Nakhara: Journal of Environmental Design and Planning (2025)
Volume 24(1), Article 501
DOI: https://doi.org/10.54028/NJ202524501
Article Type: Research Article

Influence of Sociocultural Aspects and Home Modification on Fall Risks Mitigation Among the Elderly in Thailand

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Received 2024-08-05; Revised 2024-10-24; Accepted 2025-01-23

ABSTRACT

This study investigates the impact of sociocultural dimensions on home modifications aimed at mitigating fall risks among elderly individuals residing in community settings. Personal measurements and questionnaire interviews were conducted across five regions in Thailand. Additionally, fall risk assessments were performed on the households of the elderly participants. These assessments incorporated both personal health factors and environmental risks associated with falls, resulting in quantifiable scores. The factors included health conditions, body size, sociocultural factors such as family conditions, physical-cultural aspects of elevated houses, bathroom and bedroom. The research revealed that these factors are significantly associated with fall risk ($\rho < 0.01$), except body dimensions. Differences in body size among elderly individuals in different regions were significantly related to incidences of fall risk ($\rho < 0.05$ in Chiang Mai female, Khonkaen male, Rangsit female, and Songkhla female). The contribution of this research is that different regions have varying body limitations and living culture. It was concluded that elderly females in Chiang Mai are at the highest risk of falling due to body shrinkage, residing in vernacular houses with hazards, and living alone. Overall, universal design may not be directly applicable for home modification in each region. Consequently, the study suggested that home modifications alone may not offer a comprehensive solution for mitigating fall risks as sociocultural factors related to living conditions also play a significant role in shaping these outcomes.

Keywords: fall risk, elderly, home modification, sociocultural, body dimension

INTRODUCTION

The concept of active and healthy aging can extend the period of good health for the elderly. Aging in place helps the elderly live confidently and reduces the time required to adapt to new environments. However, deterioration in their physical health can pose various risks to the elderly in the existing environment. For example, weak legs can lead to fall risks in the elderly living in existing housing. Research indicates that the elderly are more likely to experience low muscle mass and bone mass, decreased height, and shrinking stature (Jain & Ma, 2020), resulting in declined physical performance and challenges in maintaining balance while walking and standing (Stel et al., 2003).

Elderly females tend to have twice the fall risk as elderly males. The fall history of the Thai elderly reported that elderly females fell 1.6 times more than elderly males (Thai Civil Rights and Investigative Journalism [TCIJ], 2020). A majority of elderly females (at 66%) experienced accidents within their accommodation, whereas elderly males were prone to falls in public areas. Surprisingly, one-third of the elderly had a fall from an object on flat floors with no steps (33%) and on a slippery floor (30%) (Aekplakorn, 2022). This may be due to the physical deterioration of the elderly. Internal factors affecting the fall risk of the elderly include age, female gender, chronic diseases, physical movement capability, and vision impairment (Panel on Prevention of Falls in Older Persons; American Geriatrics Society; British Geriatrics Society, 2010, 2012; Appeadu & Bordoni, 2022; Pynoos et al., 2010) . The higher fall risk in females can be attributed to the higher deterioration rate of muscle mass in females. Many cases have indicated height shrinkage in the elderly (Huang et al., 2013; Hussain et al., 2023), with elderly women exhibiting the highest degree of height shrinkage compared to elderly men (Jain & Ma, 2020).

Cultural differences cause differences in people's behaviors and practices. Although the elderly in modern society reside mostly in modest houses, the majority of the elderly in rural areas still live in vernacular houses or lived in a modest house but exhibit behavior typically followed when they live in vernacular houses. Approximately 33% of houses in the north and 26% in the central regions of Thailand are elevated. In contrast, the south has predominantly one-story houses (at 49%), and Bangkok has a majority of 2-story houses (78%) (Aekplakorn, 2022). The characteristics of vernacular houses in Thailand vary by region, making them suitable for different climatic conditions. Specifically, vernacular houses vary in terms of features such as the height of elevated houses, steps in houses, and steep roofs. For example, vernacular houses in the north are elevated houses to mitigate low temperatures from the ground (Khrueraya, 2011), while northeastern houses feature multiple steps, facilitating agricultural storage and avoiding reptiles (Suppamityotin, 2016). Although these features may suit the local climate and activities, they may pose safety hazards for elderly occupants, even those aging in place. In addition, some cultural behaviors can lead to fall risks depending on factors such as different practices of bathing or showering, sleeping on the floor or in a bed, or in rooms on the top floor or the ground floor. To address these issues, the universal design of houses can be applied with certain limitations.

Cultural differences are related to the health conditions of the elderly. The correlation between fall risks and ethnic diversity has not been extensively studied. The elderly in English-speaking countries (Feldman & Chaudhury, 2008; Letts et al., 2010) and Asia (Cheng & Chang, 2017; Cho et al., 2013; Iamtrakul et al., 2021; Zhao et al., 2019) exhibit a greater tendency to falls. Research in northern Thailand revealed that different ethnic groups living in the same area exhibit different health literacy levels, quality of life, and fall experiences. The health literacy of the elderly living in rural areas is less than those in urban areas. The quality of life of the elderly who had experienced a fall in the previous year was significantly lower than that of the elderly who had not experienced a fall in the previous year (Kantow et al., 2021). Cultural diversity influences the acceptance of fall prevention interventions among the elderly in China (Horton & Dickinson, 2011). In addition, sociocultural resilience impacts urbanization and the kinship between the elderly and other family members in rural areas (Wu & Yuan, 2023). Certain local cultural norms result in certain unfavorable behaviors or practices that may affect physical environments, such as the shape of the roof or terrace. Certain norms related to

living conditions in Thai culture may pose fall risks of the elderly. Research indicated that the elderly in rural areas had a higher fall risk than those in urban areas (Chindapol & Arkarapotiwong, 2023; Cho et al.,2013; Rongmuang et al., 2016). This can be attributed to the lower standard and quality of facilities in rural areas than in urban areas (Cook et al., 2005). There could also be a link to lifestyles and intense cultural practice in rural areas. The relationship between sociocultural difference across regions in Thailand and the risk of falling among the elderly still presents a gap in the research.

The present study aims to investigate the sociocultural factors, along with the health and environment factors, that influence the fall risk of the elderly in Thailand. The research question is whether the degree of correlation between these health-related and sociocultural factors with fall risk differs by area across the country. Lower physical and mental health conditions, as well as body size among the elderly, are expected to be associated with a higher risk of falls. Additionally, cultural-related characteristics of house, such as elevated platforms, house style, bathrooms and bedrooms, are projected to be associated with fall risk.

