



## Healthy Aging in Home Environment Exposures

P. Iamtrakul\* and S. Chayphong

**Abstract**— *The rapid growth in the number of older populations has many implications for public health including the need to better understand the risks posed by the environmental exposures, which calls for urgent attention to sustainable healthy aging care. In addition, the considerations should be made towards creating an appropriate built environment that can help create opportunities for the elderly to fully participate in societal activities. Perhaps, focusing on the convenient ways to design homes or home environment for elderlies is another important factor that could help facilitate a safe and comfortable life. However, this study conducted site investigation along with a questionnaire survey covering a total of 1,000 older people's homes which were clustered and classified their home character for explaining healthy aging in home environment exposures for Ban Phaeo district of Samut Sakhon, Thailand. The results discovered that for a healthy aging home, environment exposures play a key role in the provision of preventive health care to the elderly ones in accordance with their socio-economic and health status, including the role in reducing other risks inherent in the aging population.*

**Keywords**— **Home environment, aging society, built environment, health care.**

### 1. INTRODUCTION

Nowadays, many countries around the world are entering the aging society. And developed countries tend to enter the aging society faster than the developing countries. The rate at which countries enter an aging society varies, and it is dependent on the environment of the country [1]. According to Help Age International, the latest released data on the analysis of the elderly population trend across the world covers between 2015-2050. In 2030, it is projected that 1,402 million people aged 60 or more, or 16.5 percent of the total population within the next 20 years (2050) will have a population aged of 60 years or more (2,092 million people), or 16.5 percent of the total population. It can be observed that the process of aging society occurs in both the developed and developing countries, however, it may take a different period of time. Part of the reasons for this time variation is that most developed countries confront the situation with advanced technology and medicine. They made access to public health services and hospitals easy for majority of the aged people. In addition, their governments and private agencies also give importance to the well-being of their people in terms of food, and hygiene; resulting to good quality of life far better than those in developing countries. However, the rising of this situation can be noticed to favor current tend to live longer, but with declining birth rate due to family planning and contraception [2].

Considering the trend of the elderly population in Thailand for an instance, the increase rate demonstrated more than 20 percent of the elderly population with the elderly index of 103.2 is towards the aged society in 2021 and subsequently to 25.1 percent in 2035 [3]. Therefore, it is necessary to build a city that is able to meet the needs of both the elderly and the other group of people in the city. Some of the challenges most elderly people experience as they get older includes; the limitation of movement, vision, hearing and various diseases. But proper planning and designing of favorable environments will help the elderly ones to sub-mantle those challenges and more self-reliant. However, due to the characteristics of built environments and its contribution to their fear of falling oftentimes prevents this group of people from leaving their homes [4]. Research has found that Universal Design is a unique approach to be considered in designing homes for this group of people due its support for the elderly. It is considered to create the ability to use in daily life and also helps promote continuous participation within the living environment. Most importantly to be considered is the risk of falling which some studied literature indicated that 75 percent of the elderly suffers a fall in their own home [5]. The fall has different level of severity to the health of these elderly especially for those at high risk areas prone to physical violence. Statistics have shown that in Thailand, more than 1,000 elderly people have died from falling approximately 3 people per day [6].

Therefore, this research leverage on the study of healthy aging in home environment exposures to launch an appropriate way to optimize the health of older people. Home environment exposure plays a key role in reducing the risk of fall in population ageing, therefore, create an appropriate built environment that can provide opportunities for the elderly to participate actively in society and perform different activities.

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## 2. LITERATURE

### 2.1 Home environment exposures

Many elderly adults reside in older homes that are not well suited to their living conditions, with most the households containing potential hazards such as slippery floors, inadequate lighting, loose rugs, unstable furniture, and obstructed walkways, etc. [7]. These are major causes of their frequent falls to trips or slips inside the home or immediate home surroundings [8]-[9]. This is hypothetically true since home attachment is rightly defined as an emotional bond between an individual and environment [10]. However, environmental factors that affects medical care and life at home can be categorized into 4 factors; 1) *physical environment* (types of homes, age and condition, layout including location of bathrooms and bedrooms, accessibility in, out, and around the home, supportive features, communications/internet access, adequacy of utilities, presence of children and animals), 2) *social environment* (immediate family, extended family, friends, religious affiliates, colleagues, cultural community, neighborhood community, clubs/associations, charitable activities, leisure activities), 3) *community environment* (safety conditions, weather conditions, presence and condition of streets and sidewalks, existence and condition of parks and recreation centers, existence and condition of meeting centers/locations, availability of goods and services, availability of public transportation), 4) *health policy environment* (housing policies, zoning policies, building codes, social services policies, medical insurance company policies, medicare policies, medical aid policies, health care and long-term care reimbursement policies) that intertwined the effects of multiple environments [11]. It is imperative to emphasize that the physical environments of homes are more uncontrolled, dynamic, personal, and diverse [12]-[13]. Therefore, making home condition to be considered as the closest thing to everyday life for the elderly, such as sleeping places, eating, and other places for various activities is important. Also, characteristics of residents of different ages that need to be planned for in providing suitable facilities for usage should also be considered, especially, those elderly group, with limitations in the body's ability as they age. For these people, provision of home environmental attachment can improve the quality of life as well as their psychological and physical health.

