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The Association of Falls Risk in Older Adults and Their Living Environment: A Case Study of Rural Area, Thailand

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Abstract: Falls in older adults have become a serious problem and a major cause of home injuries and even deaths. The increasing number of older people that will enter the "older adults" category in a few years' time calls for an effective plan to mitigate the risk factors to falling. This article reported on our study of the relationship between living environment hazards and fall risk in older adults to reduce and prevent the risk of falling using a specific case of a rural area in Thailand. A site investigation together with a questionnaire survey were conducted in a total of 950 homes of older people who were interviewed in conjunction with authorities from Banphaeo district of Samutsakorn Province, Thailand. Using a multinomial logistic regression model, this research found the following risk of falls based on the categorizations of the calculated risk factors among socio-economic characteristics (sex, age, marital status, income), health status (congenital diseases), and living environment characteristics (toilet availability in bedroom). The analysis identified a multifactorial relationship involving intrinsic and extrinsic factors that determined fall risk among older adults. Based on the findings of the research, risk factors associated with socioeconomic determinants in term of poverty were found as a key barrier in promoting the health and well-being of older adults. We recommend interventions for fall prevention and fall risk-reduction strategies through improvement of the physical environment in the homes of older adults as a proactive measure to lessen the causes of home injuries from falls.

Keywords: accidental falls; elderly; home and environment hazards; older adults; rural area

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1. Introduction

The age of the world's population is growing at an unprecedented rate [1]. Thailand currently has 11.3 million people over 60 years old (approximately 17.1% of total Thailand's population), which, according to projections [2], will lead the country to transition into the category of an "aging society" by 2021 [3]. Furthermore, by 2041, increased longevity and life expectancy worldwide could lead to an increase in falls among adults over 70 years (see Figure 1). Globally, falls are a major public health problem according to the WHO [4]. A number of studies show that the severity of fall related complications increases with age [5–10]. In Thailand, more than 1000 older adults die yearly due to falling, or approximately three persons per day [11].

This risk of falls derives from multifactorial events and stems from both intrinsic and extrinsic factors. Extrinsic factors include environmental and home hazards; intrinsic factors, on the other hand, include history of falls, age, sex, and living arrangements (e.g., living alone, medical conditions, impaired mobility). A study by Hill et al., (2013) reported that 75% of the older adults suffer a fall in their homes compared with those who fall outside their homes [13]. Moreover, the WHO found that the cost to the public health system for older adults who are hurt in falls is increasing all over the world, incurring both direct and indirect expenses for the family, community, and society [14].

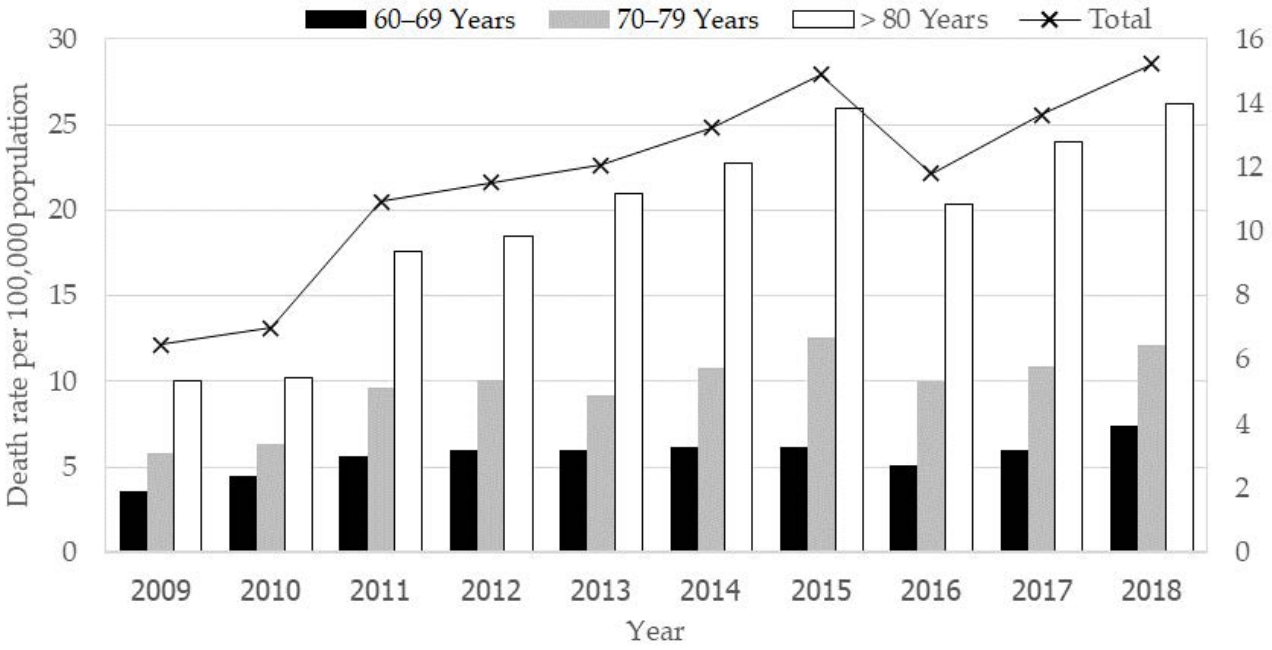


Figure 1. The death rate from falling in the older adults (60 years and above per 100,000 population), Thailand [12].