METHODOLOGY

To answer the research question, this study investigates four factors related to fall risks and incidences: personal health conditions including physical and mental health and body size, and sociocultural factors, including family conditions, physical-cultural aspects of elevated houses, cultural-related bathrooms and cultural-related bedrooms.

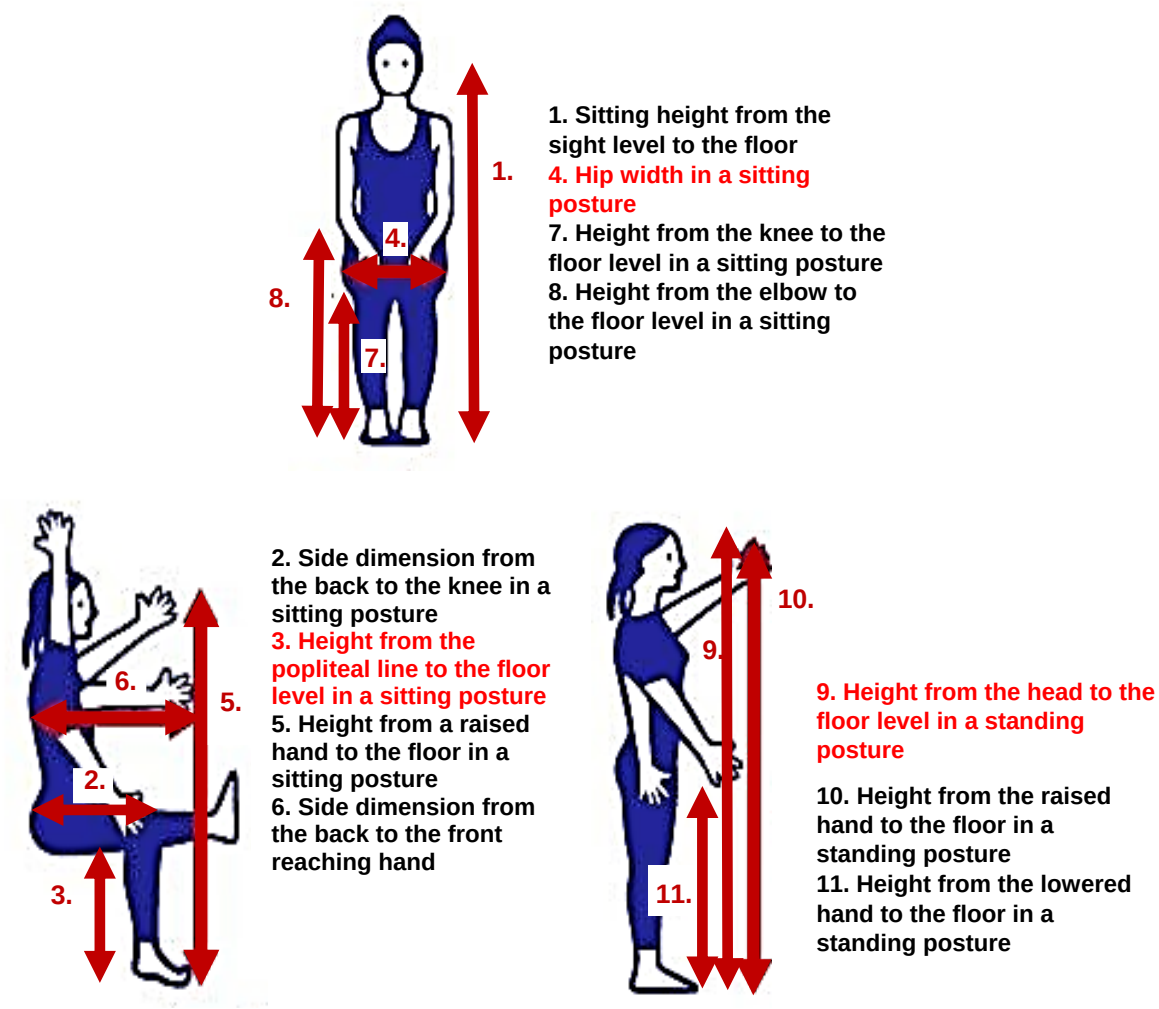
This research is an extension of a study that investigated the effectiveness of home modification in mitigating fall risks among the elderly through fall risk assessment performed in five areas in Thailand in 2021 (Chindapol & Arkarapotiwong, 2023). The main survey was conducted in 2021[1], while extensive interviews in this research were conducted in 2023 to investigate the influential impact of sociocultural factors on fall risk across five different sub-cultures in Thailand. The study surveyed four different cultural regions in five areas: Chiang Mai to represent the north, Khonkaen to represent the northeast, Rangsit in Patumthani to represent the central region, Bangkok to represent the central region and the suburban area around the capital, and Songkhla to represent the south. Personal health and physical environmental risk assessments were conducted among 40 elders in each area, totaling 205 elders and houses. These elderly participants, who were continually engaged in senior welfare activities and had not modified their homes, were nominated by their communities to participate in the project. The fall risk assessment tool included a questionnaire interview and an environmental assessment of the home, consisting of 27 questions referring to health and family conditions related to fall risk[2]. However, this article focused on health and sociocultural factors associated with fall risk. The collected hazard environment scores in the homes were not presented in this article.

The personal health factors affecting fall risks that were screened included gender, age, health conditions, noncommunicable diseases (NCDs), mental health conditions, fall experiences within a six-month period, and body size. All conditions of the Thai Falls Risk Assessment Test (Thai-FRAT) (Thiamwong et al., 2008) were scored for personal health factors affecting falls. The body size of the elderly was measured using the same posture and protocol as in the Thai-FRAT. A total of 11 dimensions were measured (Figure 1).

[1] This research conducted the survey along with the research project titled “Appropriate housing for Thai Elderly to promote physical and mental health by Age friendly community concept” (Jarutat, 2020)
[2] Details of the sampling methods were explained in the main research, published in 2023 (Chindapol & Arkarapotiwong, 2023)

Figure 1

Eleven Dimensions of the Elderly Body Size Recorded in the Survey



Note. Dimension 3, 4, and 9 related to sit-to-stand posture. Adapted from *Research Report: Minimum Standards for Resident and Common Area Spaces in Long-term Elderly Care Facilities* (pp. 3–19), by K. Sirisuk; T. Jarutach; J. Ketpichayatwattana; & S. Lormaneenoparat, 2022, National Research Center of Thailand. Copyright 2022 by Kittiorn Sirisuk; Trirat Jaruthat; Jiraporn Ketpichayatwattana; & Saranya Lormaneenoparat.