### 2.2 Health aging

WHO defines healthy ageing “as the process of developing and maintaining the functional ability that enables wellbeing in older age” [14]. Functional ability is about having the capabilities that enable all individuals to be and perform what they have reason to value. This includes a person's ability to learn, grow and make decisions, to be mobile, to build and maintain relationships, and to contribute to society [14]. As elderly population increases rapidly all over the world, the increase in age tends towards the opposite direction to efficiency and reduction of physical limitations. Changes in health and ability (physical illnesses, mental

difficulties, and physical disability; hearing, vision losses, limited movement) status is regarded as the subject of interest in housing for the elderly. Approximately 20-55 percent of all unintentional falls and fall-related injuries in adults over the age of 60 years occurs inside their home [15]-[16]. In Thailand, more than 1,000 elderly people die, or an average of 3 people per day, with males more than 3 times higher than females [17]. The risk of falling falls increases with age and tends to be continuous with time. Therefore, significantly increasing the cost of service systems for elderly people who have fallen around the world. This inadvertently affects their families, communities, and society, both directly and indirectly [18]. Falling is a major public health problem, regarded as the second leading cause of accidental injury after road. Falls are on the same level with slipping, tripping, being hit by another person, pushing or falling from one level to another. According to statistical data, housing and services should be developed in such a way that it can be associated with the design and management of the housing environment [20].

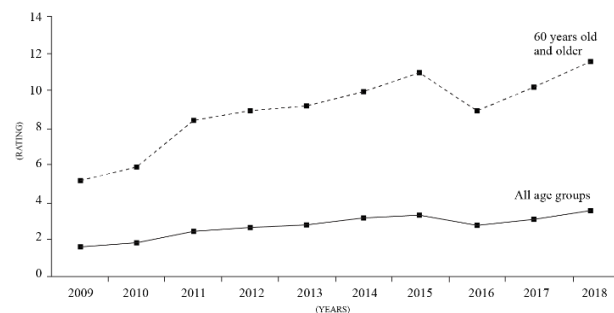


Fig. 1. Mortality Rates in Thailand Per 100,000 Population [19].

### 2.3 Universal design for aging group

Universal design is a framework for designing things, places, and communications, with the concept of “design for-all” and “lifespan design”, so they work for the widest possible spectrum of users regardless of their age, size, ability or disability. It is not a design style but an orientation to any design process that starts with a responsibility to the experience of the users. Universal design has established seven principles to provide guidance in the design of products and environments [21]. Firstly, it must be designed with concept of equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, size and space for approach and use. These principles are key concerns of creating supportive and adaptable environments for the elderly that can compensate for a person's impaired functional capacity. Home modifications can as well enhance accessibility and minimize barriers of conventional housing, particularly for persons with impairment [22]-[23]. When the design incorporates universal design principles, it will not only be perfectly suited for the needs of an aging population, but it will also be appropriate for families with young children. Finally, the features of this design

may likely prevent accidents and avert loss of life at home for both family and guests/visitors.

### 3. STUDY AREA AND METHOD

#### 3.1 Study Area

Ban Phaeo district is a district in the northern part of Samut Sakhon Province, a central regional of Thailand with 12 subdistricts, which is further subdivided into 97 villages. There are three townships which includes: Ban Phaeo, Kaset Phatthana, and Lak Ha. The non-municipal area is administered by seven tambon or unit of administrative organizations as depicted in Fig. 2.