Important considerations in assessing the risk of falls revolve around the characteristics of the house and its neighborhood environment, such as the traditional tall, wooden houses that are still prevalent in rural areas with few or no built-in safety designed features for older adults. Considering that old age is an inevitable period and the most delicate time of life, the risk of falling at home necessitates proper planning of the living environment to help prevent falls among the most vulnerable age group [15].

The aging of the population has a profound impact on the health system, both in terms of expenditures and the need to develop relevant health care strategies at all institutional levels of the public health system. Nevertheless, the risk of falling in older adults can be reduced with a suitable risk assessment plan that can lead to changes or modification of risk factors, which in turn could reduce the risk of falls. For example, a review targeted at examining interventions for older adults in the community found that multimodal assessments and targeted interventions led to a decrease in fall rates by 25% to 40% [16–18].

Although there are numerous studies related to the identification of factors associated with falls, only a few have examined the rural dimensions among Thailand's older adults. Thus, this research aimed to examine the relationship between risk of falls of older adults and their living environment using a case study of a rural area in Banphaeo district, Samutsakhon province within the Bangkok Metropolitan Region of Thailand. Furthermore, several studies reported a significant association between the living environment and the risk of falls among older adults in rural areas. Due to living in isolation and associated home environment risks, this would predispose older adults to falls, which may become sentinel events in the lives of this vulnerable group. The rural area selected for the study is predominantly engaged in agricultural production, small-scale commerce wherein its residents rely on both farm and non-farm income. Geographically, its populated areas are distributed over extensive cropland to less densely settled areas with sparse vegetation. The transportation system in Banphaeo at present is inadequate, making physical travel to markets, social activities, and public service destinations a challenge, particularly for older people who do not have their own means of transport [19].

Several studies have shown that differences in social and economic characteristics in older adults led to particular provisioning of correspondingly appropriate health services and fall prevention approaches [20,21]. At present, prevention strategies for falls at the community level have yet to be properly studied; thus, the identification of risk factors of falls and their associated variables need to be studied in depth to maximize the effectiveness

of any proposed intervention. In this study, by focusing on the analysis of the relationship between home and living environment hazards and risk of falls in older adults, the results allowed the evaluation of the relative probability of falls risk in a sample of a community in Banphaeo district, Samutsakhon province, Thailand. Based on the findings of the research, measures were recommended to reduce and prevent the risk of falling in different types of homes. Finally, the result of the analysis can be useful to policy makers such that policy measures conform to the variations of risk exposure according to the socio-economic and home environment characteristics of different older-age groups.

2. Methodology

This study examined the linkages between living environment hazards and falls so that we may find ways to lower the risk of falls among the elderly, especially those living in the rural areas of Thailand. Understanding these linkages can contribute to the design of policies aimed at improving the health and well-being of those people who live in sparsely populated settlements, which are mostly agriculture-based and have little or no access to public services. The conceptual framework of this study is presented in Figure 2.