Fall risks were indicated and measured in the research by assessing physical environmental factors in 41 scores. Various features of the houses where elderly resided were assessed, including house styles, bathrooms and toilet conditions, bedrooms and mattress characteristics, stairs, entrance halls, kitchens, and surrounding areas. The health risk and environmental risk scores were then combined to obtain the total score of fall risk of the elderly.

Sociocultural factors, including family condition, generations within the family, number of elderly members in the family, and cultural practices related to bathrooms and bedrooms, were surveyed. Certain sociocultural factors were investigated through in-depth interviews with the elderly. Bathroom and bedroom differences across sub-culture were analyzed considering both fall risk scores and characteristics.

The analysis in this study utilized a combination of a quantitative method to determine the association between body dimensions and fall risk scores and a qualitative method to determine the specific sociocultural factors of each area impacting fall risk mitigation constraints. Correlation and T-test statistical tools were used to analyze the relationship between health, sociocultural factors and fall risk.

RESULTS

Personal health factors

Physical and mental health conditions

Personal health factors impacting the fall risk score assessed using the Thai-FRAT indicated the highest health risk scores for the elderly in Songkhla and Khonkaen. NCDs such as hypertension, diabetes, gout, knee conditions, and dizziness are typically associated with fall risks. Multiple NCDs impacting fall risk were scored, with 0 point for no NCDs, 1 point for one NCD, and 2 points for more than one NCD. The NCD scores indicated that the elderly in the north and south had more than 1 NCD, with scores of 1.49 and 1.10 points, respectively. The elderly with mental issues such as depression, anxiety, and dementia, as well as signs of confusion, disorientation, or difficulty in perceiving time and date, are at a high risk of fall. Rangsit had the highest number of elderly with mental health issues (22 people or 53.7%, presented in bar chart in Figure 2). Although fall risk scores related to health were the highest in Songkhla, Khonkaen, and Chiang Mai, at 7.02, 6.20, and 5.55, respectively (as presented in the line chart in Figure 2), the total fall experiences were highest in Khonkaen, Songkhla, and Chiang Mai, at 75%, 65%, and 54% of the elderly participants, respectively. It seems that the health risk scores profile somewhat align with fall experiences. The relationship between health risk scores, mental health and fall experiences will be discussed in the last section of the results section.

Body size of the elderly

Body dimensions of the elderly can significantly impact fall risk because physical changes impose constraints on their daily activities. While each of the 11 dimensions measured showed variation among five areas, no significant differences were found in the average dimensions (t-test; ρ-value > 0.05). However, three dimensions— popliteal line height (height from the popliteal line to the floor in a sitting posture), hip width in sitting posture, and height in standing posture—are related to fall risk activities such as sitting, sit-to-stand, and stand-to-walk. Popliteal line height averaged 42.74 ± 3.15 cm for males and 40.91 ± 5.23 cm for females; hip width averaged 37.70 ± 4.13 cm for males and 37.59 ± 5.59 cm for females; standing height averaged 48.50 ± 13.20 cm for males and 43.25 ± 4.95 cm for females (Table 1). Differences in these dimensions, alongside certain furniture and architectural features, may affect stability and safety, thereby influencing fall risk. For instance, individuals with lower popliteal line height may struggle with high beds or stairs, while those with smaller hips may find large-seat toilets challenging. If smallest body dimensions correlate with the highest risk, female elderly in Bangkok, Chiang Mai, and Khonkaen may be more vulnerable, given their shorter popliteal line height, smaller hip width, and shorter standing height, respectively (Table 1).

Specific designs tailored to different body sizes should be considered rather than the universal design. The comparison of the three dimensions measured in the sitting position within the same gender revealed that the elderly in some areas had significantly different body sizes than the average. The t-test analysis of the three dimensions measured in the sitting position for the elderly in each area was conducted. Elderly males in Khonkaen (representing the northeastern region) exhibited a significantly greater popliteal line height (44.71 cm, with $\rho = 0.01$, $t = 2.40$; Table 1). Elderly females in Chiang Mai (representing the north) exhibited a significantly smaller sitting hip width and lower standing height (34.69 cm, with $\rho = 0.02$, $t = -2.12$ and 147.16 cm, with $\rho = 0.04$, $t = -1.84$, respectively). The elderly females in Bangkok (representing the rural capital) showed a significantly shorter popliteal line height and wider sitting hip width (38.60 cm, with $\rho = 0.00$, $t = -3.67$ and 41.43 cm, with $\rho = 0.00$, $t = 3.45$, respectively). The female elderly in Songkhla, representing the southern region, exhibited a significantly wider hip width (43.55 cm, with $\rho = 0.00$, $t = 4.02$).

Figure 2

Percentages of the Elderly With Poor Health and Mental Health Conditions Associated With Fall Risk Scores Related to Health: A Comparison in Five Areas.