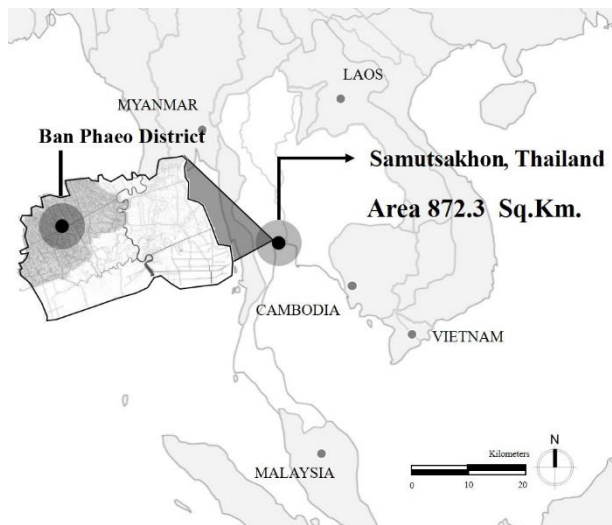


Fig. 2. Ban Phaeo District, Samutsakhon Province, Thailand.

#### 3.2 Data Collection and Sampling

As part of the study as described in the introduction, the data used for analysis were obtained through a survey in Ban Phaeo, Samut Sakhon, Thailand. Considering the trend of the study area viz a viz its demographic change in Fig. 3, it was found that the elderly population in Samut Sakhon province will attend between 2015 – 2030 an aging index of 129.92 percent. This means that it will likely become completely elderly society by 2025 with likely increase to 53.25 percentage in the year 2030 based on data from Ministry of Social Development and Human Security (2015) (Fig. 3). The samples included individuals who were aged of 60 and above, and basically the target group for this research. The data collection was designed to gather a total of 1,000 samples, through a combination of site investigation together with a questionnaire survey.

The survey contained questions related to physical environment (types of homes, age and condition, layout including location of bathrooms and bedrooms, accessibility in, out, and around the home, supportive features, communications/Internet access, adequacy of utilities) and social aspects, economic aspects and health status information of elderly. The questionnaires make it possible to gain further insight into the socio-economic and physical environment of elderly in Ban Phaeo

district, Samut Sakhon province. Framework of the analysis can be explained as shown in Fig. 4.

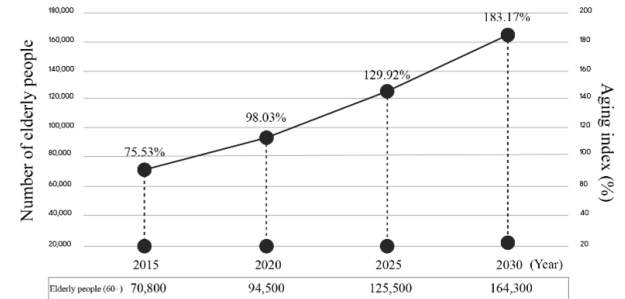


Fig. 3. Elderly Population Trends and Elderly Index, Samut Sakhon Province.

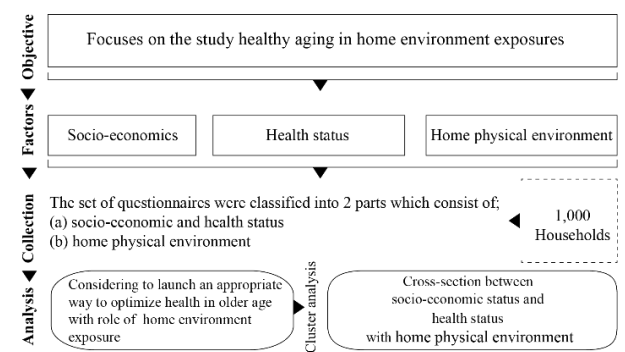


Fig. 4. Framework of study

#### 3.3 Variables and Analysis

In order to analyze the collected data, this study relied on healthy aging in home environment exposures to launch an appropriate way to optimize health in older age with regards to role of home environment exposure. This was found to play a key role in reducing the risk of fall in population ageing. This study designed the content of analysis to comprise the contributing factors which can be classified into 3 parts as follows:

**Socio-economic:** this is based on explainable indicators such as age, gender, income and family, living type, and were collected by face to face interview and questionnaire survey. It demonstrated difference social and economic characteristics that could led to provision of appropriate home environment.

**Health status:** this consists of 2 factors:

1) Health status both ADL (Activities of daily living) and the number of chronic diseases, the ADL were measured with self-rated health by using likert scale range from 1 [very poor] to 4 [very good]. It consists of 10 factor which are (1) transfer, (2) mobility, (3) toilets use, (4) grooming, (5) bladder, (6) bowels, (7) bathing, (8) feeding, (9) dressing, and (10) stairs.

