ORIGINAL ARTICLE

Factors affecting falls in the dependent elderly in Sukhothai Province, Thailand

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ABSTRACT

This cross-sectional survey aimed to study factors affecting falls in dependent elderly individuals in Sukhothai Province, Thailand, both in urban and rural areas. The study was conducted between October and November 2024, and 447 participants aged 60 years and older were selected using stratified random sampling. Data were collected using standardized, interviewer-administered questionnaires that included demographics, health status, sleep, physical activity, and home environment. Descriptive statistics and multivariable logistic regression were used to find significant predictors of falls. The results of the study showed that a majority of the informants had a history of falls (60.2%). The factors that could predict the chance of falls in the dependent elderly group with statistical significance at the 0.05 level were history of chronic illness (Adj OR = 9.52), insufficient Sleep (Adj OR = 5.90), area with different levels (Adj OR = 5.58), lack of exercise (Adj OR = 5.15), slippery floor (Adj OR = 4.63) and income inadequacy (Adj OR = 3.15). In conclusion, the management of risk factors affecting falls involves biology, economics and society, behaviors, and environment. These factors should be integrated into health promotion, environmental management, and income support strategies to effectively reduce the fall rate in the dependent elderly group and improve the quality of life of the elderly in the long term.

Keywords:
dependent elderly; falls; Falls in the dependent elderly

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INTRODUCTION

The global population is rapidly aging, with the proportion of elderly individuals rising from 7.96% in 1950 to 13.90% in 2022.[1] This shift reflects a global trend toward an aging society, where the number of older adults continues to grow while the proportions of children and working-age adults decline.[2–4] In ASEAN, the elderly individuals accounted for 11.74% of the population in 2022, with Singapore reporting the highest share at 22.96%, followed by Thailand at 18.86%.[1] In Thailand, the elderly population steadily increased from 16.06% in 2018 to 18.86% in 2022,[1] signaling the country's transition into a fully aging society. Sukhothai Province, in particular, has seen elderly population growth outpacing the national average, with a five-year average annual increase of 1.0%, compared to the national rate of 0.7%. The number of dependent elderly individuals —those needing assistance with daily activities—has also risen. Between 2020 and 2022, the proportion of homebound elderly individuals in Sukhothai (ADL scores 5–11) increased from 2.03% to 2.30%, while bedridden individuals (ADL scores 0–4) rose slightly from 0.48% to 0.50%.[5]

Falls are a major global health issue among the elderly, affecting one in three individuals each year, with 20% resulting in injury. They are the second leading cause of unintentional death after traffic accidents.[6] In Thailand, fall prevalence over a six-month period (2019–2020) was 14.7% for those aged 60–69, 16.0% for 70–79, and 17.3% for those 80 and older.[7] Mortality rates in 2021 also increased with age, reaching 26.84 per 100,000 among those 80+, compared to 6.29 in the 60–69 group.[8] Those aged 80 and above face the highest risk of repeated falls and are four times more likely to die from fall-related injuries. In Sukhothai Province, fall rates among the elderly have steadily increased. Between 2018 and 2022, the incidence ranged from 658.0 to 1,812.0 per 100,000 population, with inpatient admissions (over six hours) and mortality also rising.[8] In 2022, Sukhothai reported the highest fall morbidity rate in Health Region 2 (1,255.4 per 100,000), and fall-related deaths tripled—from 5.5 to 16.8 per 100,000—making it the highest increase in the region. During the same period, the elderly population in Sukhothai grew from 19.04% to 23.05%.

Falls can result in serious consequences, including injury, disability, fear of falling, reduced independence, and increased healthcare costs.[9] They impact not only physical and mental health.[7,10–14] but also economic and family well-being[15]. Risk factors span biological, behavioral, environmental, economic, and social domains.[12,16–19] Despite increasing awareness, research on falls in dependent elderly populations remains limited—especially in high-risk areas like Sukhothai. Understanding these risks is essential for effective long-term care planning and public health strategies. The research aims to study factors affecting falls in dependent elderly people in Sukhothai Province, aiming to reduce risk factors that lead to fall-related injuries, disability, and mortality.