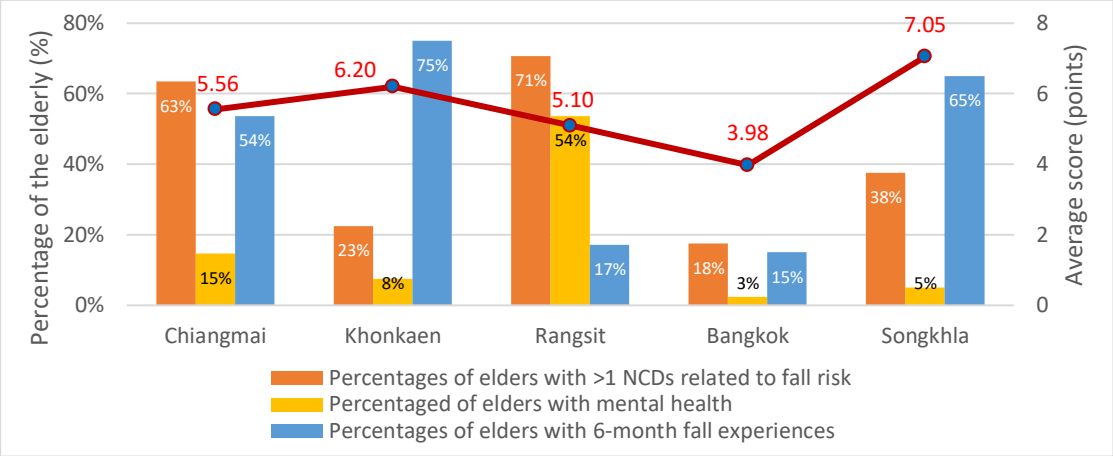


Table 1

Eleven Body Dimensions of the Elderly in Five Areas

Position	1.	2.	3.***	4.***	5.	6.	7.	8.	9.***	10.	11.
Male											
Chaing Mai	111.27± 6.97	44.55± 4.35	41.61± 2.77	37.33± 5.04	145.39± 27.15	91.71 ±30.88	46.33± 4.16	105.88± 46.88	161.87± 7.17	190.41± 15.99	75.28± 8.79
Khonkaen	112.50± 9.16	48.93± 3.24	44.71* ±2.60	37.14± 2.50	137.43± 28.44	82.21± 4.36	55.00 ±26.35	100.86± 4.82	159.29± 7.34	170.21± 14.53	77.64±10 .81
Rangsit	113.41± 5.11	35.59± 3.63	41.61± 3.61	38.33± 3.73	130.67± 10.94	69.44± 5.17	46.78± 3.49	101.00± 5.49	160.22± 6.15	166.28± 7.75	88.00± 8.93
Bangkok	112.50± 2.87	44.81± 2.06	43.00± 2.40	39.50± 5.02	123.25± 11.33	80.25± 9.26	47.75± 3.34	102.25± 3.96	164.75± 7.22	162.25± 5.99	84.38± 6.10
Songkhla	117.33± 9.09	44.00± 3.50	43.56± 2.11	36.33± 3.56	141.22± 12.86	80.33± 5.35	46.11± 3.18	101.67± 4.47	162.00± 5.72	181.89± 12.14	70.89± 8.65
Average	**113.14± 7.32**	**43.06± 6.04**	**42.74± 3.15**	**37.70± 4.13**	**136.15± 21.82**	**80.34± 17.73**	**48.50± 13.20**	**102.36± 7.65**	**161.22± 6.96**	**174.49± 16.03**	**79.89± 10.94**
Female											
Chaing Mai	102.59± 14.37	43.32± 3.96	39.71± 2.91	34.69* ±5.40	136.30± 20.80	76.49±12 .29	41.87± 2.94	92.49± 4.53	147.16* ±7.70	175.46± 17.17	65.72± 8.31
Khonkaen	106.50± 9.65	45.69± 4.19	40.65± 2.77	36.27± 2.88	135.50± 12.67	74.77± 4.41	42.19± 2.43	91.04± 5.95	146.50± 6.15	163.31± 11.35	74.69±15 .36
Rangsit	105.95± 4.42	37.14±10 .65	41.64± 4.01	37.45±2 5.72	116.64±1 34.26	94.95± 4.77	42.50± 6.20	130.27± 3.33	149.59± 170.22	153.86± 6.76	82.272 72727
Bangkok	103.11± 14.29	43.57± 3.75	38.60** ±2.36	41.43** ±5.41	116.97± 9.58	74.07± 9.61	44.03± 8.32	95.23± 6.87	150.03±5 .72	144.40± 9.42	77.80± 9.10
Songkhla	109.23± 7.70	44.65± 3.45	43.55** ±2.60	37.29± 4.26	142.161 2.50	76.26±1 1.44	44.61± 3.69	95.48± 3.72	151.13±7 .96	177.52± 12.64	72.39± 7.49
Average	**105.59± 10.67**	**43.14± 4.77**	**40.91± 5.23**	**37.59± 5.59**	**129.55± 20.29**	**78.98 ±55.62**	**43.25± 4.95**	**99.26 ±70.35**	**148.61± 7.23**	**161.05± 18.67**	**74.42 ±11.26**

Note. means significant level $p < 0.05$, and ** means significant level $p < 0.01$; *** Dimension 3. Distance from the popliteal line to the floor level in sitting posture; 4. Hip width in sitting posture; and 9. Height from the head to floor level in standing posture.

Sociocultural aspects

Family conditions

Fall risk may be influenced by family situations. Multigenerational families often provide the elderly with essential physical and mental support, whereas those living alone or only with other elderly individuals may be at a higher risk of falling. Rangsit had the highest number of elderly members per family, with three or more elderly members, and the highest proportion of three-generation families (53.66%, Figure 4), correlating with the lowest incidence of falls. About three-fourths of the elderly in rural areas, like Chiang Mai and Khonkaen lived in two- or three-generations families. In contrast, approximately half of the elderly in urban areas, such as in Rangsit and Songkhla, lived alone or with another elderly person, with Bangkok being the exception where no significant association with fall risk was observed. Figure 3 indicates that an increase in family generations correlates with a decrease in fall incidents. This statistical relationship is significant, with $\rho < 0.001$, and is explored further in the discussion section.

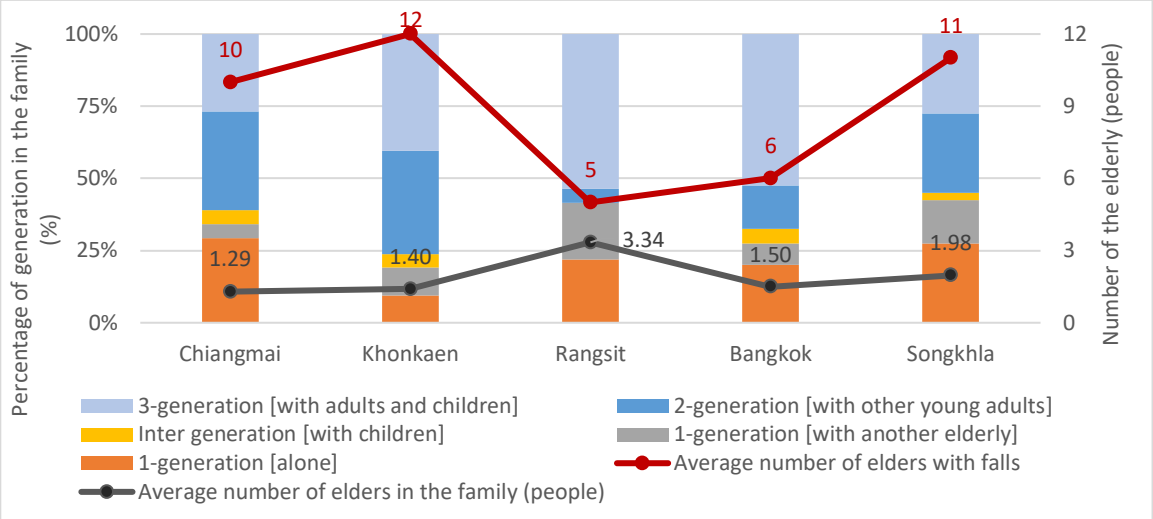
Physical–cultural aspects of elevated houses

Residing in elevated or two-story houses with steep staircases is a cultural norm among Thai people. The height of elevated houses varied across the four regions, reflecting differences in vernacular house styles. Houses in the northern region are elevated 1.5–2.0 m for timber storage and cowsheds, similar to those in the central region. Northeastern houses are elevated only 1.0–2.0 m to avoid reptiles rather than for habitation. Houses in the southern region are also lifted 1.0–1.5 m for boat storage and hanging bird nests. The space under the elevated houses is often used for living quarters, with brick walls installed for bedrooms at the ground level. Half-timber, half-cement houses have become popular, particularly in rural areas. People of low economic status are more likely to reside in one-story houses built by local governments.