2) The number of chronic medical conditions were measured with scores ranging from 0 - 3; (0=No chronic diseases, 1=1-2 chronic diseases, 2=3-4 chronic diseases, 3=more than 4 chronic diseases upwards).

**Home and physical environment:** The physical condition of homes can put individuals at greater risk of accidents; making daily living activities more difficult. Therefore, the consideration factors should cover both the inside and outside of the house. The following factors were considered which consist of 5 factors: 1) types of homes, 2) layout including location of bathrooms and bedrooms, 3) accessibility to the home, 4) supportive features, 5) communications /internet access.

The statistical analysis was conducted to understand the most vulnerable group of elderly in home physical environment using cluster analysis. Cluster analysis is a valid and objective approach to classify home physical environment in each of the elderly groups that could pose a risk to living in a home or environment in order to propose appropriate improvements in each of the groups. K-means cluster method, very popular for cluster analysis in data mining was employed to classify the home physical environment involved in different elderly groups. This study generated input data for socio-economic status, health status, home physical environment. The result of the analysis is explained in next section.

#### 4. RESULTS OF ANALYSIS

This study focused on aging and environment in rural older adults in order to devise ways to create an environment that is conducive for the elderly living using a rural communities of Ban Phaeo district as a case study.

##### 4.1 Socio-economic and Health Status

A total of 1,000 samples were collected and entered into the study cutting across different type of elderly groups with socio-economic and personal characteristics as demonstrated in Table 1. This demonstrated the characteristics of the elderly in a social group consists of 66.7 percent, followed by home bound elderly 28.2 percent and bed bound elderly 5.1percent. On age consideration, it is found that as the age increases, the elderly will transition to the elderly group at home and next to the bed bound condition in accordance with the decreasing physical condition. Most of the respondents are female at early age group. The income of these elderly group is over 63.3 percent and it is considered as low income group with income less than 2,000 baths. Their sources of income are mainly from elderly fund and low income fund that were supported by the government. The characteristics of residential areas were located in the suburb area, with the average household members relatively higher than the urban area. Here, the average number of household members is 2-5 person per household. Regarding the pattern of living, even though 93percent of these elderly are living with their families, however, it is found that 5.98 percent of the elderly are living alone without family or family care, necessitating them to be considered as a risk group that needs to be given priority.

**Table 1. The Characteristics Of Socio-Economic Among Different Aged Groups**

Variables	Social bound N (%)	Home bound N (%)	Bed bound N (%)	Total (%)	P-value
<b>Gender</b> (missing data 2 sets)					0.084
- Male	257(25.8)	88(8.8)	17(1.7)	36.3	
- Female	408(40.9)	194(19.4)	34(3.4)	63.7	
<b>Age</b>					0.000
- 60-69 years	382(38.2)	37(3.7)	9(0.9)	42.8	
- 70-79 years	217(21.7)	120(12.0)	13(1.3)	35.0	
- >80 years	68(6.8)	125(12.5)	29(2.9)	22.2	
<b>Status</b> (missing data 1 sets)					0.001
- Married	361(36.1)	118(11.8)	20(2.0)	49.9	
- Divorce	56(5.6)	24(2.4)	2(0.2)	8.2	
- Single	249(24.9)	140(14.0)	29(2.9)	41.8	
<b>Income</b>					0.000
- <2,000 ฿	376(37.6)	212(21.2)	44(4.4)	63.3	
- 2,000-5,000 ฿	152(15.2)	36(3.6)	5(0.5)	19.3	
- 5,001-10,000 ฿	73(7.3)	23(2.3)	2(0.2)	9.8	
- 10,001-15,000 ฿	51(5.1)	11(1.1)	0(0)	6.2	
- 15,001-20,000 ฿	3(0.3)	0(0)	0(0)	0.3	
- > 20,000 ฿	12(1.2)	0(0)	0(0)	1.2	
<b>Source of income</b>					0.000
- full time jobs	18(1.8)	0(0)	0(0)	1..8	
- labor	105(10.5)	16(1.6)	0(0)	12.1	
- child/grandchild	160(16.0)	66(6.6)	9(9.0)	23.5	
- Welfare	662(66.2)	282(28.1)	51(5.1)	99.4	
<b>Number in families</b>					0.009
- 1 person	69(6.9)	30(3.0)	0(0)	9.9	
- 2-5 persons	435(43.5)	192(19.2)	37(3.7)	66.4	
- 6-9 persons	147(14.7)	56(5.6)	12(1.2)	21.5	
- 10-13 persons	16(1.6)	4(0.4)	2(0.2)	2.2	
<b>Number of elderlies in families</b>					0.004
- 1 person	350(35.0)	158(15.8)	29(2.9)	53.7	
- 2 persons	308(30.8)	111(11.1)	17(1.7)	43.6	
- 3 persons	6(0.6)	9(0.9)	1(0.1)	1.6	
- 4 persons	1(0.1)	2(0.2)	2(0.2)	0.5	
- 5 persons	2(0.2)	2(0.2)	2(0.2)	0.6	
<b>Living type</b>					0.040
- Alone	38(3.8)	20(2.0)	0(0)	5.98	
- With relatives	30(3.0)	8(0.8)	0(0)	0.86	
- With family	599(59.9)	254(25.4)	51(5.1)	93.17	