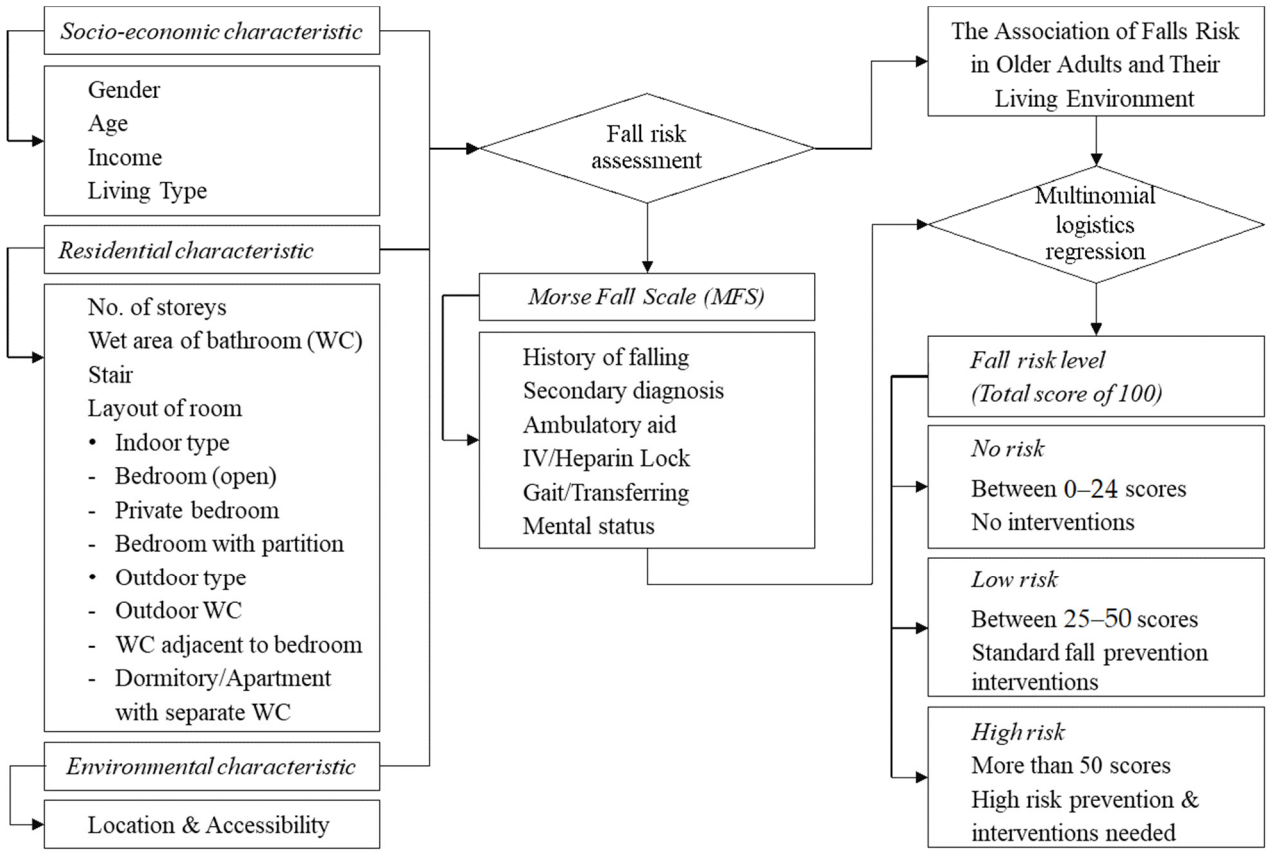


Figure 2. Conceptual framework of the study.

2.1. Framework of Fall Risk Identification

One of the greatest concerns for the older adult population, especially those living in long term or acute care facilities, is the risk of falls. Older adults who fall once are two to three times as likely to fall again within a year [8]. The literature review examined various studies on the relationship between living environment hazards and fall risk in older adults.

This study focused on older adults in a rural area in Thailand to come up with recommendations for preventing falls and reducing their risk of falling specific to their particular context. The review of literature provided information and insight into the

relationship between living environment hazards and risk of falls. Although older persons in general often have an overly positive perception of their state of health, research has shown that falling poses a major risk for this particular age group [22,23]. Fall risk is defined as "an unexpected event in which the participant comes to rest on the ground, floor, or lower level" [24]. Most of the injuries occur in the home, which is consistent with fall research findings that showed 70–80% of falls occur in and around an older adult's home [25]. Furthermore, falls are the leading cause of fatal home injuries [26,27]. As such, many of those who fall at least once develop the fear of falling again, which could lead to a decrease in physical activity and social isolation [28,29]. The causes of falls are complex, including intrinsic factors (e.g., medical conditions, such as eye diseases, osteoarthrosis, or reduced sense of balance) [8,30,31] and extrinsic factors (e.g., environmental hazards such as poor lighting or tripping hazards) [32–35]. Liu-Ambrose et al. [36] found that increased risk of falls is linked with mild cognitive impairments. A public health strategy that focuses on improving the health status of an entire population should, therefore, include fall prevention using a multifaceted population health-promotion approach [37].

Most older adults spend a lot of time at home, which they consider as a place of safety and refuge from the world. However, many accidents may occur at home for these individuals. Many older people attribute their falls to trips or slips inside their home or immediate home surroundings [38,39]. The most common areas for falls within the living environment of their homes are the bedroom, the stairs, and the bathroom [40–42]. In this regard, safe and elder-friendly home design may reduce the risks of falls and improve the general well-being for older adults [43]. The environmental interventions must be adapted to reduce the risk of falls for older people living in the community include their physical environment, either indoors or outdoors, and should be combined with greater awareness on fall hazards following a fall-risk assessment of the home environment [44]. A number of fall prevention strategies include both intrinsic and extrinsic components referred to previously; however, several prevention strategies have been found to be very effective (i.e., home hazard reduction), though others may not be [45,46].

A fall risk assessment is used to determine the level of risk of falling (a low, moderate, or high risk). Assessment by a health care provider can help to reduce the rate of falls by using prevention of falls guidelines to educate older people in contact with healthcare professionals and follow-up their case if they had falls in the past year [47]. A fall risk assessment provides an evidence-based fall safety initiative, which is reliable and highly effective when health care providers take steps to prevent falls among their patients. The assessment usually includes an initial screening (of overall health situation, incidents of falls, or problems with balance, standing, and/or walking), and a set of tasks, known as fall assessment tools (to test for strength, balance, and gait) [48]. Understandably, therefore, in older adults' physiotherapy assessment, there is significant focus on fall history, which utilizes, for example, the Morse Fall Scale (MFS), a rapid and simple method of assessing an older adult's likelihood of falling. The MFS consists of six variables (history of falling, secondary diagnosis, ambulatory aid, IV/Heparin lock, gait/transferring, and mental status) that represent a simple process of scoring with predictive validity and interrater reliability. This tool can be used to identify risk factors for falls in older adult groups. The total score may be used to predict future falls and identify risk level for recommended actions (e.g., no interventions needed, standard fall prevention interventions, high-risk prevention interventions) [49,50].

2.2. Sample Size

The interview samples for this study were restricted to respondents living in the Banphaeo district, Samutsakhon, Thailand. The Banphaeo district was selected due to demographic trends in the province indicating that the older population in the period 2015–2030 will lead to a predominantly elderly society by 2025, with an aging index of 129.92 and which is likely to increase to 183.17 percent in the year 2030 [51]. The Aging Index refers to the number of elders per 100 persons younger than 15 years old in a specific population.

