FACTORS RELATED TO FALLS AMONG COMMUNITY DWELLING ELDERLY

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Abstract. Falls among the elderly can lead to disability, hospitalization and premature death. This study aimed to determine the factors related to falls among community dwelling elderly. This case-control study was conducted at the Samlium Primary Care Unit (SPCU), Khon Kaen, Thailand. Cases were elderly individuals who had fallen within the previous six months and controls were elderly who had not fallen during that same time period. Subjects were taken from elderly persons registered at the SPCU. The sample size was calculated to be 111 cases and 222 controls. Face to face interviews were conducted with subjects between May and June, 2011. The response rate was 100%. On bivariate analysis, the statistically significant factors related to falls were: regular medication use, co-morbidities, mobility, depression, cluttered rooms, slippery floors, unsupported toilets (without a hand rail), sufficient exercise, rapid posture change and wearing slippers. When controlling for others significant factors, multiple logistic regression revealed significant factors were: regular medication use (AOR: 2.22; 95%CI: 1.19-4.12), depression (AOR: 1.76, 95%CI: 1.03-2.99), sufficient exercise (AOR: 0.34; 95%CI: 0.19-0.58) and wearing slippery shoes (AOR: 2.31; 95%CI: 1.24-4.29). Interventions need to be considered to modify these significant factors associated with falls and education should be provided to these at risk.

Keywords: falls, elderly, community

INTRODUCTION

A fall is an unintentional loss of balance, causing one to make unexpected or unprepared contact with the ground or floor. Falling is a common problem among the elderly in many countries (Bekibele and Gureje, 2010). In Thailand, Jitapunkul *et al* (1998) found the prevalence of one or more falls is 18.7% and elderly females fell more often (21.5%) than their male counterparts (14.4%). Most falls occurred outside (65%) and during the day time (85%) (Jitapunkul *et al*, 1998). In urban areas, Assantachai *et al* (2003) found the overall prevalence of falls among elderly Thais was 19.8% over a period of six months. The prevalence of falls among Thai women is 24.1% and among Thai men is 12.1% (Assantachai *et al*, 2003). Among elderly Thais suffering from stroke, Chaiwanichsiri *et al* (2006) found 15.9% experience at least one fall, the incidence rate of falls among elderly Thais is 3.44/1,000 person/day. Most falls (71.4%) occur in the bathroom (37.1%) or

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bedside (22.9%) and falls frequently occur while transferring (22.9%) or walking (20%) (Chaiwanichsiri *et al*, 2006).

Many falls among the elderly result in sequalae. The incidence of fall induced death among older persons in Finland increased considerably between 1971 to 2002, from 441 to 1,039 (136% increase); among men it increased from 162 to 488 (201% increase) and among women it increased from 279 to 551 (97% increase), respectively (Kannus *et al*, 2005). Falling is a major cause of injury among the elderly resulting in death. A previous study revealed more than half of all falls resulted in minor injury, and one quarter resulted in a serious injury, with approximately 10% causing fractures (Bergland and Wyller, 2004). Nurmi and Luthje (2002) found one-third of all falls resulted in an injury and every fifth injurious fall resulted in the need for treatment outside the patient's own ward, and those over age 75 were more likely to be hospitalized when experiencing a fall. A single non-injurious fall and at least one injurious fall were each associated with a decline in basic and instrumental activities of daily living over a three years period after adjusting for covariates (Tinetti and Williams, 1998). Experiencing two or more non-injurious falls was associated with a decline in social activities while experiencing at least one injurious fall was associated with a decline in physical activity (Tinetti and Williams, 1998). Results of the falls included discomfort and disability in the older adults and stress among the caregivers (Tinetti and Kumar, 2010).

Falls are a result of the complex combination of medical and lifestyle factors operating alone or in association with precipitating environmental factors (Weir and Culmer, 2004). There are several risk factors involved in falling, including postural hypotension, use of sedatives, use of at least four prescription medications, impairment of arm or leg strength or range of motion, impaired balance, transfer skills (inability to move safely from bed to chair, bathtub, or toilet), gait disturbance, history of stroke, cognitive impairment, visual impairment, chronic pain and specific pathogenic ailments (Larson and Bergmann, 2008). The presence of one or more of these factors considerably increases the possibility of a fall, especially in the case of advanced age.