Among the elderly surveyed in this research, half resided in elevated or two-story houses, with the majority residing in Khonkaen and Rangsit (70%). The living arrangements of the elderly have shifted to more modest houses, with approximately half of the elderly residing in cement houses (48%) and half-timber, half-cement houses (34%) (Figure 4). Vernacular timber houses were less common, with only 11% of the elderly residing in such houses (Figure 4). An exception to this trend was observed in the north, with 20% of the elderly in Chiang Mai living in traditional timber elevated houses. The scores for house styles indicated that Bangkok and the south scored the highest (2.28 and 2.40, respectively). This is because of the prevalence of cement and half-timber half-cement houses. By contrast, such houses were rare in Khonkaen, with a score of only 2.10, indicating that 60% of houses were the half-timber, half-cement style.

Figure 3

Comparison of the Generations Within the Family Among the Five Areas in Terms of the Percentage and Average Number of Elderly With Fall Experiences in Six Months.



Note. The number of generations within the family is represented by scores: a 5-point score denotes living alone, corresponding to the highest fall risk; a 4-point score denotes living with another elderly person; a 3-point score denotes living with children or intergenerationally; a 2-point score denotes living with other younger adults; and a 1-point score denotes living with other adults and children in three generations, corresponding to the lowest fall risk.

Figure 4

Percentage of House Style in all Five Areas

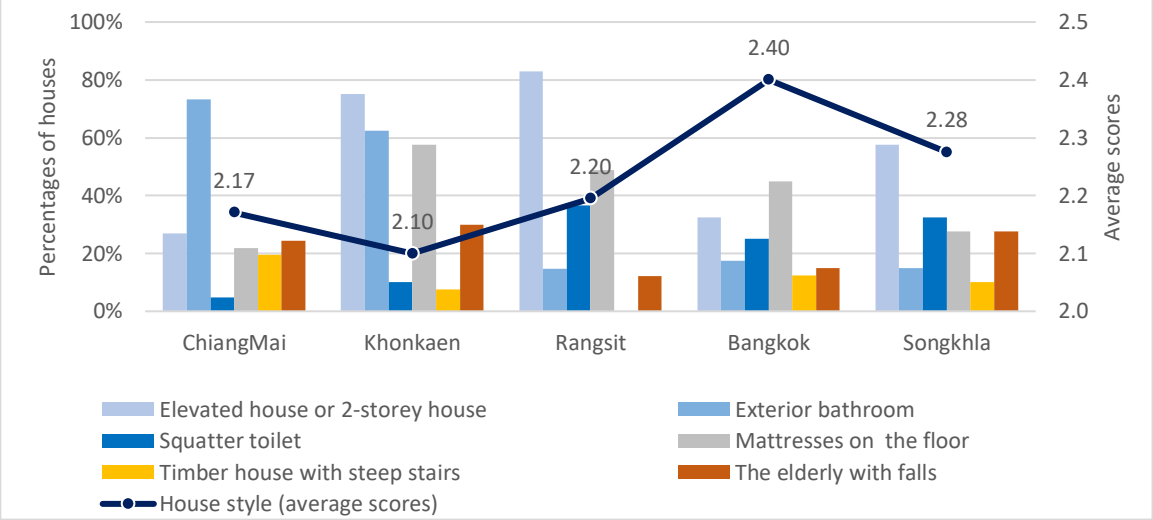
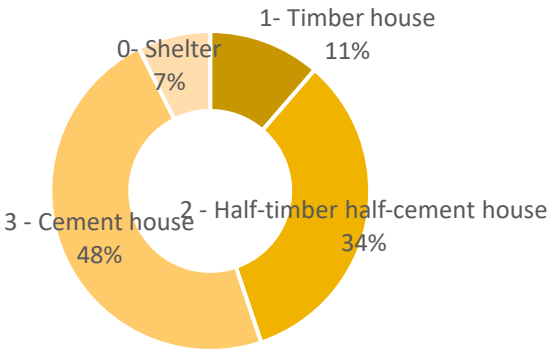


Figure 5

House-Style Score of the Elderly Dwelling in Five Areas



Note. House style scores were averaged based on house characteristics: “0” for Shelter, “1” for Timber house with steep stairs, “2” for Half-timber, half-cement house, and “3” for Cement house.

Bathroom

The bathroom represents an environment that poses the most fall risks for the elderly. In rural areas, the prevalence of outdoor bathrooms increases fall risk, particularly during nighttime use. In traditional houses in the northern and northeastern regions of Thailand, toilet facilities are often placed in separate structures outside the main dwelling to maintain sanitary functions, involving germs and odors, separated from living areas. While only 15% of bathrooms in urban areas are located outside the house, the majority in rural areas are external bathrooms. Chiang Mai and Khonkaen had a majority of house plans with exterior bathrooms (73% and 63%, respectively; Figure 5), which correlates with the sociocultural norm of the elderly in rural areas.

Although commode chairs may be utilized within bedrooms, mainly for urination, elderly individuals face heightened fall risks when accessing external bathrooms, particularly at night. An interview conducted during the research underscored the challenges faced by an elderly individual with diarrhea, necessitating multiple nighttime visits to the external toilet shelter (Participant CM04, personal communication, January 23, 2023). Figure 6 shows examples of the exterior bathroom plan in Chiang Mai and Khonkaen. In cases where constructing an internal toilet is financially constrained, the implementation of strategic modifications is advised. These may include enhancements, such as improved lighting, pathway modifications, installation of handrails along walkways and within the toilet zone, and the use of rough-surfaced flooring materials to mitigate fall risks.

