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ORIGINAL RESEARCH

Home Environmental Factors Associated with Falls Among Elderly in Ubon Ratchathani, Thailand

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Purpose: The demographics of the world's population have changed over time. Previous research demonstrated the high rate of falls among elderly people living in rural areas in their own houses. This study aimed to use the Thai-Home Fall Hazard Assessment Tool (Thai-HFHAT) to look into the environmental factors inside and outside of residential homes connected to falls among elderly living in rural Thailand.

Methods: Data was gathered between August and October 2023 using a questionnaire to obtain demographic data and the 44-question Thai-HFHAT survey. The survey was divided into seven sections covering the areas inside and outside the elderly home facility. Descriptive statistics were used in the data analysis, and statistical tests, including Fisher's exact test and the Chi-square test, were used to examine the relationship between environmental factors and falls in elderly people.

Results: The study found that issues with an elderly rural home included split-level flooring in the living room, bathroom, and bedroom, an insecurely attached carpet in the kitchen and bedroom, and a shower area not separated from the toilet. The environmental factors linked to falls among the elderly encompass insufficient lighting in the living room, bathroom, bedroom, and parking garage, debris and obstacles such as wires along the path in the living room and parking garage, and the poor condition of the staircase, characterized by inconsistent step heights or a slippery surface.

Conclusion: Community agencies should consider the living conditions of elderly people in rural areas to effectively reduce the occurrence of falls among this population.

Keywords: falls, environmental factors, elderly, Thai-HFHAT, rural area

Introduction

The global population has experienced successive changes in its demographic composition, with particular emphasis on the shifting dynamics of the older adult population. According to the World Health Organization, the global population of older adults is expected to grow from 1 billion in 2020 to 1.4 billion by the year 2050.[1] Falls provide a prominent factor in unintentional injury and mortality rates within the elderly population.[2] Previous studies have revealed that environmental factors are linked to falls.[3–5] Kim et al indicated that falls are predominantly related to a confluence of intrinsic and external causes, encompassing individual and environmental factors.[6] Hai Minh Vu et al claimed that older people who lived in homes with high stairs had a 2.54 times higher risk of recurrent falls than those who lived in homes with normal-height stairs (OR = 2.54; 95% CI = 1.04; 6.19). Similarly, elderly people who did not have dry, clean, and non-slippery toilets had a higher chance of falling again (OR = 2.77; 95% CI = 1.66; 4.62).[7] According to Zhang et al research, elderly people living in rural areas experience more falls than those in urban settings.[8] Additionally, Pawinee Iamtrakul et al found that home environment influences the risk of falls among the elderly living in a rural area in Thailand.[9] Out of all the Thai regions, the Northeast has the largest percentage of older people.[10] The features of the

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house and the surrounding region are taken into account when estimating the risk of falls. For example, in rural areas, the traditional tall, wooden houses, which are still common, lack many or any built-in safety precautions intended for elderly people.[9,11] To prevent the potential risk of falling at home requires an appropriate design of the living environment because elderly people are in an inevitable and delicate period of life. Doing so will help prevent falls among the elderly.

The Thai-Home Fall Hazard Assessment Tool (Thai-HFHAT) was developed to assess the potential risk of falls among elderly people within their home environments. Previous studies have indicated that this tool exhibits satisfactory quality and is considered appropriate for evaluating instances of falls occurring within the homes and surrounding areas of elderly people residing in Thailand.[12,13] Nevertheless, there is a lack of research that has investigated the prevalence of falls among elderly people in rural areas. The research team intends to utilize the Thai-HFHAT to examine the environmental factors present in and around residential homes that contribute to falls among elderly people living in rural areas of Thailand. This research presents a case study conducted in That Subdistrict in Ubon Ratchathani Province. This region, located in the northeastern part of Thailand, exhibits a higher proportion of elderly people in comparison to other areas.[14] Ubon Ratchathani Province is recognized for having one of the top five largest elderly populations among all provinces in Thailand.[15] Additionally, northeastern Thailand has the lowest average monthly income per household.[16] Promoting the construction of homes to enhance accessibility for elderly people and mitigate the risk of falls has not yielded satisfactory results.