Health behavioral factors have been found to provide significant protection against falls. Peel *et al* (2006) found never having smoked, moderate alcohol consumption in middle or older ages, no loss of weight between middle and older age, playing sports at an older age and practicing a number of preventive medical care and self-health behaviors were factors associated with hip fractures. Home factors and environment were also associated with falls in the elderly (Pynoos *et al*, 2010).

The development of fall prevention strategies is essential in caring for elderly people. However, a global consensus does not exist for the elderly living independently in their communities (Cornillon *et al*, 2002). Some environmental factors relating to falls among the elderly have triggered controversy (Sattin *et al*, 1998). Further behavior related falling, such as climbing ladders, a rapid change in posture, walking speed, inappropriate clothing (such as wearing long dressing gowns) and unsuitable or slippery shoes have not yet been investigated. Fall prevention must identify population based risk factors appropriate to one's life stage. This study, therefore aims to determine

the factors related to falls among the community dwelling elderly. It attempts to contribute to the evidence for the promotion of population based intervention for fall prevention.

MATERIALS AND METHODS

We conducted a case-control study among people aged >60 years living in Samlium Community and registered for health care at Samlium Primary Care Unit (SPCU), Khon Kaen, Thailand for more than 1 year. The exclusion criteria were elderly residents who were dependent, severely disabled, or were unable to participate or communicate with others.

Cases were elderly subjects who had fallen within the previous 6 months and controls were elderly who had not fallen within the previous 6 months, registered by the SPCU and resulted in a preliminary survey. There were 621 names registered with the SPCU who were elderly (139 cases and 482 controls). A sample size calculation was conducted based on preliminary study results of estimated risk factors. Using a correlation coefficient of 0.5, an odds ratio of 2, a power of 90% and an alpha risk of 5%, the proportion of controls exposed to a risk factor was 42%. An over sample size of 333 subjects was required (cases=111, controls=222).

Independent variables (the factors related to falls) were identified by a systematic review of previous studies and interviews with the elderly within the study area. The analyzed factors consisted of three domains. First, internal factors, namely, hospital admission within the past year, regular medication use, co-morbidities, hearing problems, vision problems, body mass index (BMI), mobility and depression. Second, external factors, namely, a cluttered room, slippery floors, unsupported toilet (without a hand rail) and dim lighting. Third, behavioral factors, namely, alcohol use, smoking, energy drink use, coffee or tea drinking, sufficient exercise, walking up and down stairs daily, rapid changes in posture, regular lifting of heavy objects, wearing clothes clumsily and wearing slippers.

The study tool was a questionnaire with two parts: the participant's demographics and the factors related to the fall. Demographics were collected by the research team and factors associated with falls included measuring the weight and height of the participants. BMI was used to divide subjects into two groups: 19-23 was considered normal and >23 was considered as moderate to high risk (Barba *et al*, 2004). We determined depression using Geriatric Depression Scale (Yesavage *et al*, 1982); subjects were divided into two groups: a score <6 was considered normal and a score ≥6 was considered depression (Jitapunkul *et al*, 1994). Mobility was determined using the Time Up and Go test (Marcon *et al*, 2010). Environmental and behavioral factors were adopted from Huang and Acton (2004).

The content validity was reviewed and tested by experts. Face to face interviews were conducted in an environment comfortable for the participants between May and June, 2011. The data and forms were checked for completeness; the data was double entered and validated in EPI INFO for DOS before the data was transferred into SPSS for Windows for data analysis.

Descriptive statistics were used to describe frequency, percentage, mean, SD, median, and IQR. Inferential statistics for bivariate analyses were: chi-square, Mann-Whitney *U* test, odds ratio and

Table 1
Demographic characteristics of the sample.