This index increases as the population ages [52]. The samples included individuals who were aged 60 years and above, which serves as the inclusion criterion related to demographic characteristics. The exclusion criteria related to physical conditions of older adults included being bedbound, dependent on a wheelchair, and bedridden, which could bias the results. The sample size was calculated according to the number of populations 60 years and above in Banphaeo district. In 2018, the total district population of 16,614 persons was used to determine the number of the sample size using Taro Yamane formula [53]. This was calculated by defining the sampling error of 0.04%, which obtained the minimum number of samples of 602. The research survey covered a total of 950 samples in the rural environment of the Banphaeo district where fall risk assessment of the older adults was carried out. The personal data of all participants were treated confidentially, and the distribution of questionnaires was made in proportion to population density in each sub-district (*tambon*) for proportional coverage (Figure 3).

Figure 3. Study area of Banphaeo District showing sub-districts (*tambon*), Samutsakhon, Thailand.

2.3. Living Environment Assessment

The design of safe and more comfortable homes is another important factor in creating a home environment that enhances opportunities for older adults to participate more in social and physical activities as well as improve their well-being [45,46]. This research applied the site investigation technique together with the questionnaire survey to assess the environment and housing condition of the older adults in the study area. A home assessment was applied to evaluate the living condition of each household of respondents in relation to the design of elder-friendly housing, which should consider the following four aspects [14,54]:

1. Home location and approach: Housing should be located close to public services and facilities. An affordable home must be provided to enable older people, especially

those who are frail, to remain at home. The residence must be clean and located at a safe distance from road traffic.

2. Access and circulation: Each house should have its own access and its own entrance. There should be sufficient space to enable older people to move around freely. The surfaces and passages should be wide enough for wheelchairs with appropriately designed bathrooms, toilets, and kitchen.
3. Spaces for living: Housing should be appropriately designed and equipped with a range of appropriate facilities and amenities to provide a safe and comfortable environment. Housing should be integrated with the surrounding community to allow neighborhood connections for more social interactions among residents.
4. Design and Facilities: Housing should be made of appropriate materials and well-constructed with a range of facilities available for older people. Housing design should take into account the specific needs of the older adults with safety and ease of movement in mind. The integration of special assistive devices or home modifications can be recommended to accommodate physical impairments.

2.4. Variables

The questionnaire survey data from face-to-face interviews and living environment assessment were subsequently analyzed by using descriptive statistics classified into three parts consisting of (a) socio-economic characteristics, (b) fall risk assessment using Morse Fall Scale (MFS), and (c) home characteristics.

Dependent variables: The fall risk scores of the older adults were derived using the Morse Fall Scale (MFS) fall risk assessment tool (J. M. Morse, Black, Oberle, and Donahue, 1989). It consists of six dependent variables: (1) *History of falling*, immediate or within 3 months (No = 0 score, Yes = 25 score), (2) *Secondary diagnosis* (No = 0 score, Yes = 15 score), (3) *Ambulatory aid* (bed rest/nurse assist = 0 score, crutches/cane/walker = 15 score, Furniture = 30 score), (4) *IV/Heparin Lock* (No = 0 score, Yes = 20 score), (5) *Gait/Transferring* (Normal/bedrest/immobile = 0 score, Weak = 10 score, Impaired = 20 score), and (6) *Mental status* (orientation by own ability = 0 score, forgetfulness limitations = 15 score). The scores represent the fall risk level whereby recommended actions would be undertaken corresponding to the total score of 100; 0–24, no interventions (No risk); 25–50, standard fall prevention interventions (Low risk); and more than 51, high risk prevention interventions needed (High risk). MFS provides an important scoring method for fall prevention strategies to target those most at risk. Each elder's care plan can utilize MFS as a tool for long-term care providers to record a patient's needs and preferences and identify caregiving responsibilities to ensure these needs are met with timely, high-quality responses. Proper care planning requires identifying those who are at risk of falling and to ensure both seniors and their family receive support that they need [55].

Independent variables: These consisted of two major factors: socio-economic and home characteristics. Socio-economic risk factors for a fall refer to age, sex, marital status, income, and physical condition of living, which were collected by survey interviews and questionnaires [56–59]. The research collected socio-economic characteristics and fall risk assessment through face-to-face interviews. Home and built environment characteristics were assessed by using observable physical indicators that include number of floors, living area location in residence (upstairs or downstairs), the need to step up/or down the stairs (yes or no), availability and location of toilet/bathroom, and bedroom characteristics (i.e., layout).

2.5. Method of Analysis

This research used applied descriptive statistics to analyze the quantitative and qualitative variables to evaluate the probability of risk of falling in the sample of older adult respondents living in a rural community where falls among older people constitute a major public health problem [60]. Firstly, the relationship between MFS (in three levels: no risk, low risk, high risk), socio-economic, and living environment characteristics factors was tested using chi-square and ANOVA statistics where appropriate. This was followed by

a multinomial logistic regression (MLR) modeling that treated the dependent variable to be explained as polytomous and categorical [61]. In order to estimate the probability of falls in the older adults in association with risk factors, the level of significance was set at $p < 0.05$ for the analyses.

