occurred at the bedside and 18% in the living room; this is different from the traditional view that most falls occur in the bathroom or toilet. Health care professionals should identify the risk factors in bedrooms during their home visits.

The non-faller group had more support from domestic helpers than the faller group (p=0.051). Social environment and caring is important to reduce falls in people with stroke in community dwellings. In addition, participants with visual acuity below normal (20/20) were 6.7 times more likely to experience multiple falls. Older people with a history of falls were 5.4 times more likely to develop a fear of falling than those with no history of falls.[29] However, in the current study, the ABC-C was not associated with fall history. This may be due to the fact that different fall efficacy scales were used in different studies, leading to discrepant results.

This study had several limitations. First, selection bias may have influenced the results. 89% of participants were classified as community walkers. Participants were from a volunteer, community-based sample. Participants' functional and cognitive performances might have been better than those for people who are homebound. Second, there may have been recall bias, but this was minimised by including a cognitive screening test and having a caregiver present during the assessment. Third, the functional and clinical information collected at the time of the assessment might have differed from that at the time of the fall. Participants were in the chronic stage of stroke and had no hospital admissions 30 days prior to participation; abrupt changes in functional performance would not be expected. The causes of falls were not differentiated into intrinsic or extrinsic factors because of recall difficulties. Future studies with follow-up by monthly phone calls over 1 year are recommended to identify risks of falls or domestic accidents in the stroke population.

Fall rate is high among people with chronic stroke in Hong Kong. Poor balance and visual acuity are associated with falls. Adequate social support may reduce the risk of falls. Home-based or environmental interventions targeting modifiable risk factors should be considered in fall-prevention programmes.

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REFERENCES

1. Hong Kong Hospital Authority. *Hospital Authority Statistical Report 2007/2008*. Hong Kong: Hospital Authority; 2007.
2. Hyndman D, Ashburn A. People with stroke living in the community: attention deficits, balance, ADL ability and falls. *Disabil Rehabil* 2003;25:817-22.
3. Hyndman D, Ashburn A, Stack E. Fall events among people with stroke living in the community: circumstances of falls and characteristics of fallers. *Arch Phys Med Rehabil* 2002;83:165-70.
4. Yates JS, Lai SM, Duncan PW, Studenski S. Falls in community-dwelling stroke survivors: an accumulated impairments model. *J Rehabil Res Dev* 2002;39:385-94.
5. Forster A, Young J. Incidence and consequences of falls due to stroke: a systematic inquiry. BMJ 1995;311:83-6.
6. Harris JE, Eng JJ, Marigold DS, Tokuno CD, Louis CL. Relationship of balance and mobility to fall incidence in people with chronic stroke. *Phys Ther* 2005;85:150-8.
7. Weerdesteyn V, de Niet M, van Duijnhoven HJ, Geurts AC. Falls in individuals with stroke. *J Rehabil Res Dev* 2008;45:1195-213.
8. Simpson LA, Miller WC, Eng JJ. Effect of stroke on fall rate, location and predictors: a prospective comparison of older adults with and without stroke. *PLoS One* 2011;6:e19431.
9. Ho SC, Woo J, Chan SS, Yuen YK, Sham A. Risk factors for falls in the Chinese elderly population. *J Gerontol A Biol Sci Med Sci* 1996;51:M195-8.
10. Belgen B, Beninato M, Sullivan PE, Narielwalla K. The association of balance capacity and falls self-efficacy with history of falling in community-dwelling people with chronic stoke. *Arch Phys Med Rehabil* 2006;87:554-61.
11. Jorgensen L, Engstad T, Jacobsen BK. Higher incidence of falls in long-term stroke survivors than in population controls: depressive symptoms predict falls after stroke. *Stroke* 2002;33:542-7.
12. Lamb SE, Ferrucci L, Volapto S, Fried LP, Guralnik JM. Risk factors for falling in home-dwelling older women with stroke: the Women's Health and Aging Study. *Stroke* 2003;34:494-501.
13. Chiu HF, Lee HC, Chung WS, Kwong PK. Reliability and validity of the Cantonese version of Mini-Mental State Examination: a preliminary study. *J Hong Kong Coll Psychiatry* 1994;4:25-7.
14. Mak MK, Lau AL, Law FS, Cheung CC, Wong IS. Validation of the Chinese translated Activities-Specific Balance Confidence scale. *Arch Phys Med Rehabil* 2007;88:496-503.
15. Bohannon RW, Smith MB. Interrater reliability of a modified Ashworth scale of muscle spasticity. *Phys Ther* 1987;67:206-7.
16. Berg K, Wood-Dauphinee SL, Williams JL, Gayton D. Measuring balance in the elderly: preliminary development of an instrument. *Physiother Can* 1989;41:304-11.
17. Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. *J Am Geriatr Soc* 1991;39:142-8.
18. Hsueh IP, Hsieh CL. A revalidation of the Frenchay activities index in stroke: a study in Taipei area [in Chinese]. *Formos J Med* 1997;6:123-30.
19. Powell LE, Myers AM. The Activities-specific Balance Confidence (ABC) Scale. *J Gerontol A Biol Sci Med Sci* 1995;50A:M28-34.
20. Berg KO, Wood-Dauphinee SL, Williams JL, Maki B. Measuring balance in the elderly: validation of an instrument. *Can J Public Health* 1992;83(Suppl 2):S7-11.
21. Berg K, Wood-Dauphinee S, Williams JI. The Balance Scale: reliability assessment with elderly residents and patients with an acute stroke. *Scand J Rehabil Med* 1995;27:27-36.
22. Ashburn A, Hyndman D, Pickering R, Yardley L, Harris S. Predicting people with stroke at risk of falls. *Age Ageing* 2008;37:270-6.
23. Segal ME, Schall RR. Determining functional/health status and its relation to disability in stroke survivors. *Stroke* 1994;25:2391-7.
24. Shumway-Cook A, Woollacott M, Kerns KA, Baldwin M. The effects of two types of cognitive tasks on postural stability in older adults with and without a history of falls. *J Gerontol A Biol Sci Med Sci* 1997;55:M232-40.
25. Wilson BA, Cockburn J, Halligan P. *Behavioural inattention test.* Suffolk: Thames Valley Test Company; 1987.
26. Fong KN, Chan KL, Chan BY, et al. Reliability and validity of the Chinese Behavioural Inattention Test–Hong Kong version (CBIT-HK) for patients with stroke and unilateral neglect. *Hong Kong J Occup Ther* 2007;1:23-33.
27. Huo M, Maruyama H, Chen L. Relationship between probe reaction time during walking and falls for patients with post-stroke hemiplegia. *J Phys Ther Sci* 2009;21:349-54.
28. Fong KN, Siu AM, Au Yeung K, Cheung SW, Chan CC. Falls among the community-living elderly people in Hong Kong: a retrospective study. *Hong Kong J Occup Ther* 2011;21:33-40.
29. Friedman SM, Munoz B, West SK, Rubin GS, Fried LP. Falls and fear of falling: which comes first? A longitudinal prediction model suggests strategies for primary and secondary prevention. *J Am Geriatr Soc* 2002;50:1329-35.