Characteristic	Cases *n*=111	Controls *n*= 222	*p*-value
Gender			
Male	35 (31.5%)	88 (39.6%)	0.148
Female	76 (68.5%)	134 (60.4%)	
Age			
Median (Years)	69 years	68 years	0.394
IQR	11	10	
Education			
None	8 (7.2%)	22 (9.9%)	0.839
Primary school	78 (70.3%)	155 (69.8%)	
Secondary school	19 (17.1%)	33 (14.9%)	
Bachelor degree	6 (5.4%)	12 (5.4%)	
Caregiver			
No	26 (23.4%)	74 (33.3%)	0.063
Yes	85 (76.6%)	148 (66.7%)	

multivariate analysis using multiple logistics regression. A probability (*p*-value) <0.05 was considered significant on multivariate analysis. Ethical approval for the study was obtained from Khon Kaen University. Participants gave written consent prior to participation in the study.

RESULTS

Demographic characteristics

The response rate was 100%. Participants consisted primarily of females. The median age of cases was 69 ± 11 years and of controls was 68 ± 10 years. Most participants had a primary school education. One quarter of participants had no caregiver. There were no significant differences in demographic characteristics between cases and controls (Table 1).

Bivariate analysis

Bivariate analysis revealed the internal factors related to falls were: regular medication use, co-morbidities, mobility problems and depression, the external factors related to falls were: a cluttered room, slippery floors, and toilets without a hand rail, and the behavioral factors relating to a fall were: insufficient exercise, rapid posture changes and wearing slippers (Table 2).

Multivariate analysis

Multiple logistic regression analysis was performed for factors significant on bivariate analysis. After adjusting for potentially confounding factors, multiple logistic regression analysis found clinical factors associated falls were regular medication use and depression, the behavioral factor associated with falls was wearing slippery shoes. We also found getting sufficient exercise was protective against falling (Table 3).

DISCUSSION

The risk factors categories for falls are: internal, external and behavioral factors. Although no single risk factor causes all falls, the greater the number of

Table 2
Bivariate analysis of factors associated with fall.

Characteristic	Cases *n*=111	Controls *n*= 222	*p*-value	COR	95%CI
Hospital admission within the previous year					
Yes	51 (45.9%)	74 (33.3%)	0.025[a]	1.70	1.04-2.78
No	60 (54.1%)	148 (66.7%)			
Regular medication use					
Yes	80 (72.1%)	122 (55.0%)	0.003[a]	2.12	1.26-3.57
No	31 (27.9%)	100 (45.0%)			
Co-morbidities					
Yes	89 (80.2%)	151 (68.0%)	0.020[a]	1.90	1.07-3.41
No	22 (19.8%)	71 (32.0%)			
Depression					
Yes	74 (66.7%)	97 (43.7%)	<0.001[b]	2.58	1.56-4.27
No	37 (33.3%)	125 (56.3%)			
Hearing problems					
Yes	29 (26.1%)	47 (21.2%)	0.310	1.32	0.75-3.32
No	82 (73.9%)	175 (78.8%)			
Vision problems					
Yes	48 (43.2%)	84 (37.8%)	0.342	1.25	0.77-2.04
No	63 (56.8%)	138 (62.2%)			
BMI					
Normal	36 (35.3%)	72 (35.2%)	0.450	Ref	
Underweight	5 (4.9%)	14 (6.8%)	0.546	0.71	0.21-2.35
Over weight	61 (59.8%)	119 (58.0%)	0.923	1.03	0.60-1.75
Mobility					
Normal	86 (77.5%)	199 (89.6)	0.012[a]	Ref	
Walks without aids	11 (9.9%)	10 (4.5%)	0.034[a]	2.55	0.96-6.76
Walks with aids	14 (12.6%)	13 (5.9%)	0.021[a]	2.49	1.05-5.92
Cluttered room					
Yes	46 (41.4%)	62 (27.9%)	0.013[a]	1.83	1.10-3.03
No	65 (58.6%)	160 (72.1)			
Slippery floor					
Yes	54 (48.6%)	75 (33.8%)	0.009[a]	1.86	1.14-3.04
No	57 (51.4%)	147 (66.2%)			
Toilet without hand rail					
Yes	80 (72.1%)	129 (58.1%)	0.013[a]	1.86	1.11-3.14
No	31 (27.9%)	93 (41.9%)			
Insufficient/dim lighting					
Yes	28 (16.2%)	56 (25.2%)	0.635	1.14	0.65-2.00
No	73 (83.8%)	166 (74.8%)			
Alcohol use					
Yes	38 (15.3%)	70 (22.5%)	0.169	1.13	0.68,1.89
No	73 (84.7%)	152 (77.5%)			
Smoking					
Yes	15 (8.1%)	28 (12.6%)	0.817	1.08	0.52-2.22
No	96 (91.9%)	194 (87.4%)			

Table 2 (Continued).

