Thai Falls Risk Assessment Test (Thai-FRAT) Developed for Community-Dwelling Thai Elderly

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Objective: *To develop falls risk assessment test that is appropriate for community-dwelling Thai elderly, and to verify this test with the second set of population.*
Material and Method: *A cross-sectional study was performed in 270 elderly living in Bansrang subdistrict, Ayuttaya province to identify a combination of variables that effectively predicted fall status in order to develop the Thai-FRAT. The Thai-FRAT was validated with a second set of population whose cohort data had been collected during 1997 – 2002 in the study named "CERB project". One hundred fifty six elderly subjects were recruited in the analysis.*
Results: *The newly developed Thai-FRAT was composed of six factors including "History of falls", "Impaired body balance", "Female", "Specific medication use", "Impaired visual acuity", and "Thai style house". Possible score of the Thai-FRAT ranged from 0-11. The best cutoff score identified by the receiver operating curve analysis was 4. Sensitivity and specificity were 0.92 and 0.83 respectively. The Thai-FRAT could predict recurrent fall after two years among the elderly subjects who had had a history of fall during the past six months in the second set of population. Association between the Thai-FRAT score and mortality was also shown.*
Conclusion: *The Thai-FRAT is the first fall risk assessment test developed for Thai community-dwelling elderly. It is a valid and reliable measure of fall risk. An effect of environment on falls among Thai elderly was clarified in the present study.*

Keywords: *Falls, Risk assessment test, Elderly, Community, Thai*

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With the rapidly increase in number of the elderly, the problem of falls has taken on ever increasing importance[1]. The elderly are especially prone to falls because of age-related physiological changes as well as pathological diseases of various body systems. The probability of falling increases with the use of medications, advanced age, having a history of falls and unsafe environment[2].

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Falls can have physical, psychological, and economic consequences. The incidence of falls rises steadily from middle age and peaks in persons older than 80 years[3]. The prevention of injuries associated with falls in older persons is a public health target in many countries around the world. There is good evidence that interventions such as multifactorial fall prevention and individually prescribed exercise are effective in reducing falls[4,5]. However, tailor-made interventions for community dwelling elderly need a high amount of resources including manpower and time. In order to make tailor-made interventions more cost-effective, we need to provide intervention only

for the elderly with high risk to falls. Therefore, development of assessment test that can identify the elderly at risk for falling is an essential step in a formal fall prevention program.

The purpose of the present study was to develop falls risk assessment test that is appropriate for community-dwelling Thai elderly and to verify this test with the second set of population.

Material and Method

The present study was comprised of two phases. The first phase of the study aimed to develop the fall risk assessment test (Thai-FRAT), which was appropriate to use in Thai elderly living in communities. The development of the Thai-FRAT was carried out in three steps. The first step was an extensive literature review in order to get all possible risk factors of falls in the elderly living in communities. Factors of falls that existed in two or more studies conducted in non-Thai communities or factors of falls found in one or more studies conducted in Thai communities were listed and sent to seven experts including three geriatricians, three nurses, and one epidemiologist. In the he second step, these experts were asked to give their opinions on the validity of these factors for predicting falls among the elderly living in communities. Then all factors that had been confirmed by the experts were used in the third step, a community based study, to determine the FRAT suitable for Thai elderly. The third step was conducted in 275 elderly aged 60 years and over living in Bansrang subdistrict, Bangpa-in district, Ayuttaya province. However, five subjects were not able to communicate because of various causes and were disqualified. Therefore, only 270 subjects were recruited in the present study. They were all interviewed by one of the investigators to ask for willingness in participation (informed consent) and to collect personal data and history of falls during the past six months. Of the 270 subjects, subjects had two or more falls during the past six months, were enrolled in the case group (the "fallers")[6,7]. For each case, three controls were randomly selected from the elderly who reported of having no or one fall in the past six months (the "non-fallers"). All of the elderly in both cases (the fallers) and control (the non-fallers) groups were revisited and collected data by interviewing and physical ability tests including visual acuity[8], cognitive impairment[9], and full tandem test[10,11]. A fall was defined as "an incident in which a person suddenly and involuntarily came to rest upon the ground or surface lower than their original station[12,13]".