Materials and Methods

Study Area

This research is a cross-sectional descriptive study aiming to study the environmental factors inside and outside of residential homes related to falls among elderly people living in That Subdistrict, Warin Chamrap District, Ubon Ratchathani Province, Thailand. This location is located in the northeastern part of Thailand, considered a rural area. Maps of Warin Chamrap District and Ubon Ratchathani Province is available in the following public website https://en.wikipedia.org/wiki/Ubon_Ratchathani_province.

Population and Sample

The population in this study consists of elderly people and their respective households living in That Subdistrict, Ubon Ratchathani Province, Thailand. This subdistrict comprises a total of 11 villages and 714 households.

The sample group was determined using the formula below to calculate population proportions:

$$n = \frac{NZ^2\alpha/2[p(1-p)]}{[e^2(N-1)]+[Z^2\alpha/2[p(1-p)]]}$$

where n = sample size

N = population (714 households)

Zα/2 = the coefficient under the standard normal curve at 95% confidence level, *Z* (0.025) = 1.96

p = proportion estimates; 0.68 obtained from literature reviews.[17]

e = precision of estimate; 0.045

$$n = \frac{714(1.96)^2[0.68(1-0.68)]}{[0.0045^2(714-1)]+[(1.96)^2[0.68(1-0.68)]]} = 264$$

The researchers employed incidental sampling to gather data from 264 elderly people residing in 11 villages. These participants were asked to complete a questionnaire regarding their living conditions, while a survey was conducted to assess the environmental factors both inside and outside their homes.

Research Tools

The researcher developed a questionnaire to gather demographic data on elderly people. This questionnaire includes variables such as gender, age, marital status, living arrangements, type of housing, history of falling in the preceding six

months, the cause of the falls, and the place where the falls happened. The questionnaire was developed by our research team and its validity was confirmed with the Index of item objective congruence (IOC) scores of 0.67–1.0.

The Thai-HFHAT survey, which is divided into seven parts, contains 44 questions. The questions are intended to assess risks in different parts of the elderly home: four for living room, four for the kitchen, five for the garage, six for the house's outdoors, seven for the stairs, eight for the bedroom, and ten for the bathroom. The survey was developed by Charupa Lektip et al.[13]

Research Tool Quality Assessment

The questionnaire consisted of several closed-ended questions. After three experts had assessed the content validity, an item objective congruence index ranging from 0.67 to 1.00 was achieved.

The quality of the Thai-HFHAT was assessed by Yuwadee Wittayapun et al. The study used the intra-class correlation coefficient (ICC), and the inter-rater reliability of the Thai-HFHAT was determined to be 0.74 (95% CI: 0.57–0.84). The test-retest reliability was also shown to be 0.80 (95% CI: 0.64–0.88) for elderly people, 0.80 (95% CI: 0.65–0.89) for caregivers, and 0.70 (95% CI: 0.477–0.83) for village health volunteers.[12] The Thai-HFHAT has been demonstrated to be suitable for assessing home hazards in elderly homes in Thailand.

Data Collection

Data collection took place between August and October 2023. A face-to-face interview was conducted to gather general information concerning the occurrences of falls among elderly people, house type, and housing characteristics and basic information pertaining to the subject matter. Additionally, various environmental elements both inside and outside dwellings were collected using the Thai-HFHAT form by community health volunteers. The five community health volunteers were trained by researchers on collecting individual data before proceeding to the actual location.

Data Analysis

This research employed applied descriptive statistics to examine both quantitative and qualitative characteristics to assess the demographic data. The association between environmental factors and falls among elderly people was statistically examined using the Chi-square test, suitable for analyzing data collected on a nominal scale, except when more than 20% of cells have expected frequencies less than 5, the Fisher's exact test was used instead. In all tests, the significance level was set at 0.05.