The design of bathrooms also has implications for the body size dimensions of the elderly. When considering the popliteal line height and hip width, elderly women in Chiang Mai had significantly smaller hips compared to the average of 34.69 cm, with a difference of 2.12 cm. The standard toilet seat may not be suitable for these women because their hips may sink into the toilet while sitting. According to an extensive interview with participant CM38, she used a chair cushion over the toilet seat to avoid sinking her hip into the toilet (Participant CM38, personal communication, January 23, 2023). A small-seat toilet model, with a 27.8-cm-wide void, can be specifically selected for this case. By contrast, the elderly women in Bangkok, with the widest hips measuring 43.43 cm, could not stably use small-seat toilets. A large-seat toilet model, with a 38.5-cm wide void, is more suitable for the elderly women in Bangkok.

Bedroom

The traditional sleeping practice in the northern region involves sleeping on the floor. The research revealed that all elderly who slept on the floor resided in timber and half-timber, half-cement houses (Figures 7). By contrast, in urban settings, only three-fourths of the elderly who

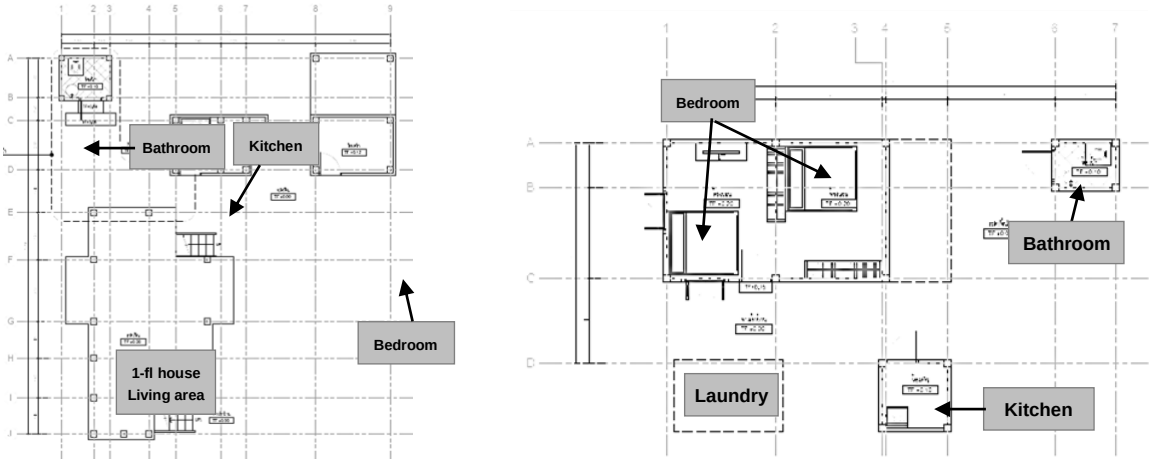
slept on the floor resided in timber and half-timber, half-cement houses (79% in the central region, 56% in suburban Bangkok, and 72% in the southern region). The majority of elderly people in all five areas, accounting for 60%, preferred sleeping in beds. In the north and south, 80% and 71% of the elderly used beds, while only half of the elderly in the central region and the capital used beds, respectively. By contrast, most of the elderly in the northeast used mattresses on the floor, while only 41% used beds.

Sleeping on the floor can increase the risk of falling because the lack of elevation of mattresses placed directly on the floor causes difficulty in rising from a low position. The elderly are typically recommended to sleep on beds with a total height of 40–45 cm. However, considering the difference in the popliteal line height in each area, different bed heights suitable for different body sizes of the elderly are required to mitigate fall risk. Older men in Khonkaen and older women in Songkhla had significantly higher popliteal line longer than others (2.40 cm and 4.20 cm, respectively). Older women in Chiang Mai and Bangkok had shorter body and leg lengths compared to the others, with differences of 1.84 cm and 3.67 cm, respectively. Therefore, for such individuals, beds with specifications on the height must be considered, with a maximum of 4.88 cm difference in bed height. The recommended bed height for Songkhla is the maximum (43.55 cm), whereas that for Bangkok is the least (38.67 cm), followed by Chaing Mai (39.71 cm). This research recommends a bed with a height of 27.50 cm for Songkhla, Bangkok, and Chiang Mai, with 6-inch (15 cm) and 4-inch (10 cm) mattresses for Bangkok and Chiang Mai, respectively.

The survey also revealed that the majority of bedrooms of the elderly were located on the upper level of the two-story and elevated houses (55%). Traditional Thai culture dictates that placing elderly bedrooms on lower floors means disrespect to the elderly. People in the northern region follow this norm more stringently than in the other regions. Despite the presence of sharp stairs on timber houses, leading to a higher fall risk, the elderly in the northern region insist on sleeping in bedrooms on upper floors. The study in the north highlighted a case of an old lady who, despite experiencing six falls over the stairs, refused to move her bedroom to the ground level due to the fear of causing misfortune to her descendants (Participant CM15, personal communication, January 23, 2023). Such constraints increase the risk of falls among the elderly. [3]

Figure 6

Plans of the House in Which Elderly Reside, Showing the Exterior Bathroom in (a) Chaing Mai (b) and Khonkaen



(a) (b)

[3] This case required an honorable senior in the community, along with a doctor and an architect, to convince the elderly to move the bedroom to the ground level.

Figure 7

Typical Sleeping Arrangements in Northern and Northern Thailand

Note. From *Roi Sara Sappa Lanna Kadee* Lem3 [Hundred Wisdoms, a Myriad of Virtues: Issue 3] (p.12), by Thammathi, 2013, Suthep printing. Copyright 2013 by Thammathi.

DISCUSSION

Relationship between health conditions, body dimensions, and fall risk assessment

This research demonstrated that fall experiences can be predicted through fall risk assessment and their correlation with health conditions. A significant correlation was observed between fall experiences and fall risk scores ($\rho < 0.00$, $r = 0.15$, $r^2 = 0.2$), and an even stronger correlation was observed between the fall risk score and health conditions ($\rho < 0.00$, $r = 0.50$, $r^2 = 0.25$) (Table 2). Health and mental health conditions were statistically related to fall risk ($\rho < 0.00$, $r = 0.19$, $r^2 = 0.03$). This aligns with previous studies, which confirmed that mental health issues such as dementia, depression, and Alzheimer's disease have a significant correlation with fall risk (Thiamwong et al., 2008).