Univariate factors of falls were identified by using chi square test or unpaired student t-test wherever they were appropriate. Those associations with a statistical significance attaining a p-value of 0.05 or below were entered into a stepwise logistic regression analysis using falls as the dependent variable. All multivariate factors in the logistic regression model were then included in discriminate analysis to separate the fallers and the non-fallers. Discriminant function coefficients were used as a weight of each individual risk factor composed in the Thai-FRAT. The sensitivity and specificity and the receiver operating characteristic curve (ROC) of the developed FRAT were analyzed to determine the best cutoff score.

The second phase of the present study was conducted in order to validate the Thai-FRAT with the second set of population. The authors used the existing data of cohort study named "Cohort study of problems, their risk factors and determinants of good health among the elderly living in Romklao community, Ladkrabang district, Bangkok" (CERB)[14,15]. The CERB study, started in 1997, was conducted in a population aged 50 years and above living in the Romklao area of Ladkrabang district, Bangkok, Thailand. The CERB project was mainly aimed at determining factors for healthy ageing among the Thai elderly. The total numbers of the population aged 50 and above during the time of the first survey in 1997 was 1,311. Only 1,166 subjects were permanent residents and eligible for this cohort study. After informing them about the purpose of the CERB project, 941 agreed to participate in the project. Of 941, 451 were the elderly aged 60 years and over. These 451 elderly subjects were interviewed and various kinds of data were collected including personal history, social network, physical activity, nutrition, activity of daily living, mental test, body mass index, physical ability test, visual acuity, hearing acuity, and laboratory tests, etc. Assessed items of the Thai-FRAT were available in the collected data and could be used for the second phase study. These elderly subjects were followed and re-visited in 1999 and 2002. In 1999- and 2002-follow up (FU) survey, various data including history of falls during the past six months were collected. Seventy-nine and 96 elderly had died or migrated during the 1997-1999 cohort and 1997-2002 cohort respectively.

Because the authors wanted to develop the test that could be used practically in community service setting, the authors simulated a situation that only the elderly who came to consult or were found with a history of falls during the past six months were

assessed by the Thai-FRAT. Therefore, only 156 elderly subjects with a history of fall (one or more times) were recruited in the analysis. The authors found that 19 and 21 elderly had died or migrated to live in other areas in the 1999- and 2002-follow up surveys respectively. Thus, only 137 and 116 elderly subjects were enrolled in 1997-1999 and 1997-2002 cohort analysis respectively. Validity of the Thai-FRAT was tested by its ability to predict recurrent falls found in the 1999- and 2002-FU surveys among subjects with a history of one or more falls during the past six months found in the 1997 survey. However, the authors also examined the value of the Thai-FRAT for screening in all community-dwelling elderly population by applying the Thai-FRAT with all 451 elderly subjects.

The authors also tested concurrent validity of the Thai-FRAT by examining association between Thai-FRAT-positive result (high-risk cases) in 1997-survey and mortality of the elderly during 1997-1999 and 1999-2002.

Apart from descriptive statistical analysis, sensitivity and specificity of the Thai-FRAT at the cutoff score for classifying the fallers were computed. To analyze the difference between two groups, Chi-square test, Fisher exact test, and un-paired student t-test were used wherever they were appropriate. The p-value < 0.05 (Alpha error < 5%) was determined as statistical significance.

Results

Phase 1 study

Twenty-eight studies including two Thai studies were used in the review process[1,7,8,16-40]. From 28 reports, 11 risk factors of falls were listed and sent to be validated by the experts. These risk factors were advanced age, female sex, visual impairment, cognitive impairment, gait and balance impairment, mobility impairment, chronic disease, medication use, physical activity, history of falls, and environment hazard. The experts had common agreement on ten risk factors except gait impairment and physical activity. Therefore, ten risk factors were then used in the first phase community study.

In the first phase community study, 270 Thai elderly were visited and collected screening data including falls during the past six months. Thirty-six elderly had a history of falls at least two times during the past six months and were classified as "the Fallers". Then 108 elderly were randomly selected by using a table of random numbers and were classified as "the non-fallers". Demographic characteristics of the fallers and the non-fallers are presented in Table 1.