3. Results

The increasing trend of a growing older population is an important issue for urban planning in order to provide them with a good quality of life within the community. This challenge requires consideration of several elements that are appropriate and consistent with life planning that create good health behavior and prevent risks from individual, home, community, and city levels. This study focused on the assessment of risk of falling among older people either in their homes or community categorized in three levels of risks (no, low, and high) (see Table 1).

Table 1. The socio-economic and home characteristics among different fall risk levels.

Variables	Fall Risk Assessment (*N*, %)			*p*-Value [a]
	No Risk (0–24 Score)	Low Risk (25–50 Score)	High Risk (>50 Score)	
Sex				0.000
Female	397 (41.8%)	151 (15.9%)	37 (3.9%)	
Male	290 (30.5%)	58 (6.1)	17 (1.8%)	
Age				0.000
60–69 years	338 (35.6%)	52 (5.5%)	6 (0.6%)	
70–79 years	232 (24.4%)	80 (8.4%)	24 (2.5%)	
>80 years	117 (12.3%)	77 (8.1%)	24 (2.5%)	
Status				0.000
Married	363 (38.2%)	73 (7.7%)	30 (3.2%)	
Divorced	69 (7.3%)	27 (2.8%)	3 (0.3%)	
Single	255 (26.8%)	109 (11.5%)	21 (2.2%)	
Income (baht)				0.000
Less than 2000	420 (44.2%)	168 (17.7%)	51 (5.4%)	
More than 2000	267 (28.1%)	41 (4.3%)	3 (0.3%)	
Fall experience				0.000
Yes	1 (0.1%)	76 (8.0%)	21 (2.2%)	
No	686 (72.2%)	133 (14.0%)	33 (3.5%)	
Diseases				0.000
No disease	504 (53.1%)	116 (12.2%)	14 (1.5%)	
More than one disease	183 (19.3%)	93 (9.8%)	40 (4.2%)	
Living type				0.460
Living alone	38 (4.0%)	13 (1.4%)	1 (0.1%)	
Living alone (near family)	22 (2.3%)	10 (1.1%)	0 (0.0%)	
Living with the family	627 (66.0%)	186 (19.6%)	53 (5.6%)	
Private bedroom (toilet availability)				0.003
No	412 (43.4%)	152 (16.0%)	37 (3.9%)	
Included	275 (28.9%)	57 (6.0%)	17 (1.8%)	
Using stairs				0.942
No	469 (49.4%)	142 (14.9%)	38 (4.0%)	
Yes	218 (22.9%)	67 (7.1%)	16 (1.7%)	

Note: $n = 950$, [a] The level of significance was set at $p < 0.05$ from the analyses, chi-square.

3.1. Socio-Economic Characteristics and Risk of Falling

The relationship between MFS and the following socio-economic characteristics was examined according to sex (female and male), older adult age groups (60–69, 70–79, and over 80), marital status (married, divorced, and single), income (less than 2000 baht and more than 2000 baht (per month)), and living type (living alone, living alone (near family) and living with family). The analyses were initially used to identify any significant associations between the abovementioned variables and risk level.

The findings showed that females have a greater risk of falls than males, representing 61.6 percent. In contrast to 72.3 percent of total respondents without risk of falls, over 27.7% of the respondents are at risk of falls, accordingly, divided into low risk of 22.0 percent and high risk of 5.7 percent. While those who are at risk of falls represented a minority, it is an important issue considering that the trend of risk of falls increases with age [14,42,62,63]. In Thailand, driven by falling fertility rates and remarkable increases in life expectancy, population aging will continue, and even accelerate in the years to come.

3.2. Living Environment Characteristics in Banphaeo

From Table 1, the availability of a bathroom within the bedroom is a key element that increases the risk of falls in older adults. A majority of respondents' houses (63.3%) were within this category. However, the majority of older adults (91.2%) were living with their family. In addition to creating an environment that enables the older adults to participate in society and carry out different social and productive activities, safe and comfortable design of elder-friendly home environments is another important objective to pursue to improve their quality of life. From the 950 samples examined, it was found that there are many different types of housing in the Banphaeo district, as illustrated in Figure 4. These included single stand-alone houses, row houses, commercial buildings, townhomes, condominiums, and temporary residences (cottages). The number of floors ranged from one to five. The housing materials used for the residences consisted of four main types: timber, cement, gypsum, and galvanized iron, depending on affordability. Banphaeo district is characterized as a rural area with more than 90% of its area classified as agricultural and natural areas (e.g., fruit orchard and mangrove forest) [64]. The scattered pattern of settlements impacts the lives of the older adults in terms of limiting their access to health services and places for social interactions. Specifically, the distances between these scattered settlement areas to public service centers and lack of means of transportation discourage older people from travelling, which leads to a sense of isolation.