Results

The demographic characteristics of the elderly sample indicated that 61.4% of the participants were female. The study found that the median age of the participants was 68.00, and the interquartile range (IQR) was 9. The majority of the houses in the sample were one-story houses, with 57.2% having a low floor evaluation. Additionally, 12.1% of the participants reported a history of falling in the preceding 6 months. Among those who fell, the most common causes were tripping (37.5%), slipping (28.1%), and misstepping (21.9%). Data indicates that the locations where elderly people are most prone to falling are the immediate surrounding area of their residence, parking garage and bathrooms, accounting for 53.1%, 18.8% and 12.5%, respectively (Table 1).

A study revealed that the environmental factors within and in the surrounding area of the houses of elderly people were identified as significant determinants. These factors included the shower area not separated from the toilet (84.1%), the absence of shower seat/shower chair (60.2%), split-level flooring in the living room (29.5%), bathroom (28.8%), bedroom (25.8%), and parking garage (4.9%), and an insecurely attached carpet in the kitchen (14.8%) and bedroom (13.6%). Moreover, it was discovered that the staircases in the elderly's homes had uneven step heights (7.2%) (Figure 1).

The study identified several statistically significant environmental factors associated with elderly falls. In the living room, the factors included insufficient lighting and obstacles and wires. In the kitchen, falls associated with too low or too high cabinets. In the bathroom, the common issues included the absence of a shower area from the toilet, inadequate lighting, and sitting toilets installed either too low or too high. As for the bedroom, the factors were the inadequate space

Table 1 The Demographic Characteristics of the Elderly Residing in That Subdistrict (N= 264)

Demographic Data	Frequency	Percentage
Gender		
- Male	102	38.6
- Female	162	61.4
Age		
- Median =68.00, IQR =9, Max =93, Min =60		
Marital status, Living type		
- Single, Living with family	29	11.0
- With a spouse, Living with family	139	52.7
- Separated, divorced, or widowed, Living with family	96	36.4
House types		
- One-story house with a low floor elevation	151	57.2
- One-story house with a high floor elevation	35	13.3
- 2-story house	78	29.5
History of falling in the previous 6 months		
- Yes	32	12.1
- No	232	87.9
The cause of falling (n=32)		
- Tripping	12	37.5
- Slipping	9	28.1
- Misstepping	7	21.9
- Falling or falling from a height	4	12.5
The location where the fall occurred (n=32)		
- Bedroom	1	3.1
- Bathroom	4	12.5
- Living room	4	12.5
- Parking garage	6	18.8
- Area around the house	17	53.1

Abbreviations: IQR, Interquartile Range; Max, Maximum; Min, Minimum.

for mobility and lighting. Moreover, the stairs were found to have uneven heights, their railings were in poor shape, or their handrails were uncomfortable As for the parking garage, the factors included inadequate lighting, obstacles or cables blocking the walkway and cabinets installed too low or too high. The study also found that in the area surrounding the house, the stair surface is slippery with a p-value < 0.05 (Table 2).

Discussion

This study found the significant environmental factors within and in the surrounding area of the houses of elderly people that were associated with falls included the absence of a separated shower from the toilet, the lack of a shower seat/ shower chair, split-level flooring in the living room, bathroom, bedroom, and parking garage, and poorly attached carpet in the kitchen and bedroom. It's possible that the construction of houses in the northeastern region of Thailand, which tend to combine the shower room and toilet into a single space, is primarily driven by the need for convenience and cost-effectiveness. In addition, most of the villagers used discarded garments as doormats. Consequently, the absence of a doormat securely fastened to the floor poses a heightened risk for elderly people, increasing their susceptibility to slip, stumble, and subsequently fall. Addressing these issues is essential to foster comprehension and collaboration among homeowners and relevant organizations. Implementing intervention activities that focus on educating and problem-solving, as well as training village technicians to address unsuitable housing conditions in the homes of elderly individuals, can lead to a sustainable solution. Research has revealed that the incidence of falls among the older population due to stumbling and slipping stood at 37.5% and 28.1%, respectively. According to a study by Iamtrakul

