EFFECT OF THE LIVING ENVIRONMENT ON FALLS AMONG THE ELDERLY IN THAILAND

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Abstract. The household environment influences the health of the elderly. We studied home hazards and living arrangements and their association with falls among the elderly in Thailand. The data were obtained from a national survey among the elderly in Thailand conducted by the National Statistical Office in 2007. The survey asked about a history of falls, the household environment and possible risk factors for falls. The survey was conducted in 26,689 subjects aged ≥ 60 years. The factors associated with a chance of falls were: a slippery floor in the first storey of the house (OR 1.39; 95% CI 1.21-1.59, $p =0.000$), a slippery floor in the bathroom or toilet (OR 1.32; 95%CI 1.16-1.49, $p=0.000$) and bathroom or toilet located outside the house (OR 1.23; 95%CI 1.12-1.35, $p=0.000$). Elderly people who lived with spouse had a 32% lower chance (OR 0.68; 95%CI 0.59-0.78, $p=0.000$) of experiencing a fall than those who lived alone in the house.

Keywords: household environment, falls, elderly, Thailand

INTRODUCTION

In Thai society, most elderly live at home. Living conditions that allow the elderly to age safely within their own home are universally valued (WHO, 2007b). The household environment is a basic factor influencing health and ability to "age in place". It can either support or limit physical, mental and social well-being (Bonnefoy, 2007).

Falls are the most common unintentional injury among the elderly and are an important public health problem (Minis-

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try of Public Health, cited by Chunharas, 2007). Approximately one-third of people aged ≥ 65 years experience falls at least once a year (Rubenstein and Josephson, 2002). A national survey in Thailand showed 10% of elderly experienced falls during the 6 month period prior to the survey (National Statistical Office, 2007). Falls are associated with morbidity, such as fractures, soft tissue injuries and post-fall syndromes, which can dramatically impact quality of life (Tinetti and Powell, 1993; Tinetti and Williams, 1997; Rubenstein and Josephson 2002). Falls are a leading factor determining hospital admission (Assantachai and Maranetra, 2005) and a common cause of death in the elderly (Centers for Disease Control and Prevention, 2010). Falls are particularly costly to the individual and society (Stevens *et al*, 2006).

The household environment may have an impact on fall risk but there have been few studies supporting this view. Several studies have examined the association between home hazards and falls, but the results are not consistent. Some studies support the association between home hazards and falls. Prospective cohort studies by Northridge *et al* (1995) and Bemmel *et al* (2005) found the elderly who lived in homes with greater numbers of hazards were more likely to fall. A case-control study by Fletcher and Hirdes (2002) found an association between the presence of one or more hazards and fall risk. A case-control study by Isberner *et al* (1998) reported differences between fallers and non-fallers in the presence of hand-rails and the presence of uneven floors. However, no association was found between the presence of home hazards and falls in a number of case-control studies (Clemson *et al*, 1996; McLean and Lord, 1996; Sattin *et al*, 1998; Kinn and Clawson, 2002) and cohort studies (Campbell *et al*, 1990; Gill *et al*, 2000). Teno *et al* (1990) found no association between risk factors, such as loose rugs and slippery floors, and the risk of falls.

Slippery surfaces on stairs, narrow steps, loose rugs, and poor lighting are often mentioned as risk factors for falls but there is little evidence to support this. Context sensitive research is needed. There are differences in landscape, weather, culture, lifestyle, beliefs and household environments. Several studies of Thai-style houses (Jitapunkul *et al*, 1998; Thiamwong *et al*, 2008) have found elevated floors are a risk factor for falls, suggesting studies from other countries may not be applicable to Thailand.

Isolation and loneliness triggered by living alone are associated with fear of falling, physical, cognitive, and sensory limitations, which can cause falls (WHO, 2007a). The proportion of Thai elderly who live alone increases every year (National Statistical Office, 2007). These living arrangements and their effect on falls have not been previously studied within the Thai context.