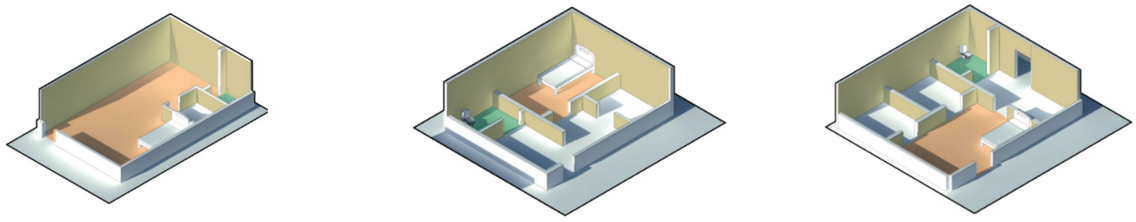
The environment and housing condition of the older adults in Banphaeo district are clearly lacking in planning and design standards to provide a healthier lifestyle for older adult residents. The current condition of housing structures, streets (unpaved in some areas), inadequate public transportation, and inaccessible sources of public information present a barrier to mobility, particularly for older persons with disabilities. Furthermore, this elder-unfriendly built environment limits their ability to participate in physically active leisure and social activities, which could contribute to overall cognitive and physical health to help reduce their risk of falling in their old age.

In the context of living conditions in rural areas, which has become familiar over generations, the older adults have been constrained to adjust to their difficult physical environment. With the population of older adults in Thailand expected to increase substantially in the near future, this study could potentially provide insights in terms of how to improve their quality of life and implement effective fall prevention programs for this age group.

One-Storey Housing Type

In-door type

Bedroom (open) Private bedroom Bedroom with partition

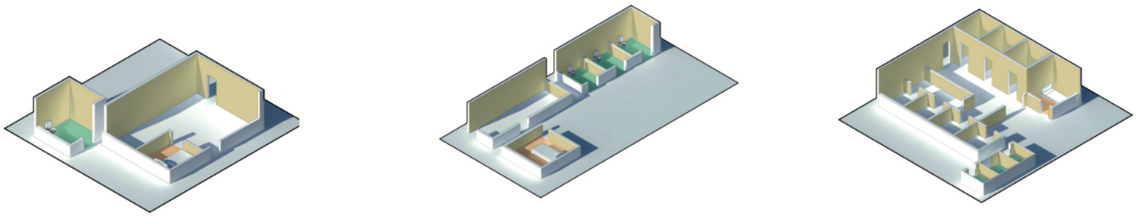


Remark: Bedroom area Bathroom

The characteristics of the older adults' housing for one-storey housing of indoor types can be classified into three types: (1) Bedroom with no partitions and not adjacent to a bathroom (WC), (2) Private bedroom (bathroom located within), and (3) Bedroom with partition (bathroom located within). Most houses have a separation between the bedroom and bathroom where bedroom characteristics can also be divided into two types of bathrooms: internal or external. Bedrooms for older adults are usually adjacent to the bathroom and toilet for easy access.

Out-door type

Outdoor WC WC adjacent to the bedroom Dormitory/Apartment with separate WC



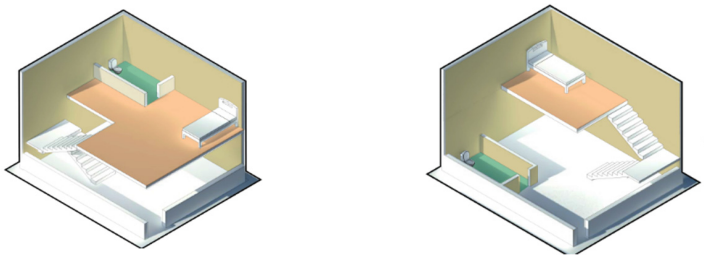
Remark: Bedroom area Bathroom

The characteristics of the older adults housing for one-storey housing can be considered "appropriate of home design" in terms of bathroom (WC) access, which can be classified into three types; (1) Outdoor WC, (2) WC adjacent to the bedroom, and (3) Dormitory/Apartment with separate, shared WC. When the bathroom and bedroom are separated from each other and the location of WC is outside, access should be designed in such a way to reduce the risk of falling.

Two-Storey Housing Type

2nd Floor type

WC include in bedroom WC separate in different level



Remark: Bedroom area Bathroom

The characteristics of the older adults housing for two-storey housing can be categorized into two types; (1) 2nd floor bedroom includes a bathroom on the ground floor, and (2) 2nd floor bedroom with no bathroom. The location of the bedroom is related to the condition of the health or age of older adults, who require an appropriately designed layout of bedroom and bathrooms. The pattern of adjacent bathroom and bedroom could provide easy access for older people and reduce the risk of falling as falls and home accidents are the most serious and frequent among older people.

Figure 4. Living environment characteristics (layout of the bedroom and bathroom).

3.3. Relationship between Home Hazards and Level of Fall Risk

The results of the MLR model shown in Table 2 indicated that there is a significant relationship between home hazards and fall risk in the older adults.

Table 2. The relationship between home hazards and fall risk in the older adults.