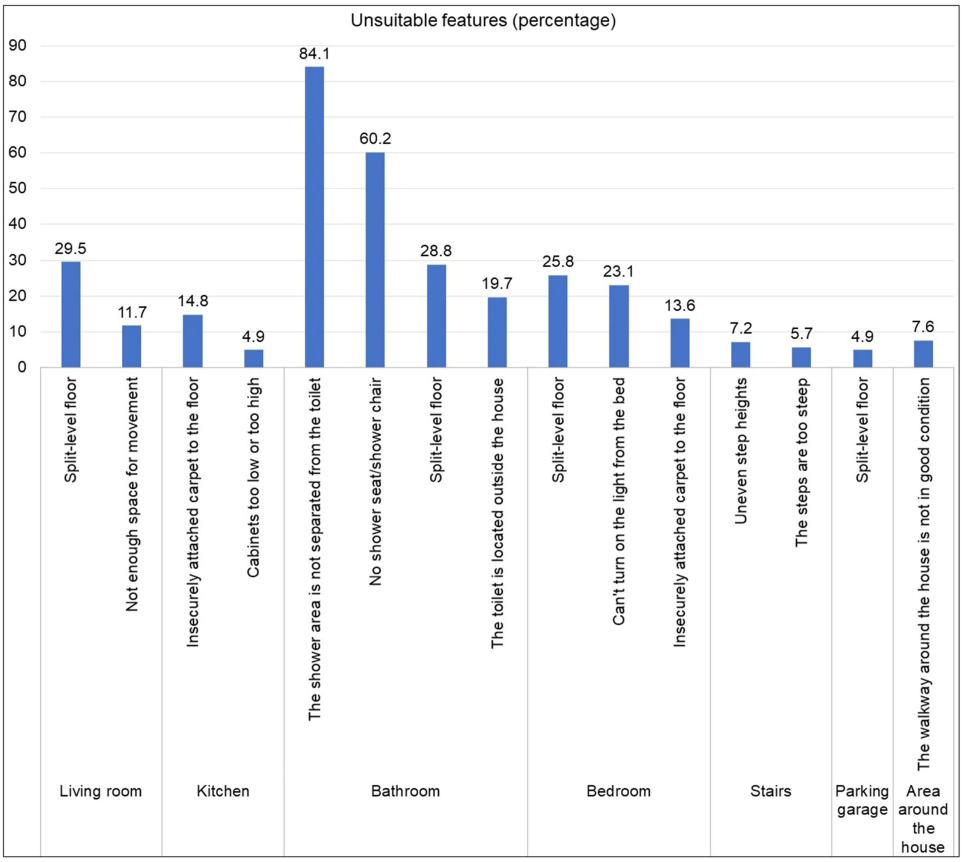

Figure 1 Percentage of unsuitable features in elderly home.

et al, the bathroom is a significant location for fall risks among elderly people, specifically due to slipping.[9] This study, in line with the research by Hai Minh Vu et al found that older people in Vietnam are more likely to fall when their bathrooms are not dry, clean, and non-slippery.[7] It also discovered that the staircase in the elderly's homes had uneven

Table 2 The Relationship Between Environmental Factors and Falls in Elderly People (N= 264)

Environmental factors	History of Falls Within a Six-Month Period Frequency (Percentage)		Chi-Square Test	p-value
	With Falls	Without Falls		
Living room				
1. Insufficient lighting			31.138*	<0.001
- yes	9 (3.4)	7 (2.7)		
- no	23 (8.7)	225 (85.2)		
2. Split-level floor			1.107	0.293
- yes	12 (4.5)	66 (25.0)		
- no	20 (7.6)	166 (62.9)		
3. Not enough space for movement			4.813*	0.090
- yes	6 (2.3)	25 (9.5)		
- no	25 (9.5)	206 (78.0)		
4. Obstacles or wires on the walkway			5.929*	0.044
- yes	4 (1.5)	7 (2.7)		
- no	28 (10.6)	224 (84.8)		

(*Continued*)

Table 2 (Continued).