RESEARCH METHODOLOGY

Study design and population

This cross-sectional study was conducted among elderly individuals aged 60 and over in Sukhothai Province. Participants were screened using the Barthel Activities of Daily Living (ADL) Index, and only those scoring between 5 and 11 — classified as "home- bound" with partial independence were included. From a total population of 1,655, the sample size was calculated using a finite population formula with a 5% allowance for non-response, resulting in 447 participants. Multi-stage random sampling was used. In the first stage, stratified sampling ensured

proportional representation from all nine districts based on the provincial database of dependent elderly individuals. In the second stage, individuals were randomly selected using a lottery method without replacement.

Inclusion criteria were aged 60 or older; ADL score of 5 – 11(excluding completely dependent individuals with scores 0 – 4); ability to travel to the study point and give informed consent; and ability to communicate effectively in Thai.

Research Instruments

The questionnaire was reviewed for content validity by five experts — three in research methodology and two in geriatric care — using the Index of Item- Objective Congruence (IOC), with all items scoring between 0.5 and 1.0. A pilot test was conducted with 30 older adults who were not included in the main sample. Reliability was assessed using the Kuder- Richardson Formula 21(KR- 21) and Cronbach's alpha, with a threshold of 0.7 indicating acceptable internal consistency. The instrument included six parts. Part 1 covered biological data such as gender, age, body measurements, chronic conditions, fall history, sensory and motor functions, defecation capability, and fear of falling. Part 2 addressed economic and social factors, including education, income, perceived income adequacy, living arrangements, and access to health services. Part 3 covered knowledge of fall risks and prevention using 16 yes/ no questions (KR-21 = 0.952), with knowledge levels categorized as high, moderate, or low based on Bloom's taxonomy. Part 4 explored behavioral factors such as medication use, footwear, sleep, alcohol consumption, exercise, physical exertion, and mobile phone use, using a three-point rating scale (Cronbach's alpha = 0.818). Part 5 examined environmental risks in the home through 15 yes/ no items and demonstrated high reliability (KR- 21 = 0.984). Part 6 consisted of a single yes/ no question assessing fall history within the past six months, covering all types of falls.

Data Collection

Permission was obtained from the district public health offices. With their support, we informed Subdistrict Health Promoting Hospitals (SHPH) officers of the study's objectives and procedures. Participants were purposively selected based on the following criteria: aged 60 or older, living in SHPH areas, and having at least one fall in the past year. Eligible individuals were identified from SHPH records and invited to join. After giving informed consent, participants completed questionnaires at local primary care units. We excluded incomplete responses, which included missing key variables or were less than 80% complete. Data were collected in October–November 2024.

Data Analysis

Data were analyzed using SPSS. Descriptive statistics (percentages, means, standard deviations, minimum, and maximum values) were used to summarize participant characteristics. To identify factors associated with falls, logistic regression analysis was performed, with significance set at $p< 0.05$. Fall history within the past six months (fall vs. no fall) was the dependent variable. Independent variables included biological, behavioral, environmental, economic, and social factors. Univariable logistic regression was conducted to identify potential predictors ($p < 0.25$), which were subsequently entered into a multivariable model using the Enter system. Multicollinearity and model fit were assessed. Results are presented as adjusted odds rates (AORs) with 95% confidence intervals.

RESULTS

1. Demographic Characteristics: Functional and Psychological Risk Factors and Economic and Social Data

A majority of the sample group was female (60.4%). Most participants were aged 60–69 years (34.9%), with an average age of 74.18 years (SD = 9.10). The most common body mass index (BMI) category was 18.50–22.90 (normal) (44.7%), and the average BMI was 23.24 (SD = 4.03). More than half of the participants were married or living with a partner (51.7%). Regarding health status, 57.7% had 1–2 chronic diseases. In terms of education, most participants had primary education or lower (83.4%). Monthly income was mainly in the range of 500–6,500 baht (95.1%), with an average of 2,485.68 baht. Among them, 69.8% perceived their income as adequate. Most participants lived with children or grandchildren (60%), and 53.5% had never lived alone during the day. A majority (73.4%) had never been hospitalized due to falls, and most (86.1%) reported no limitations in accessing health services.

Table 1. The numbers and percentages of biological risk factors. (N=447)

Biological Risk Factors	No n (%)	Yes n (%)
1. Vision problems	191 (42.7)	256 (57.3)
2. Hearing problems	307 (68.7)	140 (31.3)
3. Balance problems	130 (29.1)	317 (70.9)
4. Ability to walk without assistive devices	294 (65.8)	153 (34.2)
5. Problems with ability to defecate	245 (54.8)	202 (45.2)
6. Fear of falling	169 (37.8)	278 (62.2)

According to Table 1, a majority of participants had biological risk factors that included problems with balance or instability (70.9%), followed by fear of falling (62.2%), and vision problems (57.3%).