For these reasons we studied the home hazards and living arrangements and their association with falls among elderly Thais. We used data from a national survey conducted among elderly Thais in 2007. The findings may be used to develop fall prevention guidelines and programs.

MATERIALS AND METHODS

Source of data and study design

This study used data from a national survey among elderly Thais conducted in 2007. This cross sectional survey was conducted by the National Statistical Office (NSO) of Thailand. The NSO has conducted surveys in 1994, 2002 and 2007 to obtain the information used for developing appropriate policies and programs to ensure the well-being of elderly Thais (National Statistical Office, 1994, 2002, 2007). Data regarding elderly Thais, demographics, living household conditions, socioeconomic conditions and health were collected.

The survey was based on a probability sampling of people aged 50 years or older who were residents of their own or a family member's household. The survey employed a two-stage sampling. The primary sampling units were blocks for municipal areas and villages for non-municipal areas. The secondary sampling units were households using random sampling from a list of all households in the selected block or village. Fifteen households per block and twelve households per village were selected. A structured interview was

conducted to select respondents at the household level. This study focused on people age ≥60 years.

Dependent variables

We examined the incidence of falls among the elderly. A fall was defined as inadvertently coming to rest on the ground, floor or other lower level (National Statistical Office, 2007). Falls excluded those events resulting from outside events, such as a motor vehicle accident or violence. Responses were grouped into: 1) no fall, 2) one fall or 3) two or more falls during the previous 6 months (National Statistical Office, 2007). For logistic regression, two categories were used: no history of fall or at least one fall.

Independent variables

The independent variables chosen were based on a review of the literature, a review of guidelines on fall prevention and consultations with experts. We chose 10 independent variables. Nine variables were related to home hazards: 1) the first floor of the house was higher than the ground and a stair was required to enter the house, 2) a slippery floor on the first storey of the house, 3) a slippery bathroom or toilet floor, 4) no stair handrail, 5) no handrail in the bedroom, 6) no handrail in the bathroom or toilet, 7) a bedroom located on the second floor or higher, 8) a bathroom or toilet located outside the house and 9) a crouching position when using the toilet. For living arrangements, there were four response categories: living alone, living with a spouse, living with a child without spouse and living with people other than a spouse or a child. For analysis, dummy variables were created and the answer living alone was used a reference category.

The demographics, health status, behavioral, and socioeconomic variables were used as control variables. Two previous studies in Thailand (Jitapunkul *et al*, 1998; Assantachai *et al*, 2003) have shown these variables had an effect on falls. Therefore, we needed to control for their effects to determine the effect of household environment on falls. Demographic variables were age (60-69, 70-79 or 80 years and older) and sex. Variables related to health status included perceived health status (very good/good/fair or bad/fairly bad); chronic diseases included hypertension, stroke, diabetes mellitus, paresis/paralysis and heart diseases (reported or not reported); functional ability in bathing and toileting, crouching, walking 200-300 meters and climbing stairs 2-3 steps (independently or dependently); problems with seeing (reported or not reported); and problems with hearing (reported or not reported). Behavioral variables were exercise (regularly or never/not regularly); intake of fresh vegetables and fruits (regularly or never/not regularly); and alcohol consumption (yes or no). Socioeconomic variables were participation in social activities (never or participate in at least one kind of activity); income (sufficient or insufficient); and level of education (no schooling, primary level, secondary level, or higher than secondary level).

Statistical analysis

Bivariate and multivariate analyses were employed to analyze the data. The chi-square test was initially used to examine whether there was an association between the independent variable and the probability of falling. Significant variables on bivariate analysis were further analyzed by multivariate analysis. Logistic regression was used to examine whether each independent variable affected the likelihood of falls when controlling for other variables. A *p*-value of < 0.05 was considered statistically significant. The

statistical package, Stata.SE 9.1, was used for data analysis.