##### 4.2 Home Physical Environment

1) **Types of homes and its supportive features:** There are many types of housing in Ban Phaeo district as illustrated in Fig. 5, which includes: single houses, row houses, commercial buildings, townhomes,

condominiums, including temporary residences (cottages); with 1-3 floors of housing. This condition of housing can be divided into 3 main groups as follows: (1) *Temporary residence* which is 1 story house. The materials of the house are gypsum and galvanized wall and roof that are in disrepair condition and risky to live in, regardless of the material's strength. The furniture is not up to the standard of living for the elderly, since it has no bed, and the bathroom is separated from the house, etc.; (2) *General housing* comprise mainly of 1-2-storey house, and the materials of the house are cement, wood and half-cement/wood which was considered of good condition for living. But it still pose a risk to the elderly living in it due to lack of facilities such as handrails, emergency button, suitable height of the window, tables and furniture that are conducive to the safety of the elderly.; (3) *Good housing* that are of 1-2-storey house and the materials of the house are cement, wood and half-cement/wood. Most of these houses are in a very good condition for living, with equipment and furniture that are safe for the elderly to live. Unfortunately, the design of the house and the layout of the house plan still lack some basic considerations of a universal design standard that could guarantee completely the safety and comfort to all groups of people.

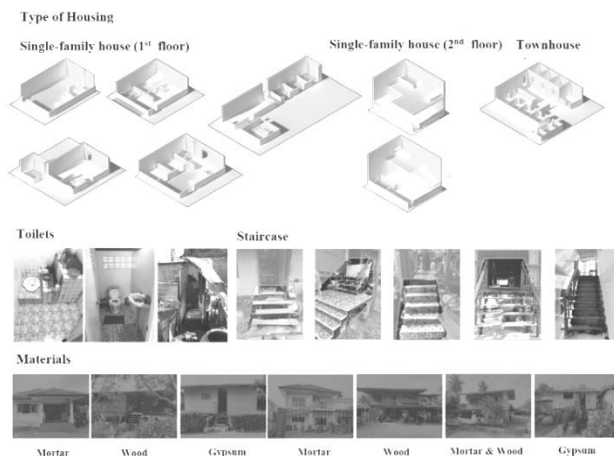


Fig. 5. Housing Characteristics of The Elderly

From the overall consideration, it can be seen that the characteristics of the residence depend on the affordability of the elderly's family. Considering parameters of housing for elderly in Table 2, 6 parameters were used for evaluation and they comprise: 1) living style 2) floors 3) using a ladder 4) layout 5) facilities for help elderly 6) slippery floor. The result of this evaluation demonstrated that the number of elderly group who has a history of falling is relatively of small proportion (11.2%). However, considering those who have a fall history, it is found that risk of falls in the elderly in a house with more than 1 story and stairs, lacking some basic facilities and has slippery floors is very high. Therefore, the aforementioned risk characteristics should be taken into considerations in order to improve the housing unit that will be very

suitable for the elderly.

**2) Layout:** This variable is considered with respect to the position of different elements of the house, especially the position of the bedroom and bathroom which is considered as an important part for the safe living of the elderly. This variable can be divided into 5 main parts which are:

(1) *Bedroom and bathroom are in the same room* implies that the bedroom of the elderly is usually close to the bathroom for easy walk in and out of the bathroom.

(2) *The bathroom and bedroom are separated, and the bathroom is still inside the house.* Here, the elderly will have to walk from the bedroom to the bathroom located away. In some cases, the elderly has restrictions on walking to the bathroom during the night, hence, resorting to urinating in a bucket or portable urinals in the bedroom.

(3) *The bathroom and bedroom are separated, the bathroom is outside the house* which is quite far from the bedroom.