Table 2. Level of knowledge about risks and prevention of falls. (N=447)

Knowledge Level	**Number**	**(%)**
Moderate	21	4.7
High	426	95.3
(Mean=14.62, SD=2.05, Min=7, Max=16)		

It was found that a majority of the sample group had a high level of knowledge about risks and prevention of falls, with a score of 10-15 points (95.3%), followed by those with a moderate level of knowledge, scoring 5-9 points (4.7%). The mean score for knowledge about risks and prevention of falls was 14.62 points with a standard deviation of 2.05 points.

2. Behavioral Data

Table 3. Behavioral risk factors for Falls in dependent elderly people (N=447)

Behavioral Risk Factors	Regularly n (%)	Sometimes n (%)	Never n (%)
1. Taking multiple medication	246 (22.0)	159 (35.6)	42 (9.4)
2. Wearing shoes that fit the feet	336 (75.2)	77 (17.2)	34 (7.6)
3. Choosing suitable clothes to wear	383 (85.7)	56 (12.5)	8 (1.8)
4. Experiencing drowsiness after waking up	219 (49.0)	98 (21.9)	130 (29.1)
5. Consuming alcoholic beverages	35 (7.8)	60 (13.4)	352 (78.7)
6. Exercise	56 (12.5)	179 (40.0)	212 (47.4)
7. Engaging in physical activities	55 (12.3)	115 (25.7)	277 (62.0)
8. Walking with help of tools	222 (49.7)	67 (15.0)	158 (35.3)

As shown in Table 3, the three most frequently observed risky behaviors among dependent elderly individuals were: choosing suitable clothes to wear (85.7%), wearing properly fitting shoes (75.2%), and walking with the help of assistive tools (71.1%).

3. Environment Data

Table 4. Environmental risk factors for Falls in dependent elderly people. (N=447)

Environmental Risk Factors	No (not suitable) n (%)	Yes (suitable) n (%)
1. Living in a one-storey house	122 (27.3)	325 (72.7)
2. Non-slippery floor surfaces	209 (46.8)	238 (53.2)
3. No uneven surfaces	252 (56.4)	195 (43.6)
4. Presence of stable handrails	228 (51.0)	219 (49.0)
5. Properly designed doors	313 (70.0)	134 (30.0)
6. Securely fixed doormats	286 (64.0)	161 (36.0)
7. Sufficient lighting both in and around the house	28 (6.3)	419 (93.7)
8. Suitable bathroom conditions	389 (87.0)	58 (13.0)
9. Arranging household items in an orderly manner	65 (14.5)	382 (85.5)
10. Bed or mattress height at knee level	149 (33.3)	298 (66.7)
11. No pets inside the house	236 (52.8)	211 (47.2)

It was found that the top 3 of the '*yes'* responses by the sample group were having sufficient lighting both in and around the house (93.7%), followed by arranging household items in an orderly manner (85.5%), and living in a one-storey house (72.7%)

4. History of Falls

Table 5. History of falls, in the past 6 months. (N=447)

History of Falls	Number	%
History of Falls		
No history of falls	178	39.8
History of falls	269	60.2

From Table 5, a majority of the participants had a history of falls in the past 6 months (60.2%), while others had no history of falls (39.8%).

Analysis of Factors Affecting Falls in the past 6 months in Dependent Elderly People

Table 6. Simple logistic regression of various factors related to falls in dependent elderly people. (N=447)