The original concept of traditional Thai vernacular houses considered significantly the body size of the owner. The dimensions of the various elements in the house are proportionate to the owner's body size. For example, the height of the elevated houses in the northeast was typically three "sok," meaning six times the arm length of the owner, which is approximately 50 cm (Suppamityotin, 2016). This research aligns with the traditional house concept because it was found that the body dimensions of the elderly were not related to the house elements, potentially causing fall risks when the physical strength of the elderly deteriorates. As previously mentioned, both hip width and leg length are strongly associated with the selection of toilet and bed models. The northern elderly women with small hip widths and short stature and the northeastern elderly men and southern elderly women with long leg lengths may have a higher risk of falling while using standard toilets or beds, because the standard models are not suitable to their changing body dimensions.

Fall experiences and fall risk assessments of the elderly in five areas showed a significant correlation with the popliteal line height and the overall height of the elderly in some areas. Similarly to the scholars (Hussain et al., 2023; Jain & Ma, 2020), female elderly seem to be more shrinkage than those males. Although the overall popliteal line height showed no significant correlation (Table 2), that of Songkhla elderly was also significantly correlated with the fall risk score ($\rho < 0.05$) (Table 3). The height of the elderly showed a significant correlation with fall experiences among Khonkaen elderly males and Rangsit elderly females ($\rho < 0.05$ and $\rho < 0.00$, respectively). Rangsit elderly females showed a very high correlation between fall history and height ($r = 0.99$ and r^2 0.98). The height of the elderly females in Chiang Mai and Songkhla showed a significant correlation with the fall risk score ($\rho < 0.05$ and $\rho < 0.00$, respectively). Songkhla elderly females also showed a high correlation between the fall risk score and height ($r = 0.57$ and r^2 0.32).

Table 2

Correlation Between Physical and Mental Health Factors and Falls

	Six-month fall experiences			Fall risk scores		
	ρ	r	r^2	ρ	r	r^2
Health conditions:						
Physical health conditions	-	-	-	0.00**	0.50	0.25
Mental health status	-	-	-	0.00**	0.19	0.03
Body dimensions:						
Male - Popliteal line height	0.70	0.05	0.00	0.08	0.03	0.00
Male - Hip	0.63	0.06	0.00	0.12	0.19	0.03
Male – Height	0.01*	0.30	0.09	0.48	0.08	0.01
Female - Popliteal line height	0.49	0.06	0.00	0.41	0.07	0.005
Female - Hip	0.18	0.11	0.01	0.04*	0.17	0.03
Female – Height	0.11	0.04	0.02	0.00**	0.35	0.12

Note. Significant value p<0.05. **Significant value p<0.01.

Table 3

Correlation Between Two Human Body Dimensions and Falls

	6-month Fall experiences									Fall risk scores					
	Chiang Mai females			Khonkaen males			Rangsit females			Chiang Mai females			Songkhla females		
	ρ	r	r^2	ρ	r	r^2	ρ	r	r^2	ρ	r	r^2	ρ	r	r^2
Popliteal line height	0.04	0.40	0.16							0.04	0.41	0.16	0.04	0.37	0.13
Height				0.04	0.56	0.32	0.00	0.99	0.98				0.00	0.57	0.32

Note. Popliteal line height: the distance between the popliteal line to the floor level in sitting posture.

In terms of ergonomic principles, the popliteal line height is related to chair and bed design. This research demonstrated that this dimension should be considered in design to ensure safe environments for the elderly. In theory, although the height of the elderly may not directly relate to fall risk (Jain & Ma, 2020), it is generally proportionate to other body dimensions. This research confirmed the significant correlation of height with fall experience and fall risk score, emphasizing the importance of scholars and architects taking into consideration this dimension in human-scale and safety-focused universal design.

Furthermore, certain myths related to nutrition impact the elderly in some areas. For example, there is a practice of women eating less during late pregnancy, following the belief that it controls baby size and facilitates easy delivery. In the northern region, reports have revealed certain dietary practices among northern women to prevent deaths during pregnancy, before delivery, and after delivery (Srilao Ketprom, personal communication, Ocyober 25, 2019). Similarly, in the northeast, local midwives recommend specific foods during the final trimester of pregnancy to control fetus size (Katanyu Horsutisima, personal communication, January 20, 2020). These myths were prevalent in the north and upper northeast regions a few

decades ago, when medical services were less standardized. However, these practices reduced the body size of the elderly. Although there was no significant difference in the heights of the elderly in the north and northeast regions, their female counterparts were the shortest among the women of the five regions.

A comparison of the heights of the elderly in this research with the national body size data for Thailand revealed that the elderly in all five regions were shorter than the Thai adults in both genders. The northeastern elderly males showed the maximum height disparity compared with the younger adults, with a difference of 9.91 cm, or 5.86%. The northern elderly females were shorter compared to the northern female adults, with a difference of 11.92 cm or 7.59% (Table 4). Moreover, the overall height of the elderly in this research was less than the overall height in the Thai database. The male elderly in this research were 2.63% shorter than the individuals aged 60 years and above (Charoensiriwath et al., 2009) and 2.34% shorter than the individuals aged 65 years and above (Wells et al., 2011). The elderly females in this research exhibited even greater differences. They were 3.18% shorter than those aged 60 years and above (NECTEC, 2009) and 2.88% shorter than those aged 65 years and above (Wells et al., 2011). In terms of the acceptable level of statistical deviation, the research results fall within the 5% acceptable range, implying that the heights in this study are not different from those in the Thai database. However, it is important to mention the potential limitation in comparing the data due to the differences between the studies in terms of the survey timelines (a gap of 10 years between the surveys), sample size, age range, and specific survey area representing the regions of Thailand.

Shrinking body sizes can lead to improper use of household accessories, such as toilet bowl width and bed height. There are several recommendations for selecting suitable household accessories. Female elderly in Chiang Mai, who have the smallest overall body dimensions with an average hip width of 34 cm and a popliteal line height of 39 cm, should select smaller toilet bowl models to avoid falls from the toilet seat (Glass et al., 2013). For safety, non-flush and squatter toilets should be replaced with seated models (Hussain et al., 2023). They should also opt for low bed height models with void widths exceeding 24 cm. Additionally, female elderly in Chiang Mai and Bangkok, with popliteal line heights of 38 cm and 39 cm, respectively, should use short toilet bowls and bed models.