(4) *The bathroom and bedroom are separated, and the bathrooms are on different floors.* This type is a two-story residence, with a bedroom on the second floor and a bathroom on the first floor. Users must walk up and down the stairs, which is quite risky for the elderly while going up the stairs, especially at night.

(5) *The bathroom and bedroom are separated by a shared bathroom with another family home.* The characteristic of this position is limited to the ability of the elderly to pay for their own rooms, but they can share the bathroom with the family of different houses.

Table 2. Parameters of House for Elderly

Main parameters	Sub parameters	Risk falls		P-value
		Yes	No	
Living style	Alone	13.00	87.00	0.003
	Living with family	20.80	77.10	
Floors	1 Floors	10.40	89.60	0.054
	More 1 Floors and up	12.04	87.96	
Using a ladder	Yes	12.10	87.70	0.054
	No	10.70	89.30	
Layout	Yes	8.40	91.60	0.035
	No	12.10	87.90	
Facilities for help elderly	Have	10.90	89.00	0.046
	Havn't	14.30	85.70	
Slippery floor	Have	16.10	83.10	0.063
	Havn't	10.60	89.40	

3) **Accessibility:** In general, concrete roads and paved are found to be more than 36 percent, followed by concrete roads along the canal which is 16 percent, with a width of only 1 meter and no handrails or barriers to prevent falling to canal as showed in Fig. 6. However, the main issue is that some elderly houses do not have land base connectivity for accessibility. These cases are peculiar to the cases of elderly who live alone on a low income with difficulty to pay for better facilities.

4) **Communications/Internet Access:** Access to communication is one of the factors that affects the daily life of the elderly because they are prone to physical limitations such as vision, memory, walking, and reading and writing. Based on the survey result as illustrated in Table. 3., it was found that the communication ability of the elderly is majorly the use of telephone; accounting for 81 percent. However, the group that uses telephone only for answering calls is about 67.1 percent, followed by the ability to access the internet, representing 11.5 percent. And finally, the group who is able to use computers represents only 1.3 percent.

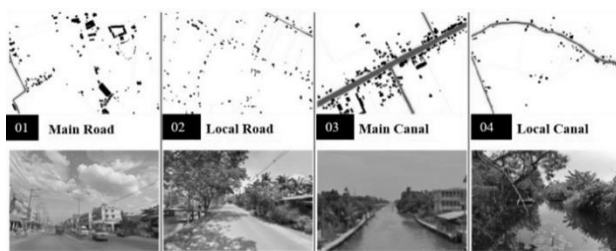


Fig. 6. Access to Housing for The Elderly.

It can be seen that there are approximately 32.9 percent of the elderly who cannot use technology for communication at all with relatively low availability to technology adoption. Therefore, with the progress in the development of technology that brought about innovations to aging promotion, consideration should be centered on the readiness of the elderly to embrace this context.

4.3 Home Environment Exposure

From Table 4, the result of data showed groupings of housing styles with social factors (age, family members health status, number of diseases), economy (income) and housing environment (number of floors, facilities for the elderly in the home, falls). Bringing these factors into the grouping scheme of housing types analysis, the distances between final cluster centers and number of cases in each cluster was clearly shown. The distances between final cluster centers were distances among three groups with different characteristics of each group

described by the following details:

1) *The characteristics of cluster 1* is a group that earns more than 20,000 baht per month. They are the elderly in the better condition of social group and their home was equipped with facilities and equipment conducive for elderly's living such as handrails in the bathroom. Moreover, within their homes, the installation of camera could be found which is specifically used for preventive care among older people when they are at home alone, as well as for the group with good health status.

2) *The characteristics of cluster 2* is a group of people with incomes less than 2,000 baht per month, who are elderly in the social bound, home bound and bed bound. The number of family members is more than 5 people and does not have equipment or facilities in their house that is helpful for the living of the elderly. They are regarded as a group with relatively low health status.

3) *The characteristics of cluster 3* is a group of people with income approximately 15,000-20,000 baht per month who are elderly in the social bound, home bound with no available equipment or facilities in the house conducive for the elderly's living, and they are regarded as a group with good health status.