RESULTS

Twenty-six thousand six hundred eighty-nine subjects were included in the study. The mean age and standard deviation were 69.99 and 0.05 years, respectively. Fifty-six point seven percent were females. Ten point four percent experienced a fall during the 6 months prior to the interview. Approximately 45% experienced more than one fall. Fifty-four point five percent of falls occurred outside the home. The two most common causes of falls were tripping (34.6%) and slipping (31.6%) (Table 1).

A higher proportion of falls occurred in older age groups. Females experienced falls more than males. Falls occurred more often among those perceiving poor health, among those with chronic diseases (stroke, hypertension, heart diseases diabetes mellitus, and paresis/paralysis), among those with difficulty in functional mobility, and among those with sensory problems (vision and hearing). Falls occurred more often among those who did not exercise regularly. Falls occurred more often among those who did not participated in social activities, had insufficient income and had lower levels of education (Table 2).

Table 3 shows the history of fall by household environment. There were no differences in falls by elevation of floor from ground, availability of handrails with stairs, bedrooms, bathrooms, or toilets or by position while using the toilet. Subjects living with spouses had a lower chance of falling.

Logistic regression was used to assess the net effect of each independent variable on falls after controlling for the

Table 1
Characteristics of falls during the 6 months prior to the interview.

	% with history of falls (N=2,787)
Number of falls in 6 months	
1	55.4
≥ 2	44.5
Not known	0.1
Place where last fall took place	
Inside the home	45.5
Outside the home	54.5
Cause of last fall	
Slipped	31.6
Tripped	34.6
Uneven floor	8.0
Fell down stairs	3.2
Syncope	14.1
Others	8.5
Medical care received after fall	
Received care but not hospitalized	27.0
Hospitalized	11.4
Self care	34.2
No need for care	27.3

other variables. Home hazards and living arrangements were significant predictors of falls (Table 4). Those whose houses had slippery first floors were 1.39 times more likely to fall than those whose houses did not (OR 1.39; 95%CI 1.21-1.59). Those who had slippery bathroom floors were 1.32 times more likely to fall than those who did not (OR 1.32; 95%CI 1.16-1.49). Those who had bathrooms or toilets located outside their house were 1.23 times more likely to fall than those who did not (OR1.23; 95%CI 1.12-1.35). However, those who had a bedroom located on the second floor had a 13% lower chance of falling than those whose bedroom was located on the first floor. Those who lived with their spouses had a 32% lower

Table 2
Study subject characteristics by history of falls (*N*=26,689).

Selected characteristics	History of falls (%)		*p*-value[a]
	No	Yes	
Age			
60-69	90.8	9.2	
70-79	88.5	11.5	0.000
≥80	87.2	12.8	
Female gender			
Yes	87.8	12.2	0.000
No	91.9	8.1	
Perceived poor health			
Yes	81.7	18.3	0.000
No	92.2	7.8	
History of stroke			
Yes	81.4	18.6	0.000
No	89.8	10.2	
History of hypertension			
Yes	86.9	13.1	0.000
No	90.8	9.2	
History of diabetes mellitus			
Yes	85.6	14.4	0.000
No	90.1	9.9	
History of heart disease			
Yes	81.5	18.5	0.000
No	90.3	9.7	
History of paresis/paralysis			
Yes	82.6	17.4	0.000
No	89.8	10.2	
Difficulty in bathing			
Yes	84.3	15.7	0.000
No	89.8	10.2	
Difficulty in crouching			
Yes	82.4	17.6	0.000
No	90.8	9.2	
Difficulty in walking			
Yes	83.4	16.6	0.000
No	91.0	9.0	
Difficulty in climbing			
Yes	83.3	16.7	0.000
No	90.6	9.4	
Problem seeing			
Yes	84.5	15.5	0.000
No	90.9	9.1	
Problem hearing			
Yes	84.5	15.5	0.000
No	90.5	9.5	

Table 2 (Continued).