Relationship between sociocultural aspects and fall risk assessment

Sociocultural aspects are related to falls through their relationship with fall experience and fall risk. Most sociocultural factors significantly correlate with falls and fall risk. Most sociocultural aspects also show significant correspondence with falls and fall risk scores ($\rho < 0.01$), except for bedroom conditions, which correlate at $\rho < 0.05$. Elevated house showed no significant relationship with fall experiences (Table 5). This research highlights that family conditions and mental health are often overlooked factors affecting falls. Although not typically included in fall risk assessments, the number of family generations shows a significant correlation with fall risk—the more generations within a family, the lower the fall risk score ($\rho < 0.001$, $r = 0.15$, $r^2 = 0.02$). This aligns with studies suggesting that extended family positively affect elderly health (Sudha et al., 2006) and mental well-being (Guglani et al., 2000). Elderly individuals in extended families tend to have better health-related behaviors than those in nuclear families (Chan-Gim & Young-Sook, 2000). People in rural areas, especially the elderly, exhibit stronger cultural attitudes than those in urban areas. Activities such as sleeping on the floor, sleeping on the upper floors, and eating at low tables may increase fall risk Vernacular house styles, uncommon in urban areas due to the need for specialized knowledge, fund, and maintenance, while economical in construction (Fuentes, 2023), pose fall risks through features like squatter toilets, outdoor bathrooms, elevated house, and floor sleeping. Although typical in Southeast Asian cultures, these features should be reconsidered for fall risk mitigation (Hussain et al., 2023). Urbanization has led to the decline of vernacular houses, primarily leaving them with the elderly in rural areas (Martínez et al., 2022), increasing fall risks for those living alone in hazardous environments.

Consequently, female elderly in Chiang Mai are concluded to be at the highest risk of falling for three reasons. First, they, along with those in Bangkok, have the most shrinking body dimensions. It is well-documented that loss of body mass, strength, and shrinking body size influence fall risk in the elderly (Lim & Kong, 2022; Wells et al., 2011). Poorer health also associated with shrinking height and falls in rural area (Huang et al., 2013). Second, sociocultural factors, such as living in vernacular houses with elevated platforms, contribute to increased fall risk for those in Chiang Mai and Khonkaen. Features like outdoor bathrooms and sleeping on the floor are significantly associated with falls, elevating the risk (Hussain et al., 2023; Yu et al., 2017). Research in Bangkok indicates similar hazards, including floor sleeping, squatter toilets, and steep stairs (Jarutat & Lertpradit, 2020). Home modifications recommended for Thai culture include moving bedrooms to the ground floor, installing bathroom handrails, and using portable toilets. This article also advises small seated toilets for elderly with shrinking bodies, like those in Chiang Mai. Finally, about half of the elderly in Chiang Mai and Songkhla live alone, with high incidences of falls, a risk factor supported by several studies (Lamtrakul & Chayphong, 2022; Lage et al., 2023). Although Chiang Mai elderly do not have the highest health risk scores or family support, they rank third. Given these factors and their top fall experiences and risk scores, Chiang Mai elderly, especially females, are at the greatest risk of falling.

Table 4

Heights of Thai People in Centimeters

	North	Northeast	Central	Bangkok	South	Average
Males, <60 y[1]	169.81	169.20	169.54	169.88	168.89	169.46
Females, <60y[1]	157.15	156.37	157.40	157.46	156.62	157.00
Males, >60 y[1]	-	-	-	-	-	165.57
Males, >65 y[2]						165.00
Females, >60y[1]	-	-	-	-	-	153.49
Females, >65y[2]						152.90
Males, >60 y[3]	**161.87**	**159.29**	**160.22**	**164.75**	**162.00**	**161.22**
Diff from males <60y	-4.68%	-5.86%	-5.50%	-3.02%	-4.08%	-4.86%
Diff from males >60y	-	-	-	-	-	-2.63%
Diff from males >65y	-	-	-	-	-	-2.34%
Females, >60y[3]	**145.23**	**146.50**	**149.59**	**150.03**	**151.13**	**148.61**
Diff from females <60y	-7.59%	-6.31%	-4.96%	-4.72%	-3.51%	-5.34%
Diff from females >60y	-	-	-	-	-	-3.18%
Diff from females >65y	-	-	-	-	-	-2.88%

Note. [1] measured in 2008, from *Sizethailand*, by S. Charoensiriwath; C. Tanprasert; P. Thiyananti; S. Phupat; P. Boonphon,A. Phiitong; & J. Jansaksri, 2009 (www.sizethailand.org). Copyright 2009 by S. Charoensiriwath; C. Tanprasert; P. Thiyananti; S. Phupat; P. Boonphon,A. Phiitong; & J. Jansaksri.

[2] From "Reproduction, aging, and body shape by three-dimensional photonicScanning in Thai men and women," by J. C. K. Wells, S. Charoensiriwath, & P. Treleaven, 2011, *American Journal of Human Biology, 23*(3), p. 291–298 (https://onlinelibrary.wiley.com/doi/epdf/10.1002/ajhb.21151). Copyright 2011 by Wells, Charoensiriwath & Treleaven.

[3] refers to the results of this study, measured in 2021.

Table 5

Significant (ρ) Value on T-test Analysis Between Sociocultural Factors and Falls

	ρ-value on T-test analysis	
Conditions	**Six-month fall experiences**	**Fall risk scores**
Generations within family	<0.00	0.00
House style	<0.00	<0.00
Elevated house	0.12	<0.00
Bathrooms	<0.00	<0.00
Bedrooms	0.03	<0.00

CONCLUSION

In conclusion, health and sociocultural factors among the Thai elderly are significantly associated with falls. Regional differences in living culture necessitate that home modifications consider health conditions, body dimensions, family dynamics, and culturally related housing characteristics. Housing styles, such as elevated platforms and the arrangement of bathrooms and bedrooms, statistically influence fall risk. Shrinking body size is proven to be linked with increased fall risk. These factors necessitate specific attention for home modification to mitigate fall risks. Chiang Mai's female elderly are identified as most at risk. Recommended modifications include sleeping on beds on the ground floor, selecting small seated-toilet models, using portable toilets in bedrooms when bathrooms are external, and adjusting mattress heights to match sitting heights.

The study's limitations include the sample size of elderly participants in each region; while 40 participants are adequate for quantitative analysis, future research should involve larger samples for better validation. Further research should also directly explore cultural aspects within households to ensure all relevant factors are included in fall prevention strategies. Additionally, different local policies could be developed to provide clearer and more concrete regional guidelines.

DISCLOSURES AND ACKNOWLEDGEMENTS

This study is the extended research contributed from the data of the sub-project entitled “Developing healthy environment of the rural Thai elderly”. The sub-project was under the research program titled “Appropriate housing for Thai Elderly to promote physical and mental health by Age friendly community concept”, funded by the 2020 National Research Council of Thailand (NRCT) Fund, ID NRCT272/2563. The ethic approval was confirmed with ID: CMUREC63/271. The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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