Factors	n (%)	No Falls n (%)	Falls n (%)	OR 95% CI	p-value
Biological Risk Factors					
Gender					
Male[1]	177(39.6)	79(44.6)	98(55.4)		
Female	270(60.4)	99(36.7)	171(63.3)	1.39(0.95 - 2.05)	0.093
Age					
60-69 years[1]	156(34.9)	68(43.6)	88(56.4)		
70-79 years	150(33.6)	54(36.0)	96(64.0)	1.37(0.87 - 2.18)	0.176
≥80 years	141(31.5)	56(39.7)	85(60.3)	1.17(0.74 - 1.86)	0.499
Body Mass Index (BMI)					
<18.50 (Underweight)[1]	40(8.9)	14(35.0)	26(65.0)		
18.50-22.90 (Normal)	200(44.7)	80(40.0)	120(60.0)	0.81(0.40 - 1.64)	0.555
23-24.90 (Overweight/ Class I Obesity)	80(17.9)	35(43.8)	45(56.3)	0.69(0.32 - 1.52)	0.359
25-29.90 (Class II Obesity)	101(22.6)	42(41.6)	59(58.4)	0.76(0.35 - 1.62)	0.472
≥30 (Class III Obesity)	26(5.8)	7(26.9)	19(73.1)	1.46(0.50 - 4.32)	0.492
History of chronic illness					
No chronic disease[1]	77(17.2)	41(53.2)	36(46.8)		
Having 1-2 chronic diseases	258(57.7)	125(48.4)	133(51.6)	1.21(0.73 - 2.02)	0.460
Having 3 or more chronic diseases	112(25.1)	12(10.7)	100(89.3)	9.49(4.49 - 20.04)	<0.001*
Vision problems					
No[1]	191(42.7)	88(46.1)	103(53.9)		
Yes	256(57.3)	90(35.2)	166(64.8)	1.58(1.07-2.31)	0.020*
Hearing					
No [1]	307(68.7)	127(41.4)	180(58.6)		
Yes	140(31.3)	51(36.4)	89(63.6)	1.23(0.82 - 1.86)	0.323

Factors	n (%)	No Falls n (%)	Falls n (%)	OR 95% CI	p-value
Balance problems					
No[1]	130(29.1)	80(61.5)	50(18.6)		
Yes	317(70.9)	98(30.9)	219(69.1)	3.58(2.34 - 5.48)	<0.001*
Walking (able to walk with assistive devices)					
No	153(34.2)	65(42.5)	88(57.5)	0.85(0.57 - 1.26)	0.407
Yes[1]	294(65.8)	113(38.4)	181(61.6)		
Ability to defecate					
No[1]	245(54.8)	113(46.1)	132(53.9)		
Yes	202(45.2)	65(32.2)	137(67.8)	0.55(0.38 - 0.82)	0.003*
Fear of falls					
No[1]	169(37.8)	87(51.5)	82(48.5)		
Yes	278(62.2)	91(32.7)	187(67.3)	2.18(1.47 - 3.23)	<0.001*
Knowledge about risks and prevention of falls					
Moderate[1]	21(4.7)	4(19.0)	17(81.0)		
High	426(95.3)	174(4.8)	252(59.2)	0.34(0.11 - 1.03)	0.560
Economic and Social Risk Factors					
Perceived income adequacy					
Adequate income[1]	135 (30.2)	83(61.5)	52(38.5)		
Inadequate income	312(69.8)	95(30.4)	217(69.6)	3.65(2.39 - 5.56)	<0.001*
Living with family members					
With spouse [1]	150(33.6)	75(50.0)	75(50.0)		
With children or grandchildren	268(60)	96(35.8)	172(64.2)	1.79(1.19 - 2.69)	0.005*
Living alone	29(6.5)	7(24.1)	22(75.9)	3.14(1.27 - 7.80)	0.014*
Living alone					
Never[1]	239(53.5)	113(47.3)	126(52.7)		
Ever	208(46.5)	65(31.3)	143(68.8)	1.97(1.34 - 2.91)	<0.001*
Limitations in health services					
No[1]	37(8.3)	23(62.2)	14(37.8)		
Yes	410(91.7)	155(37.8)	255(62.2)	2.70(1.35 - 5.41)	0.005**
Behavioral Risk Factors					
Inappropriate footwear					
Never	141(31.5)	58(41.1)	83(58.9)	0.92(0.62 - 1.39)	0.700
Regularly[1]	306(68.5)	120(39.2)	186(60.8)		
Insufficient Sleep					
Never[1]	130(29.1)	100(76.9)	30(23.1)		
Sometimes	98(21.9)	48(49.0)	50(18.6)	3.47(1.97 - 6.13)	<0.001*
Regularly	219(49.0)	30(16.9)	189(86.3)	21.0 (11.98 - 36.81)	<0.001*
Alcohol drinking					
Never	352(78.7)	138(39.2)	214(60.8)	0.81(0.39 -1.68)	0.569
Sometimes	60(13.4)	28(46.7)	32(53.3)	0.60(0.25 - 1.41)	0.240
Regularly[1]	35(7.8)	12(34.3)	23(65.7)		