Selected characteristics	History of falls (%)		p-value[a]
	No	Yes	
No regular exercise			
Yes	89.0	11.0	0.000
No	90.3	9.7	
No regular intake of vegetables			
Yes	89.1	10.8	0.073
No	89.8	10.3	
Alcohol consumption			
Yes	87.5	12.5	0.066
No	89.6	10.4	
Live in an urban area			
Yes	89.7	10.3	0.418
No	89.4	10.6	
Did not participate in social activities			
Yes	88.8	11.2	0.022
No	89.8	10.2	
Insufficient income			
Yes	86.6	13.4	0.000
No	91.3	8.7	
Education level			
No school	87.2	12.8	
Primary	89.5	10.5	0.000
Secondary	92.2	7.8	
College or higher	94.8	5.2	

[a]Chi-square test

chance of falling than those living alone. No significant association was observed with those who lived with their children but without their spouses, those who lived with people other than their spouses or children and falling.

DISCUSSION

We studied the household factors in Thailand that could cause falls in the elderly. Slippery floors in houses and bathrooms were important risk factors for falls. Most elderly Thais attributed their falls to trips or slips. Ageing is associated with a decline in several body systems essential to balance (Vejbaesya, 1997). Slippery floors contribute to loss of balance in the elderly. Another significant risk for falls among the elderly is the location of bathrooms or toilets outside the home. Falls related to toilets outside the house may be due to inadequate lighting, uneven floors and the path to the toilet. This risk factor is different from many developed countries. The layout of the house should be evaluated when assessing fall risk. A bedroom on the first storey,

Table 3
Household environment and history of falls (*N*=26,689).

Household environment	% of elderly History of falls (%)		*p*-value[a]
	No	Yes	
House with first floor elevated from ground			
Yes	89.2	10.8	0.080
No	89.8	10.2	
Slippery first floor of house			
Yes	84.2	15.8	0.000
No	90.1	9.9	
Slippery of bathroom/toilet floor			
Yes	84.8	15.2	0.000
No	90.1	9.9	
No stair handrail			
Yes	89.3	10.7	0.222
No	89.7	10.3	
No handrail in bedroom			
Yes	89.6	10.4	0.142
No	87.5	12.5	
No handrail in bathroom			
Yes	89.6	10.4	0.284
No	88.6	11.4	
Bedroom on second floor or higher			
Yes	91.4	8.6	0.000
No	88.7	11.3	
Bathroom/toilet located outside house			
Yes	87.5	12.5	0.000
No	90.2	9.8	
Crouching position when using toilet			
Yes	89.6	10.4	0.799
No	89.7	10.3	
Living arrangements			
Alone	86.7	13.3	
With spouse	91.6	8.4	0.000
With children	86.6	13.4	
With other(s)	87.7	12.3	

[a]Chi-square test

making it unnecessary to use stairs, was associated with increased risk for falls. Bemmel *et al* (2005) attempted to explain the relationship between home hazards and falls. It is possible that modification of the home is conducted in homes where the elderly have a history of falls.

In this study, absence of handrails, using squat toilets and living in houses with the first floor elevated above the ground were not associated with a history of falls. The unavailability of handrails in toilets,

Table 4
Factors related to fall among elderly Thais.