Variables		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Low risk									
Intercept		5.285	1.073	24.284	1	0.000 *			
Sex	Male	−0.518	0.217	5.671	1	0.017 *	0.596	0.389	0.912
	Female	(reference)							
Age (years)	60–69	−1.675	0.266	39.503	1	0.000 *	0.187	0.111	0.316
	70–79	−0.729	0.234	9.757	1	0.002 *	0.482	0.305	0.762
	>80	(reference)							
Income (baht)	<2000	1.430	0.294	23.652	1	0.000 *	4.179	2.348	7.435
	≥2000	(reference)							
Diseases	No diseases	−0.953	0.208	20.990	1	0.000 *	0.386	0.257	0.580
	>1 disease	(reference)							
Fall experience	No	−6.848	1.048	42.726	1	0.000 *	0.001	0.000	0.008
	Yes	(reference)							
Private bedroom (toilet availability)	No	0.649	0.219	8.777	1	0.003 *	1.913	1.246	2.939
	Yes	(reference)							
High risk									
Intercept		3.703	1.267	8.545	1	0.003 *			
Sex	Male	−0.222	0.352	0.398	1	0.528	0.801	0.402	1.597
	Female	(reference)							
Age (years)	60–69	−2.525	0.523	23.345	1	0.000 *	0.080	0.029	0.223
	70–79	−0.888	0.364	5.938	1	0.015	0.412	0.201	0.841
	>80	(reference)							
Income (baht)	<2000	2.841	0.668	18.065	1	0.000 *	17.129	4.622	63.480
	≥2000	(reference)							
Diseases	No diseases	−2.250	0.358	39.403	1	0.000 *	0.105	0.052	0.213
	>1 diseases	(reference)							
Fall experience	No	−7.295	1.098	44.122	1	0.000 *	0.001	7.887×10^{-5}	0.006
	Yes	(reference)							
Private bedroom (toilet availability)	No	0.508	0.353	2.066	1	0.151	1.662	0.831	3.321
	Yes	(reference)							

Note: The reference category is no risk. * = The level of significance was set at $p < 0.05$ for the analyses.

The results in Table 2 show that the 'low-risk group' was statistically significant for sex; that is, females have a higher probability for falls than males (exp = 0.596). In terms of age, the probability of falling increases with higher age (exp = 0.187 (60–69 years) and 0.482 (70–79 years)). In terms of income, the low-income group has a higher probability of falls (exp = 4.179).

As for the high-risk group, a statistically significant factor is fall experience (exp = 0.001). Furthermore, having a private bedroom without a toilet showed more potential for higher fall risk (exp = 1.913). The full model containing all predictors was statistically significant, indicating that the model was able to distinguish among different group of fall risk. The model

as a whole explained between 39.1% (Cox and Snell Chi-Squared) and 50.9% (Nagelkerke R Squared) of the variance in the different fall risk groups, and correctly classified 81.1% of the cases.

On the basis of these findings, it can be seen that there is no multilinearity among all the independent variables. The *p*-values for all independent variables, which was less than 0.05, except the high-risk group, showed they have a significant relationship with the dependent variables of fall risk level. As shown in Table 2, all six independent variables had a statistically significant contribution to the model. The strongest predictor of socioeconomic characteristics of older adults was their average income (baht) with an odds ratio of 4.179 for the low-risk group and 17.129 for the high-risk group. This indicated that the poverty problem is a key barrier in promoting health and well-being of the older-adult age groups. The analysis showed that poorer groups have a higher fall risk (about 4.179 times) and will be more likely to have a higher risk (17.129 times) of falling than those who have better incomes.

4. Discussion

4.1. Analysis of the Factors Affecting Risk of Falls in Older Adults in Rural Areas

This study attempted to understand the relative probability of home hazards and fall risk among older adults of the Banphaeo district. The results of the analysis indicated the factors affecting falls at various risk levels among older adults living in a rural area. The significant aspects related to the occurrence of falls in the older groups and associated factors were identified in this study. The findings are important in the evaluation process of ageing care by identifying older adults who are at risk of falling and their associated risk factors (e.g., presence of chronic, socio-economic status, home environment) rather than wait until a fall with potentially serious consequences. By taking the preventive approach, paying attention to the factors that contribute to falls risk, and emphasizing a multisectoral and multiprofessional process in understanding their causes and consequences among the associated risk factors, we are able to recommend how to improve the safety and quality of life of older adults living in rural areas.

The socioeconomic factors that affect falls risk levels are age, income, presence of congenital disease, and past fall history. These factors are often reflected in the body's ability for normal mobility in daily life that declines with age. The risk of falling arises from a combination of intrinsic and extrinsic factors, which have been analyzed in fall-risk models. Furthermore, it is important to note that data in Table 1 provide statistically significant evidence that a lower income might provoke frailty and morbidity among older adults, especially in developing countries. The main group of respondents were within the range of income of less than 2000 baht (per month) (67.3%). Older adults' households in rural communities, especially those living in poverty, have to be resourceful in making use not only of any opportunities in agriculture but also in non-farm activities (such as food processing) to augment their incomes. Thus, older people choose to stay at home in Banphaeo rather than participate in the social activities of the larger community.

Nowadays, the feeling of being cut off from outside society becomes the biggest problem among the elderly, especially the older adults who live in the countryside [65]. The problem becomes even more acute as the younger and better-educated populations from rural areas are driven to seek employment and a better life in the rapidly growing cities, leaving the older adults alone to fend for themselves in the countryside. The migration to urban areas has been occurring very rapidly, accompanied by overall low birth rates [66,67]. With lower population growth, lower density of settlements, and migration of young populations to urban areas, remaining older, adult parents, especially those who are frail and with chronic illness, live in quiet neighborhoods and become homebound as moving about becomes difficult. In Banphaeo, about a third of the respondents have congenital diseases (see Table 1).