Table 3. The Characteristics of Communications/ Internet Access Among Different Aged Groups

Variables	Social bound N (%)	Home bound N (%)	Bed bound N (%)	Total (%)	P-value
<b>Computer</b>					0.241
- Can not	655(65.5)	280(28.0)	51(51.0)	98.7	
- Can	11(1.1)	2(0.2)	0(0)	1.3	
<b>Mobile phone</b>					0.000
- Can not	81(8.1)	81(8.1)	28(2.8)	19.0	
- Can	585(58.5)	201(20.1)	0(0)	81.0	
<b>Social media</b> (from 786 persons that can use mobile phone)					0.000
- Line	60(6.0)	5(0.5)	0(0)	56.52	
- Facebook	47(4.7)	3(0.3)	0(0)	43.47	
<b>Income per month</b>					0.000
- <2,000 ฿	376(37.6)	212(21.2)	44(4.4)	63.3	
- 2,000-5,000 ฿	152(15.2)	36(3.6)	5(0.5)	19.3	
- 5,001-10,000 ฿	73(7.3)	23(2.3)	2(0.2)	9.8	
- 10,001-15,000 ฿	51(5.1)	11(1.1)	0(0)	6.2	
- 15,001-20,000 ฿	3(0.3)	0(0)	0(0)	0.3	
- > 20,000 ฿	12(1.2)	0(0)	0(0)	1.2	

Note: 1,000 data sets.

**Table 4. The Relationship Between Socio-Economic and Health Status with Home Environment**

Variables	Home environment				Total	P-value
	Cluster					
	1	2	3			
	High income house	Low income house	Medium income house			
<b>Social-economic</b>						
<b>Age</b>					0.052	
- 60-69 years	7.0	37.0	4.5	42.2		
- 70-79 years	3.0	32.8	1.7	34.8		
- >80 years	0.0	21.6	3.0	21.9		
<b>Type of elderly</b>					0.005	
- Social bound	1.0	60.3	5.5	66.7		
- Home bound	0.0	27.3	1.1	28.4		
- Bed bound	0.0	4.9	0.0	4.9		
<b>Income per month</b>					0.000	
- <2,000 ฿	0.0	63.2	0.0	63.2		
- 2,000-5,000 ฿	0.0	19.3	0.0	19.3		
- 5,001-10,000 ฿	0.0	9.9	0.0	9.9		
- 10,001-15,000 ฿	0.0	0.0	6.3	6.3		
- 15,001-20,000 ฿	0.0	0.0	0.3	0.3		
- > 20,000 ฿	1.0	0.0	0.0	1.0		
<b>Number in families</b>					0.562	
- 1 person	0.0	9.1	0.5	9.6		
- 2-5 persons	1.0	59.8	4.8	65.6		
- 6-9 persons	0.0	20.6	0.9	21.5		
- 10-13 persons	0.0	1.9	0.3	2.2		
<b>Number of elderlies in families</b>					0.000	
- 1 person	0.3	50.2	3.0	53.5		
- 2 persons	0.6	39.8	3.3	43.8		
- 3 persons	0.0	1.6	0.0	1.6		
- 4 persons	0.1	0.4	0.0	0.5		
- 5 persons	0.0	0.4	0.2	0.6		
<b>Health status</b>						
<b>Number of diseases</b>					0.040	
- No disease	0.4	33.9	2.4	36.7		
- 1 diseases	0.5	34.4	2.3	37.2		
- 2 diseases	0.1	20.6	1.7	22.4		
- 3 diseases	0.0	3.0	0.1	3.1		
- >4 diseases	0.0	0.5	0.0	0.5		
<b>Falls in home</b>					0.044	
- No fall	1.0	83.6	5.8	90.4		
- Fall	0.0	8.8	0.8	9.6		
<b>Health Status (ADLs)</b>					0.001	
- Lowest (0-1.4)	0.0	4.1	0.0	4.1		
- Low (1.5-2.3)	0.0	3.5	0.0	3.5		
- Medium (2.4-3.2)	2.0	21.9	5.0	22.6		
- High (3.3-4.1)	8.0	61.8	6.0	68.6		

- Highest (4.2-5.0)	0.0	1.0	0.0	1.0	
<b>Home characteristic</b>					
<b>Residential area</b>					0.166
- 1 st	0.7	70.2	4.1	74.9	
- 2 nd	0.3	21.4	2.4	24.2	
<b>Floors</b>					0.000
- 1 floor	0.6	50.7	2.2	53.5	
- 2 floors	0.4	41.6	4.1	46.2	
- 3 floors	0.0	0.1	0.2	0.3	
<b>Facilities for help elderly</b>					0.045
- Handrails	8.4	0.0	0.2	8.6	
- Emergency button	8.3	0.0	0.4	8.7	

Note: 1,000 data sets; missing 11 sets. The level of significance was set at  $p < .05$  for the analyses.