Environmental factors	History of Falls Within a Six-Month Period Frequency (Percentage)		Chi-Square Test	p-value
	With Falls	Without Falls		
Kitchen				
5. Not enough space for movement			0.032*	0.600
- yes	1 (0.4)	6 (2.3)		
- no	31 (11.7)	226 (85.6)		
6. Obstacles or wires on the walkway			0.009*	>0.05
- yes	1 (0.4)	8 (3.0)		
- no	31 (11.7)	224 (84.8)		
7. Insecurely attached carpet to the floor			2.101*	0.189
- yes	2 (0.8)	37 (14.0)		
- no	30 (11.4)	195 (73.9)		
8. Cabinets are too low or too high.			11.326*	0.003
- yes	6 (2.3)	7 (2.7)		
- no	26 (9.8)	224 (84.8)		
- not applicable	0 (0.0)	1 (0.4)		
Bathroom				
9. The toilet is located outside the house.			0.647	0.421
- yes	8 (3.0)	44 (16.7)		
- no	24 (9.1)	188 (71.2)		
10. Insufficient lighting			7.726*	0.017
- yes	5 (1.9)	9 (3.4)		
- no	27 (10.2)	223 (84.5)		
11. Split-level floor			4.444*	0.087
- yes	12 (4.5)	64 (24.2)		
- no	19 (7.2)	167 (63.3)		
- not applicable	1 (0.4)	1 (0.4)		
12. Obstacles on the bathroom floor			11.326*	0.003
- yes	6 (2.3)	7 (2.7)		
- no	26 (9.8)	224 (84.8)		
- not applicable	0 (0.0)	1 (0.4)		
13. The doormat is not smooth or slippery.			0.719*	>0.05
- yes	4 (1.5)	34 (12.9)		
- no	28 (10.6)	197 (74.6)		
- not applicable	0 (0.0)	1 (0.4)		
14. The shower area is not safe.				
- yes	2 (0.8)	8 (3.0)	2.259*	0.252
- no	13 (4.9)	29 (11.0)		
15. The shower area is not separated from the toilet.			16.627	<0.001
- yes	19 (7.2)	203 (76.9)		
- no	13 (4.9)	29 (11.0)		
16. No shower seat/shower chair			2.598*	0.280
- yes	23 (8.7)	136 (51.5)		
- no	9 (3.4)	95 (36.0)		
- not applicable	0 (0.0)	1 (0.4)		
17. No seated toilets			0.236*	0.829
- yes	7 (2.7)	60 (22.7)		
- no	25 (9.5)	172 (65.2)		

(*Continued*)

Table 2 (Continued).

Environmental factors	History of Falls Within a Six-Month Period Frequency (Percentage)		Chi-Square Test	p-value
	With Falls	Without Falls		
18. Too-low or too-high seated toilets			9.144*	0.005
- yes	11 (4.2)	30 (11.4)		
- no	21 (8.0)	201 (76.1)		
- not applicable	0 (0.0)	1 (0.4)		
Bedroom				
19. Insufficient lighting			9.139*	0.015
- yes	4 (1.5)	5 (1.9)		
- no	28 (10.6)	227 (86.0)		
20. Unable to turn on the light from the bed			2.305	0.129
- yes	4 (1.5)	57 (21.6)		
- no	28 (10.6)	175 (66.3)		
21. Slippery surface/uneven surface			4.967*	0.126
- yes	3 (1.1)	5 (1.9)		
- no	29 (11.0)	226 (85.6)		
- not applicable	0 (0.0)	1 (0.4)		
22. Split-level floor			3.030*	0.222
- yes	9 (3.4)	59 (22.3)		
- no	22 (8.3)	172 (65.2)		
- not applicable	1 (0.4)	1 (0.4)		
23. Not enough space for movement			5.310*	0.044
- yes	4 (1.5)	8 (3.0)		
- no	28 (10.6)	224 (84.8)		
24. Obstacles or wires on the walkway			0.032*	0.600
- yes	1 (0.4)	6 (2.3)		
- no	31 (11.7)	226 (85.6)		
25. Insecurely attached carpet to the floor			1.687*	0.274
- yes	2 (0.8)	34 (12.9)		
- no	30 (11.4)	227 (86.0)		
26. Cabinets are too low or too high.			1.827*	0.203
- yes	2 (0.8)	5 (1.9)		
- no	30 (11.4)	227 (86.0)		
Stairs				
27. The lighting on the stairs is not appropriate for going up and down.			5.122*	0.075
- yes	3 (1.1)	4 (1.5)		
- no	25 (9.5)	196 (74.2)		
- not applicable	4 (1.5)	32 (12.1)		
28. Obstacles or wires on the walkway			12.132*	0.003
- yes	3 (1.1)	0 (0.0)		
- no	25 (9.5)	194 (73.5)		
- not applicable	4 (1.5)	38 (14.4)		
29. The steps are too steep.			3.112*	0.194
- yes	4 (1.5)	11 (4.2)		
- no	24 (9.1)	183 (69.3)		
- not applicable	4 (1.5)	38 (14.4)		