Of 10 risk factors, nine univariate factors were identified. Only "age" was not a significant factor of falls. (Table 2) These nine factors were then put in the stepwise logistic regression analysis. There were five risk factors in the logistic regression model i.e. "4.25

Table 1. Characteristics of subjects recruited in the first phase study

	Total	Fallers	Non-fallers
Number	144	36	108
Mean age in years (SD)	71 (7.7)	74.6 (8.1)	68.8 (7.3)
Female: number (%)	82 (56.9)	29 (80.1)	53 (49.1)
Marital status: number (%)			
Single/widow/divorce	63 (43.7)	21 (58.3)	42 (38.9)*
Married	81 (56.3)	15 (41.7)	66 (61.1)
Literacy: number (%)			
Illiterate	19 (13.2)	10 (27.8)	9 (8.3)**
Literate	125 (86.8)	26 (72.2)	99 (91.7)
Working status			
Had a job	40 (27.8)	7 (19.4)	33 (30.6)
Housework	35 (24.3)	9 (25)	26 (24.1)
No responsible work	69 (47.9)	20 (55.6)	49 (45.4)
Financial problems			
Always or sometimes	44 (30.6)	17 (47.2)	27 (25)*
Occasional or none	100 (69.4)	19 (52.8)	81 (75)

* p-value < 0.05
** p-value < 0.005

Table 2. Odds ratio and 95% confident interval of fall-related factors in Thai community-dwelling elderly (the first phase of this study)

Factors	Fallers Number (%)	Non-fallers Number (%)	Odds ratio	95% CI
Age				
70+ years	22 (61.1)	46 (42.6)	2.12	0.92-4.92
60-69 years	14 (38.9)	62 (57.4)		
Sex				
Female	29 (80.6)	53 (49.1)	4.30	1.62-11.85
Male	7 (19.4)	55 (50.9)		
Visual impairment				
Yes	33 (91.7)	51 (47.2)	12.29	3.32-53.67
No	3 (8.3)	57 (52.8)		
Cognitive impairment				
Yes	10 (27.8)	3 (2.8)	13.46	3.09-67.06
No	26 (72.2)	105 (97.2)		
Balance impairment				
Yes	29 (80.6)	20 (18.5)	18.23	6.44-53.73
No	7 (19.4)	88 (81.5)		
Mobility impairment				
Yes	22 (61.1)	15 (13.9)	9.74	3.79-25.52
No	14 (38.9)	93 (86.1)		
Chronic disease				
Yes	20 (55.6)	35 (32.4)	2.61	1.13-6.06
No	16 (44.4)	73 (67.6)		
Medication use				
Yes	30 (83.3)	38 (35.2)	9.21	3.27-27.24
No	6 (16.7)	70 (64.8)		
History of falls				
Yes	18 (50.0)	1 (0.9)	107.00	13.49-2285.33
No	18 (50.0)	107 (99.1)		
Thai style house				
Yes	25 (69.4)	38 (35.2)	4.19	1.74-10.24
No	11 (30.6)	70 (64.8)		

(History of falls) + 2.68 (Female) + 2.31 (Impaired visual acuity) + 1.68 (Thai style house) + 1.61 (Impaired body balance) + 1.58 (Specific medication use) - 1.42". These five risk factors were used in the discriminant analysis by using falls as dependent variable. The discriminant model was "2.39 (History of falls) + 0.94 (Impaired body balance) + 0.58 (Female) + 0.53 (Specific medication use) + 0.42 (Impaired visual acuity) + 0.36 (Thai style house) - 1.42". The Thai-FRAT was then constructed using discriminant function coefficient as a weight of each individual risk factor (Appendix). Possible score of the Thai-FRAT ranged from 0-11. The best cutoff score identified by the receiver operating curve analysis was 4 (score of 4 and over means "high risk to falls") (Fig. 1). At this cutoff score, sensitivity, specificity, and positive predictive value were 0.92, 0.83, and 0.65 respectively.

Phase 2 study

In the 1997 survey, 156 elderly had a history of fall in the past six months. Their characteristics are shown in Table 3. However, only 115 and 89 subjects were re-interviewed in the 1999- and 2002-FU surveys. Thus, 115 and 89 subjects were recruited for analysis of 1997-1999 and 1997-2002 cohorts. Characteristics of subjects in 1997-1999 and 1997-2002 cohorts, of which were collected in 1997-survey, are shown in Table 3.