From the above data, it can be seen that all the 3 group of elderly characteristics are classified as follows: type of housing groups; with the group in Cluster 1 having high income house for elderly, Cluster 3 medium income house for elderly, and Cluster 2 low income house for elderly. Further analysis was carried out based on the relationship among all variables of socio-economic status, health status, and home physical environment of elderly group in Ban Phaeo district. The categorization into home and physical environment involved in different elderly groups is explained in detail as follows:

*Socio-economic:* About 42.2 percent of 60-69 years is classified as low-income house and about 63.2 percent of income that is less than 2,000 baht represented a low-income house. It was found about 1.0 percent above 20,000 bath income was classified as high-income house. Considering the household size, there are some families that have 2-5 persons in families (65.6 percent), with number of elderlies in such families about 1-2 persons. Moreover, it was found that the sample group of the elderly classified as group 2, represented a low-income house group with incomes not more than 2,000 baht per month and are mostly social bound and home bound elderlies.

*Health status:* Considering the health status sampling of the elderly group, about 37.2 percent of elderly have at least 1 disease. Furthermore, this study also carried out analysis of health status classified by ADL (Activities of daily living) and the number of chronic diseases. It can be found that among the high-income house and medium-income house groups, their health status ranged from medium to good level. However, in the low-income house group, the health status is ranged from very low to good level.

*Home environment:* The data showed that about 74.9 percent of elderly lives at first floors to ensure ease of doing activities in daily life and avoid climbing stairs. About 53.5 percent of the residents are living in one-story house. Considering the facilities for the elderly, it is found that in the high-income house group, it was well equipped with facilities installations in both the bedroom and bathroom. While the low income and medium income housing groups do not have caring facilities convenient for home living.

When possibility of falls within the home is considered, it was found that in the high-income housing group, there were no experience of falls within the home. However, most of the falls experiences occurred in the low income and medium income housing groups. However, the results of the analysis do not clearly state that a home with adequate equipment and good accessibility to facilities could guarantee reduction in the risk of living for the elderly. Furthermore, the results of this analysis can help in understanding the characteristics of the living environment with respect to different conditions based on the socioeconomic context of the respondents. This understanding will then help to propose ways to improve the conditions of the living environment based on peculiarity of their neighborhood environment.

## 5. CONCLUSION AND RECOMMENDATIONS

This study demonstrated that socio-economic status, health status, the home physical environment of different elderly groups in Ban Phaeo, the district in Samut Sakhon, Thailand can be categorized into a home and its physical environment. The results of this study indicated that the elderly group with a history of falling is relatively in a small proportion. However, considering those with a fall history, it is found that the risk of falls in the elderly occurs significantly in the homes of older adults residing in older homes that are not well suited for their living conditions; that is containing potential hazards [7]-[9]. It was also discovered that the risk of falls in the elderly is greater in a house with more than 1 story and requires daily use of stairs which lacks facilities like handrails and also in the house that has slippery floors. Consideration for the home environment, it is classified into 3 groups comprising:

*Type 1: High income house* - it is a group that earns more than 20,000 baht per month, and their home has well equipped facilities and equipment that are conducive to the elderly's living as well as a group with good health status,

*Type 2: Low income* - is a group of people with monthly incomes less than 2,000 baht and does not have equipment or facilities in the house that supports the living of the elderly. Furthermore, they are regarded as a



group with relatively low health status, and

*Type 3: Moderate income* - is a group of people with a monthly income of 15,000-20,000 baht without equipment or facilities in the house that is conducive for the elderly's living, notwithstanding regarded as a group with good health status. From the analysis, it was found that the condition of the living environment for the elderly is limited to the ability to pay for the facilities.

Most of the elderlies are considered to be in the low-income group since they do not have full-time work and their main income is government welfare. These elderlies are older and have limitations in their daily lives (ADLs), especially health problems. However, the key points of this study are focused on the physical limitations of the elderly since it plays a key role as major risk factors threatening their living conditions, as well as their income, and conditions of living especially those that live alone. According to the study by Nipha and Lavitra (2018) [24], assessment and adjustment of the home environment for the safety of the elderly's lifestyle was recommended. Furthermore, Lawton and Nahemow (1973) [25] also suggested that well-designed environments and effective home modifications should function to reestablish equilibrium between a person's capabilities, which may have declined, and the demands of the environment.

Therefore, the guidelines for promoting and raising the quality of life of the elderly should start with securing their income and ensuring adequate support from the government for both welfare and public facilities. These services and facilities should cover the entire ecosystem of the elderly starting from the individual level, the home level, and the environmental level so as to bring a positive effect in the well-being of the elderly in their daily life.

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