(*Continued*)

Table 2 (Continued).

Environmental factors	History of Falls Within a Six-Month Period Frequency (Percentage)		Chi-Square Test	p-value
	With Falls	Without Falls		
30. The steps are uneven in height.			6.148*	0.037
- yes	6 (2.3)	13 (4.9)		
- no	21 (8.0)	180 (68.2)		
- not applicable	5 (1.9)	39 (14.8)		
31. The stair steps are narrower than a foot's sole.			1.348*	0.503
- yes	1 (0.4)	6 (2.3)		
- no	24 (9.1)	190 (72.0)		
- not applicable	7 (2.7)	36 (13.6)		
32. No railing			1.908*	0.420
- yes	1 (0.4)	2 (0.8)		
- no	25 (9.5)	188 (71.2)		
- not applicable	6 (2.3)	42 (15.9)		
33. The stairs and railings are in poor shape, or the handrails are uncomfortable			7.694*	0.020
- yes	3 (1.1)	2 (0.8)		
- no	23 (8.7)	189 (71.6)		
- not applicable	6 (2.3)	41 (15.5)		
Parking garage				
34. Insufficient lighting			6.563*	0.036
- yes	2 (0.8)	2 (0.8)		
- no	29 (11.0)	200 (75.8)		
- not applicable	1 (0.4)	30 (11.4)		
35.Slippery surface			5.092*	0.072
- yes	1 (0.4)	1 (0.4)		
- no	30 (11.4)	201 (76.1)		
- not applicable	1 (0.4)	30 (11.4)		
36. Split-level floor			4.693*	0.082
- yes	2 (0.8)	11 (4.2)		
- no	30 (11.4)	195 (73.9)		
- not applicable	0 (0.0)	26 (9.8)		
37. Obstacles or wires on the walkway			6.955*	0.031
- yes	1 (0.4)	1 (0.4)		
- no	31 (11.7)	205 (77.7)		
- not applicable	0 (0.0)	26 (9.8)		
38. Cabinets are too low or too high.			6.419*	0.036
- yes	3 (1.1)	3 (1.1)		
- no	27 (10.2)	203 (76.9)		
- not applicable	2 (0.8)	26 (9.8)		
Area around the house				
39. The walkway around the house is not in good condition.			3.866*	0.100
- yes	5 (1.9)	15 (5.7)		
- no	26 (9.8)	212 (80.3)		
- not applicable	1 (0.4)	5 (1.9)		
40. The stair surface is slippery.			7.540*	0.023
- yes	3 (1.1)	2 (0.8)		
- no	24 (9.1)	183 (69.3)		
- not applicable	5 (1.9)	47 (17.8)		

(*Continued*)

Table 2 (Continued).