Factors	n (%)	No Falls n (%)	Falls n (%)	OR 95% CI	p-value
Exercise					
Never	212(47.4)	42(19.8)	170(80.2)	12.14(60.74 - 24.28)	<0.001*
Sometimes	179(40.0)	94(52.5)	85(47.5)	2.71(1.39 - 5.31)	0.004*
Regularly[1]	56(12.5)	42(75.0)	14(25.0)		
Physical activities					
Never[1]	277(62.0)	107(38.6)	170(61.4)		
Sometimes	115(25.7)	57(49.6)	58(50.4)	0.64(0.41 - 0.99)	0.046*
Regularly	55(12.3)	14(25.5)	41(74.5)	1.84(0.96 - 3.54)	0.066
Use of mobility devices					
Never [1]	158(35.3)	80(50.6)	78(49.4)		
Sometimes	67(15.0)	31(46.3)	36(53.7)	1.19(0.67 - 2.11)	0.550
Regularly	222(49.7)	67(30.2)	155(69.8)	2.37(1.55 - 3.62)	<0.001*
Environmental Risk Factors					
House conditions					
No[1]	122(27.3)	47(38.5)	75(61.5)		
Yes	325(72.7)	131(40.3)	194(59.7)	0.93(0.61 - 1.42)	0.732
Slippery floor					
No	209(46.8)	14(6.7)	195(93.3)	30.87(16.81 -56.69)	<0.001*
Yes[1]	238(53.2)	164(68.9)	74(31.1)		
Areas with different levels					
No	252(56.4)	28(11.1)	224(88.9)	26.67(15.93 - 44.63)	<0.001*
Yes[1]	195(43.6)	150(76.9)	45(23.1)		
Stable handrails or railings					
No[1]	228(51.0)	74(32.5)	154(67.5)		
Yes	219(49.0)	104(47.5)	115(52.5)	0.53(0.36 - 0.78)	<0.001*
House door					
No[1]	313(70.0)	114(36.4)	199(63.6)		
Yes	134(30.0)	64(47.8)	70(52.2)	0.63(0.42 - 0.94)	0.025*
Carpet or doormat					
No[1]	286(64.0)	105(36.7)	181(63.3)		
Yes	161(36.0)	73(45.3)	88(54.7)	0.70(0.47 - 1.04)	0.074
Lighting					
No[1]	28(6.3)	15(53.6)	13(46.4)		
Yes	419(93.7)	163(38.9)	256(61.1)	1.81(0.84 - 3.91)	0.129
Bathroom					
No[1]	389(87.0)	151(38.8)	238(61.2)		
Yes	58(13.0)	27(46.6)	31(53.4)	0.71(0.42 - 1.27)	0.263
Arrangement of household items					
No[1]	65(14.5)	24(36.9)	41(63.1)		
Yes	382(85.5)	154(40.3)	228(59.7)	0.87(0.50 - 1.49)	0.606
Bed					
No[1]	149(33.3)	63(42.3)	86(57.7)		
Yes	298(66.7)	115(38.6)	183(61.4)	1.17(0.78 - 1.74)	0.452
Pets in the house					
No	236(52.8)	93(39.4)	143(60.6)		
Yes[1]	211(47.2)	85(40.3)	126(59.7)	0.96(0.66 - 1.41)	0.850

[1] reference group * Significance level (α<0.25)

According to Table 6, the factors that were significantly related to falls in dependent elderly people were as follows: history of chronic illness, vision problems, balance problems, ability to defecate, fear of falls, income adequacy, living with family members, living alone, limitations in health services, sleep, exercise, physical activities, use of mobility devices, slippery floor, areas of different levels, stable handrails or railings and house door.