Subjects with high risk identified by Thai-FRAT score of 4 or more were more likely to have recurrent falls in 1999-FU survey but not in 2002-FU survey compared with the low risk group (Thai-FRAT score less than 4). Their ROC curves are shown in Fig. 2. Sensitivity, specificity, positive predictive values, and likelihood ratios of the Thai FRAT to

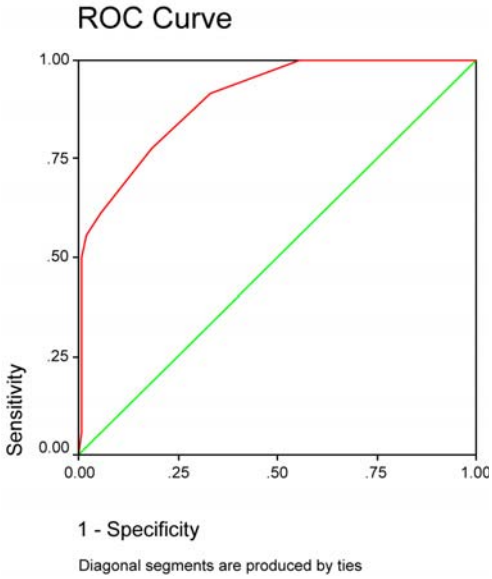


Fig. 1 The receiver operating curve of the FRAT in the first phase study

predict re-current fall in 1999 and 2002 were 0.52, 0.78, and 2.34; and 0.29, 0.76, and 1.21, respectively.

When using the Thai-FRAT as a screening tool by applying it with all elderly subjects, the authors found that sensitivity, specificity, positive predictive values, and likelihood ratios to predict re-current fall in 1999 and 2002 were 0.28, 0.93, and 4; and 0.14, 0.92, and 0.17 respectively.

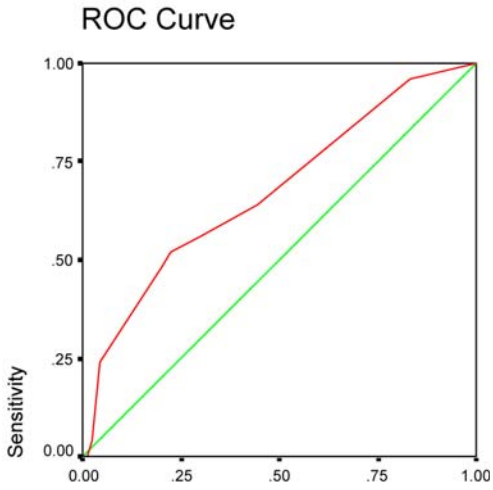
Concurrent validity of the Thai-FRAT was demonstrated by an association between risk of falls in 1997-survey and mortality both during 1997-1999 cohort ($p < 0.001$) and 1997-2002 cohort ($p = 0.7$) (Table 4).

Discussion

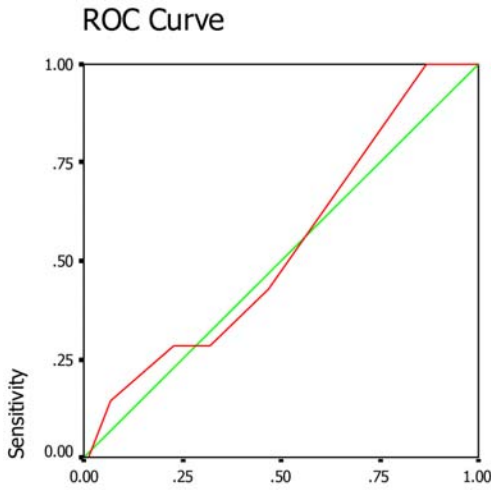
The aim of the present study was to develop an assessment test for identification of the elderly with high risk to have falls in the near future i.e. one year. The new test was intended to be applied with community-dwelling elderly in Thailand who have had a history of falls within the past six months. Generally, these elderly might be either referred / self-referred to health care providers or were found by the community network. They would be assessed by health care personnel using the Thai-FRAT to determine the high risk group. The elderly at high-risk would be appropriately referred into a fall prevention program. However, at this moment there is no specific guideline or structured programs for the prevention of fall incidence in Thailand. The fall risk evaluation tool, as presented here, involves the first step in developing an effective fall preventive program/intervention including randomized controlled trials. A valid and reliable measure of fall risk could also be used as an outcome measure for interventions designed for reduce individual's risk of falls[41].