	Dependent variable = history of falls (Reference category = no history of falls)		
	Adjusted OR[a]	95%CI	*p*-value
Living environment			
Slippery floor (ref : not slippery)			
Slippery first floor of house	1.39	1.21-1.59	0.000
Slippery (bathroom/toilet floor)	1.32	1.16-1.49	0.000
Bathroom/toilet location (ref : located inside)			
Bathroom/toilet located outside house	1.23	1.12-1.35	0.000
Floor where bedroom is located (ref : first floor)			
Second floor or higher	0.87	0.80-0.96	0.004
Living arrangements (ref : living alone)			
Lives with spouse with or without children	0.68	0.59-0.78	0.000
Lives with children without spouse	0.90	0.78-1.04	0.159
Lives with people other than spouse or children	0.86	0.71-1.03	0.100
Demographic, health status, health behavioral, and socioeconomic variables			
Gender (ref : male)			
Female	1.33	1.22-1.46	0.000
Perceived health status (reference: good health)			
Poor health	1.84	1.68-2.02	0.000
Reported chronic diseases (ref : reported)			
No reported diabetes	0.84	0.75-0.94	0.002
No reported heart disease	0.65	0.57-0.73	0.000
No reported hypertension	0.87	0.79-0.95	0.002
No reported stroke	0.82	0.64-1.05	0.124
No reported paralysis	0.97	0.78-1.21	0.783
Ability to carry out daily activities (ref : able to do)			
Unable to walk independently	1.20	1.04-1.39	0.011
Unable to crouch independently	1.44	1.27-1.63	0.000
Unable to bathe independently	0.73	0.59-0.91	0.005
Unable to climb independently	0.98	0.84-1.15	0.831
Sensory problems (ref : no problem)			
Problem seeing	1.18	1.07-1.30	0.001
Problem hearing	1.24	1.11-1.39	0.000
Exercise or physical activity (ref : regular exercise)			
No regular exercise or physical activity	0.87	0.80-0.95	0.002
Income sufficiency (ref : sufficient income)			
Insufficient income	1.39	1.28-1.51	0.000
Education level (ref : no schooling)			
Primary	0.98	0.88-1.08	0.643
Secondary	0.93	0.76-1.14	0.478
Higher than secondary	0.66	0.50-0.88	0.005
Location of home (ref : rural)			
Urban	0.88	0.84-0.93	0.000

[a]Controlled for all variables in the table

LR Chi^2 = 1,093.88, df = 34; *p*-value = 0.0000; Pseudo R^2 = 0.0612; Number of cases = 26,689

on stairs and in bedrooms not being associated falls is in contrast to the findings of Isberner *et al* (1998). These findings may be explained by differences in health and mobility levels. Isberner *et al* (1998) investigated elderly receiving home health care services, who tended to be frail. Unavailability of grab rails or using squat toilets may be risk factors for falls in the elderly if they have difficulty in climbing stairs and making transfers in bedrooms and bathrooms. Traditional Thai style houses with elevated floors were not associated with falls in this study, but Jitapunkul *et al* (1998) found an association with falls in female residents. Physical differences between males and females may have put females at higher risk in Thai houses (WHO, 2007a).

This is the first study to evaluate household environment in social aspects and their association with falls among elderly Thais. Elderly who lived alone had a greater probability of falling than those who lived with their spouses. Living alone was associated with a fear of falling (Mann *et al*, 2006). Individuals who live alone may hesitate to perform activities without some assistance. This fear often leads to avoidance of activities leading to deterioration of physical and mental health, resulting in an increase risk of falling (Howland *et al*, 1998). Living with a spouse might reflect informal caregiving, which could decrease the risk of falls. Caregiving between partners is common in Thai society; 28% of those who care for older adults are spouses (National Statistical Office, 2007). Caregivers of the elderly who are themselves over age 60 have a better understanding of the needs of older adults (Hooyman and Kiyak, 2009). This may explain the observation of no association with falls in those living with children and living with others, compared to those living alone. Although children are the largest group of caregivers (National Statistical Office, 2007), they may have less awareness of the needs of elderly.

Fall prevention strategies may be more effective if consideration is given to the home environment. Home assessment, education regarding home hazards, and home modification which are appropriate within the Thai context are essential. Nonslippery floors and age-friendly access to bathrooms should be emphasized. Those living with the elderly are an important target population for a fall prevention program.

A major strength of this study is that other variables associated with falls were included in the analysis so the net effect of the household environment on falls could be determined. A major weakness of this study was its cross sectional type. To determine predisposing factors for falls, a prospective study is necessary.

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