Characteristic	Cases *n*=111	Controls *n*= 222	*p*-value	COR	95%CI
Energy drink					
Yes	13 (11.7%)	40 (18.0%)	0.138	0.60	0.29-1.23
No	98 (88.3%)	182 (82.0%)			
Coffee or tea use					
Yes	47 (37.8%)	86 (38.7%)	0.526	1.16	0.71-1.89
No	64 (62.2%)	136 (61.3%)			
Sufficient exercise					
Yes	52 (46.8%)	161 (72.5%)	<0.001[b]	0.33	0.20-0.55
No	59 (53.2%)	61 (27.5%)			
Walk up and down stairs daily					
Yes	65 (53.2%)	126 (56.8%)	0.753	1.08	0.66-1.75
No	46 (46.8%)	96 (43.2%)			
Rapid changes in posture					
Yes	74 (66.7%)	111 (50.0%)	0.004[b]	2.00	1.21-3.31
No	37 (33.3%)	111 (50.0%)			
Regularly carries heavy objects					
Yes	76 (68.5%)	144 (64.9%)	0.513	1.18	0.70-1.97
No	35 (31.5%)	78 (35.1%)			
Wears inappropriate clothing (long dressing gowns or trousers)					
Yes	13 (9.0%)	21 (9.5%)	0.522	1.27	0.57-2.79
No	98 (91.0%)	201 (90.5%)			
Wears slippers					
Yes	33 (29.7%)	36 (16.2%)	0.004[b]	2.19	1.23-3.89
No	78 (70.3%)	186 (83.8%)			

[a] $p<0.05$; [b] $p<0.01$.

Table 3
Factors associated with falls on multivariate analysis.

Factors		AOR	95%CI	*p*-value
Hospital admission within the previous year	Yes/No	1.10	0.64-1.89	0.726
Regular medication use	Yes/No	2.22	1.19-4.12	0.012[a]
Co-morbidities	Yes/No	1.13	0.58-2.19	0.717
Mobility	Walking without aids	1.48	0.52-4.18	0.455
	Walking with aids	0.98	06.2-1.53	0.925
Depression	Yes/No	1.76	1.03-2.99	0.037[a]
Cluttered rooms	Yes/No	1.48	0.86-2.53	0.156
Slippery floor	Yes/No	1.62	0.96-2.72	0.068
Toilet without hand rail	Yes/No	1.19	0.68-2.07	0.545
Sufficient exercise	Yes/No	0.34	0.19-0.58	<0.001[b]
Rapid change in posture	Yes/No	1.68	0.96-2.90	0.070
Wearing slippers	Yes/No	2.31	1.24-4.29	0.008[b]

[a] $p<0.05$; [b] $p<0.01$.

risk factors a person has, the more likely they are to fall. In this study confounding factors were controlled on multivariate logistic analysis. Three risk factors and one protective factor were significant on multivariate analysis.

In this study regular medication use was related to falls. Regular medication use was defined as using one or more drugs on a daily basis during the previous 6 months. Little is known about regular medication use and falls among elderly Thais. A previous study found the elderly who took more drugs had a higher risk of falls (Fong *et al*, 2011). Ziere *et al* (2006) found the risk of falling increased significantly with the number of drugs used per day ($p<0.0001$) and after adjusting for a large number of co-morbid conditions and disabilities, poly-pharmacy remained a significant risk factor for falling and poly-pharmacy with or without at least one drug is known to increase fall risk (CNS drugs and diuretics).