Table 3. Characteristics collected in the 1997 survey of subjects who had history of fall (one or more time during the past 6 month) and subjects who were remained in the 1997-1999 cohort and 1997-2002 cohort (the second phase study)

	1997 survey	1997-1999 cohort	1999-2002 cohort
Number (% in each survey)	156	115	89
Mean age in years (SD)	67.9 (7.4)	69.2 (6.8)	71.8 (6.9)
Female: number (%)	122 (78.2)	92 (80)	75 (84.3)
Marital status: number (%)			
Single/widow/divorce	90 (57.7)	61 (53)	46 (51.7)
Married	66 (42.3)	54 (47)	43 (48.3)
Literacy: number (%)			
Illiterate	40 (25.6)	21 (18.3)	17 (19.1)
Literate	116 (74.4)	94 (81.7)	72 (80.9)
Working status			
Had a job	42 (26.9)	25 (21.7)	13 (14.6)
Housework	18 (11.5)	20 (17.4)	-
No responsible work	96 (61.5)	70 (60.9)	76 (85.4)
Financial problems			
Always or sometimes	20 (12.8)	19 (16.5)	15 (16.9)
Occasional or no	136 (87.2)	96 (83.5)	74 (83.1)



Apply the Thai-FRAT with 1997 data to predict the recurrent fall in the 1999-FU survey



Apply the Thai-FRAT with 1997 data to predict the recurrent fall in the 2002-FU survey

Fig. 2 The receiver operating curve of the Thai-FRAT in the second phase study

Table 4. Association between risks of falls in 1997-survey and mortality during 1997-1999 and 1997-2002 cohorts (the second phase study)

1997 survey subjects	1999-FU survey		2002-FU survey	
	Alive	Died during 1997-1999	Alive	Died during 1999-2002
FRAT = 4+	40 (75.5)	13 (24.5)	29 (93.5)	2 (6.5)
FRAT < 4	370 (93.0)	28 (7.0)	294 (94.2)	18 (5.8)
Total	410 (90.9)	41 (9.1)	323 (94.2)	20 (5.8)

* Chi-square test
1997-1999 follow up; p-value < 0.001
1997-2002 follow up; p-value = 0.7

Ten factors were primarily considered as possible predictors of fall risk, based on literature review and experts' opinion. However, only five predicting factors were independently related to fall risk. These significant factors were a history of two or more falls within the past six months, impaired body balance (unable to take full tandem for ten seconds), gender (female), specific medication use (take at least one of these medications: sedatives/hypnotics, psychotropic drugs, antihypertensive agents, diuretics or take four or more any other medications), impaired visual acuity (unable to read more than half of the letters in 6/12 line of a Snellen chart) and living in a Thai style house. The present results did not show that age was predictive of fall risk in Thai community-dwelling older persons, which supported the finding of a former study[1]. Moreover, the present study also found that Thai-style house which has high – steep stairs was a predicting factor of fall and confirmed an importance of environment as risk factor of falls among Thai elderly living in community[1]. This finding supported the authors' belief that falls risk assessment tool developed in western

societies may not be fully applied with the elderly in developing countries or different cultures.

In the first phase of the present study sensitivity and specificity of the Thai-FRAT was high (0.92 and 0.83 respectively). Although the specificity found in the second phase was still high (0.78 in 1997-1999 cohort and 0.76 in 1997-2002 cohort), the sensitivity was rather low (0.52 in 1997-1999 cohort and 0.29 in 1997-2002 cohort). The low sensitivity might be a result of cohort effect, in which subjects with high risk (Thai-FRAT score of 4 and over) died more than those with low risk significantly (Table 4). Moreover, Thai-FRAT was designed to predict recurrent fall within six months to one-year period. Hence, the authors were not surprised to find that the sensitivity in the 1997-2002 cohort further declined compared with the 1997-1999 cohort.

The second phase of the present study showed an association between risk of falls (Thai-FRAT score of 4+) and mortality. This finding confirmed the validity of this tool in term of concurrent validity. The authors recommend that the Thai-FRAT could be used for identifying older persons with high risk to fall in general practice in both community services and outpatient clinics. The Thai-FRAT could also be used in research particularly a preventive program research.

Conclusion

The Thai-FRAT is the first fall risk assessment tool developed for Thai community-dwelling elderly. Its sensitivity and specificity is 0.92 and 0.83 respectively. It is a valid and reliable measure of fall risk. An effect of environment on falls among Thai older persons was clarified in the present study.