Environmental factors	History of Falls Within a Six-Month Period Frequency (Percentage)		Chi-Square Test	p-value
	With Falls	Without Falls		
41. The steps are too steep.			5.117*	0.073
- yes	3 (1.1)	4 (1.5)		
- no	23 (8.7)	177 (67.0)		
- not applicable	6 (2.3)	51 (19.3)		
42. The stair steps are narrower than a foot's sole.			4.671*	0.132
- yes	1 (0.4)	0 (0.0)		
- no	25 (9.5)	181 (68.6)		
- not applicable	6 (2.3)	51 (19.3)		
43. The stairs and railings are in poor shape, or the handrails are uncomfortable			2.855*	0.272
- yes	1 (0.4)	1 (0.4)		
- no	25 (9.5)	180 (68.2)		
- not applicable	6 (2.3)	51 (19.3)		
44. In the case of using a wheelchair, the slope is inappropriate.			3.619*	0.169
- yes	1 (0.4)	4 (1.5)		
- no	19 (7.2)	172 (65.2)		
- not applicable	12 (4.5)	56 (21.2)		

Note: *Fisher's Exact Test.

heights and the steps were too steep. The inherent characteristics of residential staircases present a potential hazard whereby elderly people, while going up or going down, may inadvertently overlook a step, resulting in a fall. The present investigation revealed that 21.9% of elderly people exhibit missteps. According to the research conducted by Hyokeun Lee et al older people may have a diminished ability to recover postural stability in comparison to young adults after engaging in a related activity, such as going up or down stairs.[18] The study conducted by Mazloomy Mahmoodabad et al identified stairs as a significant risk factor contributing to falls among elderly people.[11]

In addition, this study revealed statistically significant associations between falls among the elderly and certain environmental factors, specifically inadequate lighting in the living room, bathroom, bedroom, and parking garage. The presence of adequate lighting will enable elderly people to effectively perceive and access their residential surroundings, as well as engage in various activities.[19,20] Insufficient lighting within a residential setting may lead to falls among elderly people. Several studies show a connection between the home environment, particularly lighting, and falls among elderly people.[21,22] Moreover, the presence of debris and obstacles such as wires in the living room and the path to the parking garage, has been found to be significantly associated with falls among elderly people. It is evident that the elderly experience a decline in muscle strength as they age.[23] This affects their ability to move and mobility. The presence of obstacles in the walkway or areas frequented by the elderly can potentially lead to an increased risk of stumbling and falling.[24,25] This finding is consistent with research by Giovannini Silvia et al which suggests that the presence of obstacles inside the home poses an additional danger for elderly people who struggle with movement and visual impairments.[26]

Additionally, this study identified a statistically significant correlation between the poor conditions of stairs and falls among the older population. These poor conditions, characterized by uneven step heights and slippery surfaces, can potentially lead to falls among elderly people.[3,27–29] Such incidents might increase the burden of injuries experienced by elderly people.[30]

Conclusion

While examining the association between environmental factors and falls in elderly people, this study emphasizes the need for community agencies that serve elderly people to take into account their living conditions. This study reveals many factors

associated with falls among elderly people, including insufficient lighting, the presence of debris and obstacles (eg, wires), and poor stair conditions. Additionally, it reveals the lack of proper separation between the toilet and the bathroom, the lack of a shower seat or chair, and split-level flooring in the living room, bathroom, bedroom, and parking garage. Furthermore, it demonstrates that the carpets in the kitchen and bedroom were loosely attached to the floor, posing a potential fall hazard for elderly residents on the premises. Therefore, the municipality's management should address elderly housing issues by establishing policies and implementing intervention activities focused on education, problem-solving, and training village technicians to improve unsuitable housing conditions for the elderly, ultimately leading to a sustainable solution.

Ethics Approval

This study was conducted in accordance with the Declaration of Helsinki and approved was approved by the Human Research Ethics Committee of Ubon Ratchathani University (code UBU-REC-55/2566).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study. The researcher gathered data anonymously without including individual names or specific data. All research data shows combined outcomes without revealing the identities or names of the individuals involved. Three years after the research project is finalized, the researcher will dispose of all research records by shredding them into bits.

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Author Contributions

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