However, when considering the analysis of the physical factors of the living environment, it was found that only the bathroom-related factors were statistically significant for

the elderly's fall risk. The fact that the physical environment of the house is directly related to the risk of falling is consistent with the literature review [68]. Letts et al., (2010) argued that the dangers present in a poorly designed and unsafe home increase the risk of falling. The physical factors that contribute to falls risk in the older adults were identified, such as uneven and slippery surfaces and inadequate lighting [69]. This study revealed that the location where fall risk among older adults is significant is in the bathroom (slips in bathroom/support handrail) and is exacerbated as a result of unsafe or hazardous physical environmental features in the home, such as slippery or uneven surfaces, steps, and poor building design [70,71]. These lack of important safety design features in the home environment are some of the causes of falls among the elderly. Therefore, the improvement of home safety and efficient design is very important [39]. Moreover, most of the findings from the analysis showed that there was no risk of falls other than exclusively low risk or high risk (i.e., no medium risk). Logistic regression analysis from this study showed that aging was the main determinant for home falls among the older adults, rather than any other causative factors.

4.2. Limitations and Suggestions

A limitation of this research is it failed to include other important individual variables such as prescription drug consumption (type/quantity) and fear of falling among others, which, according to a systematic review, are widely reported in studies on falls [72]. The results of the study presented a cogent argument that a preventive approach to falls among older adults should be suitably planned for each older adult. Although reducing hazards in the home appears not to be an effective fall-prevention strategy in the general older population and those at low risk of falls [39], the risks at homes could be reduced effectively if targeted at older people with a history of falls and mobility limitations. There should also be interventions that seek to improve the ease of movement of older adults in their physical home, since falls usually occur when impairments in multiple domains compromise the compensatory ability of the individual [73]. Therefore, it is necessary to consider both the number of hazards in the home in future studies such as the presence of poorly designed or constructed stairs, uneven flooring, loose wires, lack of handrails, inadequate house lighting, among others in relation to the degree of older adults' impairments and ambulatory ability. In addition to safety improvement of the physical home, physical activity is also encouraged to reduce falls. A recent study showed that a physical activity program can slow cognitive decline and improve quality of walking in older persons, especially those suffering from dementia [74]. Therefore, in planning to prevent falls, there should be consideration of both health and physical factors in living conditions.

Oftentimes, older adults tend to live with their family in their residence or live in long-term care homes due to changing social attitudes on reduced care opportunities for them at home by family members [75]. With the growing rate of economic expansion in cities creating a pull factor for increased migration of rural youth populations to cities in search of work and a better quality of life, older adults are left behind in the countryside to fend for themselves. The quiet neighborhoods in the rural areas have become a hallmark of an aging society [76,77]. These demographic shifts in the rise of older adults' populations combined with social transformation in rural areas with isolated, left behind older adults are causing the increasing risk of falls at home [78–80].

Therefore, there should be plans to cope with the increasing demographic trend of aging and for older adults living alone who are at risk of falling. However, apart from plans to improve the quality of life of a rising number of older populations, planning must also consider advances in innovation and technology that have proved useful in designing interventions aimed at reducing falls risk by improving physical accessibility and safety for older people [81,82]. Although such innovations may have limitations for applicability in Thailand due to cost, the lack of detailed information and the consequent reluctance to adopt or implement new ideas may likely present barriers to accept efforts towards effective home modification or design for safety. Intervention support from the government

will therefore play a vital role at the policy level. These proactive policies to help improve housing design for the older adults through funding support and guidance will help the needs of the older adults to fulfill their daily activities in order to give them the feeling of satisfaction, security, comfort, and independence despite their physical limitations.

5. Conclusions

This research focused on the identification of associated factors in the fall risk among older adults aged 60 years and above in the Banphaeo district. The research showed that an unintended, unexpected event of a fall is associated with multidimensional factors. A single event can reduce the functional capacity of elderly where their vulnerability is usually multifactorially determined by both intrinsic and extrinsic factors. The variables used in the analysis were derived from three related factors: socio-economic, fall assessment, and home hazards. Due to the geographic location of the study area with a record of lower hospitalization rate of rural residents, this study attempted to understand the fall risk of rural older adults on the basis of a preventive approach to identify the associated factors on their risks of falling. The classification of fall risks was determined using MFS techniques. The results of the study found that falls in older adults are a serious problem. The analysis showed a multifactorial relationship involving intrinsic and extrinsic factors that determine the risk of falling. In the context of living environment and behavior of the older adults, this study focused on the group of the early older adults who are still endowed with good physical and cognitive health to function in daily life. However, it was found that as the older adults age, the risk of falls increases, especially with regard to the physical condition of private living quarters. Furthermore, the low-income group may be more vulnerable to falling and hospitalization due to their poor living conditions and associated hazards in their dwellings.

Therefore, from the findings of this study, a preventive approach of health care for fall prevention and safe homes among rural older adults is recommended as an important starting point for developing an effective community falls prevention program. The higher risk of fall factors indicated can be utilized for promoting awareness among older adults through a participatory approach in the particular group who are most vulnerable to the event of a fall in different contexts. Apparently, planning to prevent falls in older adults should focus on integrating multiple dimensions that include both internal and external dwelling factors and behavioral factors. Creating a framework to develop and facilitate the wellbeing of older adults is an important response to an aging society to enable a higher quality of life for those approaching their twilight years. Clear government policy integrated with the application of modern innovations for safe and comfortable elderly living could raise the bar on society's values and attitudes to a more responsive one towards the lives of the elderly.

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