Table 7. Multivariable logistic regression analysis of factors affecting falls in dependent elderly people. (N=447)

Factors	B	Wald	AOR	95% CI		p-value
				Lower	Upper	
Biological Risk Factors						
History of chronic illness						
No chronic disease[1]						
Having 1-2 chronic diseases	0.44	1.24	1.56	0.71	3.40	0.266
Having 3 or more chronic diseases	2.25	16.16	9.52	3.17	28.54	<0.001*
Economic and Social Risk Factors						
perceived income adequacy						
Adequate income[1]						
Inadequate income	1.15	12.07	3.15	1.65	6.03	0.001*
Behavioral Risk Factors						
Insufficient Sleep						
Never[1]						
Sometimes	0.44	1.25	1.55	0.72	3.35	0.263
Regularly	1.78	21.70	5.90	2.80	12.46	<0.001*
Exercise						
Never	1.64	10.47	5.15	1.91	13.90	0.001*
Sometimes	0.53	1.161	1.70	0.65	4.47	0.281
Regularly[1]						
Environmental Risk Factors						
Slippery floor						
No[1]						
Yes	1.53	9.97	4.63	1.79	12.00	0.002*
Areas with different levels						
No[1]						
Yes	1.72	15.17	5.58	2.35	13.26	<0.001*
Constant	-4.12					

[1] reference group * Significance level (α<0.05), Enter (Wald), Psuedo R^2 = 86.1

The analysis began with Univariable Logistic Regression, in which variables with a p-value less than 0.25 were selected, resulting in 1 7 variables being included in the next phase. These variables were then entered into a Multivariable Logistic Regression model using the Enter method. The model was assessed for multicollinearity and goodness-of-fit using several indicators: The Omnibus Tests of

Model Coefficients ($p < 0.001$), the Hosmer-Lemeshow Test ($p > 0.83$), and a Pseudo R^2 value of 86.1%, suggesting that the model explained a substantial proportion of the variance. Adjusted Odds Ratios (AORs) and their 95% Confidence Intervals (CI) were also reported.

According to the multivariable logistic regression analysis in Table 7, dependent elderly people with a history of 3 or more chronic illnesses had a higher risk of falls than elderly people without chronic illness at 9.52 times (Adj OR = 9.52, p<0.001, 95% CI; 3.17 – 28.54). Dependent elderly people with inadequate sleep had a higher risk of falls than the elderly with adequate sleep at 5.90 times (Adj OR = 5.90, p<0.001, 95% CI; 2.80 – 12.46). Dependent elderly people who lived in a house with an area of different levels had a higher risk of falls than the elderly who lived in a house without such areas of different levels at 5.58 times (Adj OR = 5.58, p < 0.001, 95% CI: 2.35–13.26). Dependent elderly people who never exercised had a higher risk of falls than the elderly who regularly exercised at 5.15 times (Adj OR =5.15, p=0.001, 95% CI; 1.91 – 13.90). Dependent elderly people living in a house with slippery floors had a higher risk of falls than the elderly who lived in a house with anti-slip floors at 4.63 times (Adj OR = 4.63, p=0.002, 95% CI; 1.79 – 12.00). Finally, dependent elderly people with perceived income inadequacy had a higher risk of falls than those with perceived income adequacy (Adj OR = 3.15, p = 0.001, 95% CI: 1.65–6.03).

DISCUSSION

The study's findings emphasize significant risk factors related to falls among dependent older individuals in Sukhothai Province, which are divided into four categories: biological, socioeconomic, behavioral, and environmental. Six characteristics were identified as strongly linked with fall risk, which is consistent with previous studies.

Regarding biological factors, the study found that the elderly individuals with three or more chronic conditions were significantly more likely to experience falls than those without chronic conditions. Biological factors are directly related to the physical condition, organ systems, and bodily functions of the senior rudiments that naturally deteriorate with age. The accumulation of multiple chronic conditions contributes to a decline in mobility, which is a critical risk factor for falls.[12,17,22] This is consistent with earlier studies showing that chronic ailments such as diabetes, hypertension, and arthritis significantly affect motor function, balance, and physical capacity, thereby adding the threat of cascade likewise, aged persons are more at risk for falls,[16,20,23] indeed in putatively slight circumstances, due to the natural deterioration of the neurological, muscular, and skeletal systems, which impairs the capacity to respond instantly to a loss of balance. Thus, it's pivotal to conduct thorough screenings and manage chronic conditions, particularly among people with several comorbidities.

Socioeconomic factors reflect both social capital and the capacity for maintaining a quality of life. Older adults with inadequate income often face multiple constraints that indirectly but significantly contribute to fall risk. These findings are in line with studies indicating that economic status affects quality of life, as limited income can lead to poor nutrition, an inability to improve housing safety, a lack of assistive devices, limited access to healthcare services, and social isolation.[12,16,17] Therefore, socioeconomic vulnerability is not merely a financial issue, but a cascade of impacts on health and environmental conditions. Economic support from relevant agencies should focus on strengthening welfare systems and

providing income assistance for dependent elderly individuals.