Although our study did not determine the kind of medication used, due to limitations of the research design, psychotropic medications are commonly prescribed for older people, both in the community and in residential care setting, including benzodiazepines (particularly, the long-acting agents), antidepressants, and antipsychotic drugs (Hill and Wee, 2012). The use of benzodiazepines is the strongest predictor for falls among the elderly (Tromp *et al*, 2001). Psychotropic medication use is associated with an increased risk for falls (Gama and Gomez-Conesa, 2008; Hill and Wee, 2012). Baranzini *et al* (2009) found benzodiazepines (OR: 2.357; 95% CI: 1.5-3.702) and mood stabilizers (OR: 1.889; 95% CI: 1.091-3.270) were associated with falls when adjusting for age, sex and co-morbidities. Polypharmacy (≥ 4 drugs) is a risk factor for falls only when the daily medication regimen includes a high risk medication (OR: 2.157; 95%CI: 1.447-3.217) (Baranzini *et al*, 2009).

Our study also found symptoms of depression were related to falls. This is consistent with a study in older Taiwanese individuals, which revealed depressive symptoms were significantly more prevalent among recurrent fallers (40.0%) and once-only fallers (27.5%) than non-fallers (16.1%) (Kwan *et al*, 2012). Questionable depression (OR: 1.32; 95%CI: 1.13-1.53) and clinically significant symptoms of depression (OR: 1.70; 95%CI: 1.14-1.50) were found to be independently associated with multiple falls (Kerse *et al*, 2008). Among institutionalized elders, Wang *et al* (2012) found depression was increase the risk of fall beyond that of medical conditions alone. Compared to non-depressed elders, depressed elders on multiple medications have a 5-fold higher risk of fall, depressed elders using ancillary devices have a 6-fold higher risk of fall and depressed elders with neurological diseases have an 11-fold higher risk of fall than non-depressed elderly (Wang *et al*, 2012).

Sufficient exercise (20 minutes 3 times weekly) of appropriate type (walking, Tai Chi, jogging and aerobics) (Adab and Macfarlane, 1998) is protective against falls (Yu *et al*, 2009). Reductions in the risk for falls has also been reported in other studies (Cornillon *et al*, 2002; Sohng *et al*, 2003; Yoo *et al*, 2010). Exercise and participation in sports by the elderly also reduces the risk of hip fracture (AOR: 0.49; 0.29-0.83) (Peel *et al*, 2006). Sufficient exercise and fall prevention exercise programs significantly enhanced muscle strength, ankle flexibility and balance, and

in reduce depression among community-dwelling elderly in Korea (Sohng *et al*, 2003).

The last significant factor, of which there has been little previous research, is the association between wearing slippers and falls among elder Thais. Our study found an association between wearing slippers and falling. A slipper is a semi closed type of indoor or outdoor shoes, consisting of a sole held to the wearer's foot by a strap running over the toes or instep. Slippers are soft and lightweight compared to other types of footwear. Normally, Thai elderly go barefoot inside their homes and wear slippers to go outside, where they may fall (Jitapunkul *et al*, 1998). Our study found 50% of elderly women and 34% of elderly men wore too narrow shoes causing foot pain, leading to walking more slowly which could result in a fall (Chaiwanichsiri *et al*, 2009). The slipper is inappropriate for the elderly. The slippers often have worn and soles making them more slippery and increasing the risk of falling.

The strength of this study is that it was a population based case-control study with a high response rate. A limitation of this study was that it was based on recall of the subject and liable to recall bias.

In conclusion, factors related to falls in our study among the elderly were wearing slippers, insufficient exercise, regular medication usage and depression. Community based interventions for fall prevention among the elderly should include education about appropriate footwear. Exercise programs for the elderly should be promoted. Routine medications should be reviewed carefully to monitor for side effects, compliance and polypharmacy in order to identify problems, such as adverse drug effects, which could increase the risk of falls. Symptoms of depression should be screened for and managed.

ACKNOWLEDGEMENTS

The authors are grateful to many people who assisted in the completion of this project. We wish to acknowledge Khon Kaen University and the Faculty of Medicine for financial support. We would like to thank the public health staff, the Khon Kaen Municipality health staff, and the elders for their excellent cooperation.

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