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Appendix. Thai falls risk assessment test

Risk factors	Detail of assessment	Score
1. Female sex	-	1
2. Visual impairment	Unable to read more than half of the letters in 6/12 line of a Snellen chart	1
3. Balance impairment	Unable to take full tandem for ten seconds	2
4. Medication use	Take at least one of these medications - Sedatives / hypnotics - Psychotropic drugs - Antihypertensive drugs - Diuretics or Take four of any other medications	1
5. History of falls	Fell 2 or more times during the past 6 months	5
6. Housing style	Thai style house (The first floor is 1.5 meter or higher from ground with a traditional Thai stair style)	1
	Total score	11

เครื่องมือประเมินความเสี่ยงต่อการหกล้มสำหรับผู้สูงอายุไทยในชุมชน

ปัจจัยเสี่ยง	วิธีการประเมิน	คะแนน
1. เพศหญิง	-	1
2. การมองเห็นบกพร่อง	ไม่สามารถอ่านตัวเลขที่ระยะ 6/12 ของ Snellen chart ได้เกินครึ่ง	1
3. การทรงตัวบกพร่อง	ยืนต่อเท้าในแนวเส้นตรงไม่ได้ หรือยืนได้ไม่ถึง 10 วินาที	2
4. มีการใช้ยา	กินยาต่อไปนี้ตั้งแต่ 1 ชนิดขึ้นไป ยานอนหลับ ยากล่อมประสาท ยาลดความดันโลหิต ยาขับปัสสาวะ หรือ กินยาชนิดใดก็ได้ตั้งแต่ 4 ชนิดขึ้นไป	1
5. มีประวัติหกล้ม	หกล้มตั้งแต่ 2 ครั้งขึ้นไปในหกเดือนที่ผ่านมา	5
6. อาศัยอยู่ในบ้านแบบไทย	บ้านยกพื้นสูงตั้งแต่ 1.5 เมตรขึ้นไป	1
คะแนนรวม		11
คะแนนรวม 4-11 เสี่ยงต่อการหกล้ม		

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ลัดดา (เถียมวงศ์) เพชรประสมกูล, จิตติมา ทมาภิรัต, วันทนา มณีศรีวงศ์กุล, สุทธิชัย จิตะพันธ์กุล

วัตถุประสงค์: *เพื่อพัฒนาเครื่องมือประเมินความเสี่ยงต่อการหกล้มที่เหมาะสมกับผู้สูงอายุไทยในชุมชน*
วัสดุและวิธีการ: *เป็นการศึกษาภาคตัดขวางในกลุ่มประชากรผู้สูงอายุ 270 คนที่อาศัยในตำบลบ้านสร้าง จังหวัดพระนครศรีอยุธยาเพื่อค้นหากลุ่มปัจจัยเสี่ยงที่สามารถทำนายการหกล้มและพัฒนาขึ้นเป็นเครื่องมือประเมินความเสี่ยงต่อการหกล้ม (Thai-FRAT) และทำการตรวจสอบคุณภาพของเครื่องมือนี้กับกลุ่มประชากรผู้สูงอายุจำนวน 156 คนที่ได้รับการเก็บข้อมูลระยะยาวระหว่างปี พ.ศ. 2540 - พ.ศ. 2545 ในการศึกษาที่มีชื่อว่าโครงการ CERB*
ผลการศึกษา: *เครื่องมือประเมินความเสี่ยงต่อการหกล้มที่พัฒนาขึ้นมาใหม่นี้ (Thai-FRAT) ประกอบด้วย 6 ปัจจัย ได้แก่ ประวัติการหกล้ม การทรงตัวบกพร่อง เพศหญิง การใช้ยาบางประเภท การมองเห็นบกพร่อง และการอาศัยอยู่ในบ้านทรงไทย โดยคะแนนอยู่ในช่วง 0 ถึง 11 คะแนน และจุดตัดที่ดีที่สุดมีคะแนนเท่ากับ 4 โดยมีค่าความไวและความจำเพาะเท่ากับ 0.92 และ 0.83 ตามลำดับ ในการทดสอบคุณภาพของเครื่องมือกับประชากรพบว่าเครื่องมือนี้สามารถทำนายการหกล้มที่เกิดขึ้นภายในหกเดือนหลังจากการติดตามกลุ่มตัวอย่างไปเป็นเวลาสองปี นอกจากนั้นยังพบความสัมพันธ์ระหว่างคะแนนของเครื่องมือ Thai-FRAT กับการเสียชีวิต*
สรุป: *เครื่องมือประเมินความเสี่ยงต่อการหกล้ม (Thai-FRAT) เป็นเครื่องมือแรกที่พัฒนาขึ้นเพื่อใช้กับผู้สูงอายุไทยในชุมชน โดยมีความตรงและความน่าเชื่อถือในการประเมินความเสี่ยงต่อการหกล้ม การศึกษานี้ยังพบว่าสิ่งแวดล้อมมีผลต่อการหกล้มในผู้สูงอายุไทยอีกด้วย*