Behavioral factors also play a crucial role, particularly sleep patterns and physical activity, which directly affect bodily function and the ability to prevent accidents. The study found that dependent older adults with insufficient sleep were nearly six times more likely to fall than those who slept adequately. Sleep deprivation can cause fatigue, reduced neurological alertness, shorter attention spans, and delayed reactions to stimuli—all of which contribute significantly to fall incidents. This finding aligns with previous studies showing that sleep quality affects balance and reactivity and is significantly associated with fall risk.[23] Simultaneously, those who never exercise tend to have weaker muscles, especially in the legs and torso, which are essential for postural control. Lack of physical activity also affects joint flexibility, overall body balance, and agility—key components of "functional ability" in older adults. As such, inactivity was significantly associated with fall risk, supporting earlier findings that low levels of exercise contribute to fall incidents.[16,24] Exercise enhances muscle strength, physical resilience, and flexibility, while a lack of it increases the likelihood of balance loss and injury.[12,22] For dependent elderly individuals, poor health behaviors further accelerate functional decline and markedly increase fall risk. Promoting health behaviors should therefore include encouraging sufficient, high-quality sleep and organizing suitable physical activity programs tailored for dependent older adults.

As for environmental factors, the living environment represents an external variable that can be modified, yet it remains an often-overlooked fall risk factor. Slippery surfaces and uneven flooring inside the home were found to be significantly associated with falls. Common hazards such as tiled bathroom floors, thresholds, staircases, and uneven surfaces—although seemingly minor—pose serious challenges for older adults with limited mobility. These areas are high-risk zones that can lead to falls immediately. This is in line with previous studies, which indicated that slippery floor conditions are significantly associated with falls in older adults,[16,25] especially in bathrooms where wet or smooth tiles without anti-slip textures are common.[12,26] Furthermore, level differences inside and outside the home were significantly associated with falls. [27] For older adults with impaired vision or limited mobility, even slight changes in floor elevation can lead to tripping and falling.[7,17,22] Therefore, appropriate home environment modifications are essential, including installing anti-slip materials in risk-prone areas, leveling surfaces to eliminate elevation differences, and providing assistive devices such as handrails or ramps.

In summary, the results suggest that falls among dependent older adults are not caused by a single factor but rather stem from the interplay of multiple interconnected elements, including health status, economic conditions, personal behaviors, and living environment. Therefore, fall prevention and care for the elderly should adopt a holistic approach that integrates healthcare management, behavioral adjustment, resource support, and environmental modification tailored to support the daily living abilities of older adults.

STRENGTHS AND LIMITATIONS

A major strength of this study is its focus on a specific high- risk group — dependent senior individuals — across the entire provincial population, enhancing the

applicability and relevance of findings. Also, a large sample size and rigorous statistical methods were used. However, as a cross-sectional study, causal relationships cannot be definitively established. The data are also region-specific and may not generalize to other parts of Thailand or other countries.

RECOMMENDATION

This study highlights the complex interplay of biological, behavioral, economic, and environmental factors contributing to falls among dependent elderly individuals in Sukhothai Province. Addressing this issue requires a multi-sectoral approach involving public health, local governance, community groups, and caregivers. By combining medical care, social support, environmental variations, and public awareness, fall risks can be significantly reduced, leading to safer and further stable ageing in place. Future studies should employ longitudinal and intervention designs to clarify causal relationships and evaluate the effectiveness of targeted fall prevention strategies in dependent elderly populations. Context-specific approaches, including home modifications and caregiver training, warrant further investigation.

AUTHOR CONTRIBUTIONS

RR: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing – original draft. RW: Conceptualization, Methodology, Supervision, Validation, Writing – review & editing. NN: Methodology, Supervision, Validation, Writing – review & editing.

ETHICAL CONSIDERATION

This study was approved by the Human Research Ethics Committee, Naresuan University (IRB No. P2-0248/2567), with the approval date of July 8, 2024.

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CONFLICTS OF INTERESTS

The authors declared no conflicts of interest for the research, writing, and/or publication of this article.

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